EFFECTIVENESS OF RESEARCH AND EXPERIMENTATION TAX CREDITS: CRITICAL LITERATURE REVIEW AND RESEARCH DESIGN

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I. Introduction.

The incremental R&E tax credit has now been in place in the United States for 15 years, but it has never become a permanent part of the tax code. Similar credits are also in place in at least 10 developed and developing countries. Although several surveys of the effectiveness of the R&E tax credit have been done over its lifetime, they are now somewhat dated or less than comprehensive.[1] This report is intended to fill this gap.

The tax treatment of R&D in the United States and 21 other countries is summarized. This is followed by a comprehensive critical review of studies of the effectiveness of the R&E tax credit, both here and abroad. The report concludes with a summary of what we have learned and some suggested avenues for future research.

This review does not attempt to argue the case for the R&E tax credit, as this has been done extensively by many authors in the past.[2] I take the desirability of some kind of special tax treatment for R&D as given. The emphasis here is on the evaluation of the effectiveness of our current policy,

[1] See, for example, McFetridge and Warda (1983), Brown (1985), Cordes (1989), Penner, Smith, and Skanderson (1994), Harhoff (1994), Warda (1994), and Dumagan (1995).

[2] See, for example, Hall (1993), Baily and Lawrence (1987), Bozeman and Link (1984), Collins (1982, especially Mansfield and Nadiri in that volume), Penner, Smith, and Skanderson (1994) among authors that explicitly discuss the tax credit as a policy tool.

and on ways we might improve it.

II. History of R&D Tax Credits.

As organized industrial innovation as become an increasingly important business strategy in today's global marketplace, many countries have examined their R&D performance and found it lacking for one reason or another. This has led to the introduction of a variety of tax incentives to encourage firms to undertake R&D investment in many countries during the past 20 years or so. This section of the report surveys those incentives, beginning with a fairly detailed account of the United States, followed by a more cursory look at other countries.

II.1 U.S. Law.

The R&E tax credit as it has been implemented during the past 15 years is a good example of a how even a simple public policy idea that has bipartisan support can emerge from Congress both greatly complicated and weakened in its effects.[3] In the case of the tax credit, the major problems are twofold: first, the need for tax revenue caused it to be diluted in an attempt to focus the effects on the marginal R&D dollar, and second, poor design, indecision and lack of agreement on the part of legislators has led to repeated tinkering with and temporary extension of the credit from year to year, rather than a permanent credit that would last at least as long as the typical planning horizon for R&D investment.

[3]Parts of this section are drawn from Hall (1993), updated to reflect changes in the law since that paper was written.

A brief summary of the history of R&D tax policy in the United States during the 1980s follows. This policy has had three ingredients: (1) the expensing rules for Research and Development in general (section 174), which have remained essentially unchanged since they were instituted in 1954; (2) the R&E tax credit; and (3) the foreign source income allocation rules for R&D, which were changed repeatedly during the 1980s. The first of these policies can be summarized briefly as allowing the expensing of most R&D expenditures against corporate income for tax purposes.[4] The reduction of the corporate tax rate during the 1980s had a substantial impact on the cost of an R&D dollar, because it reduced the benefit of expensing (relative to other types of capital investment) by the fall in the tax rate (a reduction of 0.12 for firms with taxable income, possibly more if they face the alternative minimum tax of 20 percent). Note that if a firm undertaking R&D investment faces the same corporate tax rate in all periods, the corporate tax rate is irrelevant to that investment, because the firm spends after-tax dollars on the investment and

[4]Treasury regulations (sec. 1.174-2(a)) define research or experimental expenditures to mean "research and development costs in the experimental or laboratory sense." This generally includes "all such cots incident to the development of an experimental or pilot model, a plant process, a product, a formula, an invention, or similar property, and the improvement of already existing property of the type mentioned," and excludes expenditures "such as those for the ordinary testing or inspection of materials or products for quality control or those for efficiency surveys, management studies, consumer surveys, advertising, or promotions."

receives after-tax dollars as income. However, if the tax rate is changing for one reason or another, or the firm is moving in and out of taxable status, the changes in rate will begin to affect the cost of R&D capital faced by the firm (Fullerton and Lyon, 1988; Hall, 1991).

The R&E tax credit was introduced in the Economic Recovery Tax Act of 1981; it was originally scheduled to be effective from July 1, 1981, to December 31, 1985. The credit was renewed for two years (January 1, 1986, to December 31, 1988) in a somewhat reduced form by the Tax Reform Act of 1986, and extended for one year through 1989 by the Technical and Miscellaneous Revenue Act of 1988.[5] The Omnibus Budget Reconciliation Act of 1989 effectively extended the credit through 1990, and The Omnibus Budget Reconciliation Act of 1990 did the same for 1991. The Tax Extension Act of 1991 extended the credit through June 30, 1992. The Omnibus Budget Reconciliation Act of 1993 extended the research tax credit for three years to June 30, 1995. Most of these pieces of legislation also made changes to the terms of the credit.[6]

In all cases, the R&E tax credit is computed by taking qualified R&D expenditures that exceed

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[5]Another feature of the Tax Reform Act of 1986 that affected R&D incentives was the strengthening of the alternative minimum tax (AMT) system for corporations. If a firm is subject to AMT, it cannot claim the R&D tax credit in the current year, but must carry it forward (for up to fifteen years) until it is subject to regular corporate tax. Also, the rate of taxation under AMT is 20% rather than the statutory corporate rate of 34%. As Lyon (1991) has discussed, this means that firms that are temporarily subject to the AMT will face tax incentives that are slightly tilted away from investment in intangibles toward tangibles, relative to what they would face under ordinary corporate taxation. In practice, only a small number of large manufacturing firms in 1988 filed AMT returns, accounting for only 3 percent of the total tax bill paid by manufacturing firms (Statistics on Income 1988), so this is unlikely to be important. However, the reduction in the implicit subsidy to R&D that the AMT creates is likely to be more important in recession years, when corporate profits are down. This may account for some of the reduced nominal R&D spending that we observed in 1990 and 1991.

[6] From the perspective of a researcher on this topic, one of the most important changes occurred in 1986, when the Tax Reform Act rolled the R&D tax credit into the General Business Credit and subjected it to the General Business Credit limitations. This both makes it more difficult to calculate the effective credit rate from public data, and simultaneously removed the R&D tax credit as a separate line item in the Statistics on Income. It is still shown in one of the tables for the whole corporate sector, but we no longer have the industrial detail that was available through 1985.

a certain base level, multiplying by the statutory credit rate, and deducting this amount from corporate income taxes. There is a three-year carryback and fifteen-year carryforward in the case of no taxable income in the current year. After 1989, the credit also reduces the R&D expenditure available for deduction from current income under the old section 174 rules. A summary of the changes in the credit rate, qualified expenditure rules, base levels, and corporate income tax rates during the past 15 years is shown in Table 1.

The consequences of the third feature of R&D tax policy (foreign source income allocation rules) for the R&D performance of U.S. multinationals have been studied thoroughly by Hines (1992, 1994a, 1994b) and will be covered only briefly here. Basically, the problem is one of allocation of fixed costs across income sources. U.S. tax policy is to tax firms on worldwide income, but to allow credits against that tax for taxes paid to foreign governments (Dept. of Treasury, 1983, Hines, 1992). These credits are limited by the U.S. tax, which would be due on the foreign source income. Thus, the allocation of income, and therefore costs, across jurisdictions matters to firms with excess foreign tax credits. If they already have foreign tax credits they cannot use, allocating more R&D to foreign source income does not reduce their tax liability and will only increase their taxable U.S. income.[7] This is somewhat mitigated by the fact that they are allowed to carry back and carry forward these excess credits.

In 1977, Treasury regulation section 1.861-8 specified the rules by which R&D expenditure should be allocated between foreign and domestic source income: these rules specified that all government mandated R&D (R&D for safety purposes, etc.) plus 30 percent of the remainder can be exclusively allocated to U.S. sales. The 70 percent remaining must be apportioned between domestic and foreign sales using either sales or income as the method of apportionment. The allocations must be done on the basic of product lines (two-digit level). Because of concern on the part of the president and Congress that this method of allocation disadvantages U.S. corporations competing

[7]This is because most foreign governments do not allow the expensing of R&D performed in the United States, and, therefore, the R&D allocated to foreign source income does not reduce the foreign tax liability (Hines, 1992; U.S. Dept. of Treasury, 1983).

internationally, regulation 1.861-8 was suspended by Section 223(b) of the Economic Recovery Tax Act of 1981; ERTA allowed all R&D expenditure to be allocated against income earned within the United States. The allocation rules have been reviewed and revised continuously since then; a summary of the changes is shown in the last column of Table 1.

Hines (1993) discusses the implication of these allocation rules for the incentives that multinational firms face to undertake R&D directed at domestic and foreign markets. As a general matter, he finds that the allocation rules tend to make R&D directed toward increasing domestic sales a relatively more expensive input than other ordinary inputs, but that R&D directed toward increasing foreign sales (but conducted in the United States) is substantially less expensive for firms with excess foreign tax credits. This latter fact is due to the relatively light royalty rates that foreign governments impose on royalties (which are the income that results from use of the R&D) paid to the United States. He studies 116 multinational corporations between 1987 and 1989, and finds that only 21 are in a deficit foreign tax credit situation. The average tax price for R&D directed toward domestic sales is 5 percent higher than that for other (noncapital) inputs, and the average tax price for R&D directed toward foreign sales is 15 percent lower, for an overall wedge of 20 percent.

II.2 Comparison to Other Developed Countries.

The tax treatment of R&D in other countries tends to be similar to that in the United States, with the exception of the incremental R&D tax credit. This particular feature of the tax code is only used by a few countries, and varies considerably across countries when it is used. However, the users include some of the most R&D-intensive countries in the world, as well as several laggards. Tables 2A and 2B summarize the tax treatment of R&D around the world. The contents of these tables are drawn from several sources: Asmussen and Berriot (1993), Australian Bureau of Industry Economics (1993), Bell (1995), Griffith, Sandler and Van Reenen (1995), Harhoff (1994), Hiramatsu (1995), Leyden and Link (1993). McFetridge and Warda (1983), Seyvet (1995), and Warda (1994). An effort has been made to ensure that the description is accurate as of early 1995, but these laws have changed frequently and some of these incentives may no longer be in place.

The second column of the table attempts to give the definition of R&D that is used for the purpose of the tax credit, which is often somewhat more restrictive than the Frascati manual (OECD 1980) definition, but not always. The next two columns give the rates at which non-capital R&D and capital R&D are depreciated for tax purposes. 100 percent means that the quantity is expensed. In most cases it is also possible to elect to amortize R&D expenditure over 5 years. This might conceivably be an attractive option if operating loss carryforwards are not available (to use the R&D expense as a deduction even if no current tax is owed), but in most cases tax losses can be carried forward and back (see column 7).

Given that R&D capital expenditure is typically only 10-13% of business R&D, and that the business R&D-GDP ratio is typically 1-2% (OECD 1994), a remarkable amount of time has been spent in many of these countries tinkering with the expensing and depreciation rules for capital equipment used in R&D activities. Although almost all countries (saving the UK) treat it somewhat like ordinary investment, many have used complex speeded-up depreciation schemes at one time or another to give a boost to a R&D capital equipment investment. Frequently the depreciation involved is also subject to the R&D tax credit. Normally buildings or plant for use by an R&D laboratory do not participate in these schemes.

Columns 5 and 6 characterize the tax credit, if there is one. The rate and the base above which the rate applies are shown; when the base is zero, the credit is not incremental, but applies to all qualifying R&D expense. At the present time, it appears that only France, Japan, Korea, and the United States have a true incremental R&D tax credit, and they each use a slightly different formula for the base.[8] Column 8 shows that many countries also have provisions that specially favor R&D in small and medium-sized companies. In France, for example, this takes the form of a ceiling on the credit allowed that is equal to 40 million francs in 1991-1993 (approximately $6.7M). The effect is to tilt the credit toward smaller firms, whereas R&D subsidies in France go to large firms to a great extend (Seyvet 1995). An exception to this rule is Australia, which has a *minimum* size of research program to which the tax preference of 150% expensing applies: $20,000. This seems to be related more to the administrative cost of handling the R&D tax concession than to any policy decision

[8]The credit in Spain is a credit on capitalized R&D (R&D that is to be amortized over 5 years) rather than on the flow.

(Bell 1995, Australian Bureau of Industry Economics 1993).

The next two columns give any differences in tax treatment that apply to R&D done abroad by domestic firms or R&D done in the country by foreign-owned firms. For the first, typically any special incentives (beyond 100% deductibility) will not apply, except that up to 10% of the project cost for Australian-owned firms can be incurred outside Australia. For the second, it is frequently difficult to tell from the summarized tax regulations. In Korea and Australia, foreign firms do not participate in any of the incentive programs. In the United States and Canada, they are treated like domestic firms, except that they do not receive an R&D grant in Canada when their tax liability is negative.

The final column tells whether the incremental tax credit is treated as taxable income, that is, whether the expensing deduction for R&D is reduced by the amount of the tax credit. Whether or not this is true typically has a major effect on the marginal incentive faced by a tax-paying firm.

III. Effectiveness of the R&D Tax Credit.

There are two approaches to evaluating the effectiveness of any tax policy designed to correct the insufficient supply of a quasi-public good. The first asks whether the level of the good supplied after the implementation of the policy is such that the social return is equal to the social cost. In this situation, that would involve comparing the marginal return to industrial R&D dollars at the societal level to the opportunity cost of using the extra tax dollars in another way, for example, in deficit reduction. This is a very tall order, and policy evaluation of the tax credit usually falls back on the second method, which is to compare the amount of incremental industrial R&D to the loss in tax revenue. The implicit assumption in this method is that the size of the subsidy has been determined and that the only question to be answered is whether it is best administered as a tax credit or a direct subsidy. Obviously, this kind of benefit-cost ratio is only very loosely connected with the magnitude of the gap between the social and private returns to R&D, if at all. It might be that the social return from additional industrial research is very high. If it is very, very high one may be willing to give up more tax dollars than the actual research induced by the tax subsidy. On the contrary, if the social return is only slightly higher than the private return, lowering the cost of research might cause the firm to do too much. In this case, even though the tax credit induces more industrial R&D than the lost tax revenue, it would not be a good idea, because one could have spent that tax revenue on some other activity which had a higher social return. Fortunately, the available evidence on the social return to R&D suggests that the first case is more likely than the second.[9]

Most evaluations of the effectiveness of the R&D tax credit have been conducted using the second method, that is, as benefit-cost analyses. This part of the report critically reviews the methodology underlying these evaluations and surveys the resulting evidence, including the small number of studies that have been conducted using data from outside the United States.

III.1 Methodological Review

[9]See, for example, Griliches (1992), Mansfield (1965), and Bernstein and Nadiri (1988, 1989).

Because it is likely that the social return to industrial R&D in the United States exceeds the social cost at the current level of tax subsidy, a focus on the second and more easily answered question, whether this level of subsidy is more efficiently achieved with a tax credit or direct government grants, does not seem misplaced. Most of the studies reviewed here have taken this approach. There are two ingredients to the computation: computing the benefits involves estimating the amount of R&D induced by the tax credit, and computing the costs requires estimating how much tax revenue is lost due to the presence of the credit. The ratio of these two quantities is the benefit-cost ratio; if it is greater than one, the tax credit is a more cost-effective way to achieve the given level of R&D subsidy; if it is less than one, it would be cheaper to simply fund the R&D directly.[10]

Conceptually, measuring the amount of R&D induced by a tax credit is a *ceteris paribus* exercise, in which we attempt to ask the question: "How much more R&D did firms do given the existence of a tax credit than they *would have done if there had been no credit?"* The counterfactual is never observed, and researchers fall back on a variety of methods to try to estimate the level of

[10]This argument presumes that funding R&D can be achieved without inducing the firms to use the funds to replace money they would have spent on industrial R&D, which is likely to be extremely difficult. If they are reluctant to spend the monies under the tax credit, the same firms are also likely to find it preferable to spend less themselves when given an R&D grant. Obviously this is not true if the government simply does the R&D itself, but many, including myself, doubt the ability of the government to efficiently administer an industrial R&D program.

R&D without the subsidy. These methods can be classified in the following way:

1) R&D demand equation with a shift parameter for the credit. Here one constructs as well as possible an equation that predicts the level of R&D investment as a function of past R&D, past output, expected demand, perhaps cash flow and price variables, and so forth. A dummy variable is included, equal to one when the credit is available and zero otherwise. The magnitude of the estimated coefficient of the dummy is equal to the amount of R&D induced by the presence of the credit. If this exercise is conducted using firm-level data, the best method is to measure the availability of the credit at the firm level, that is, taking account of the usability of the credit. If it is conducted at the macro-economic or industry level, the identification of the credit effect will come from the variation in R&D demand over time. (*Examples:* Eisner, Albert, and Sullivan 1983; Swenson 1992; Berger 1993; Baily and Lawrence 1992; McCutchen 1993). The advantage of this method is its relative simplicity; it eliminates the need to perform the relatively complex computations to determine the actual level of the tax credit subsidy for each firm. The disadvantage is that the measurement is relatively imprecise, because there is no guarantee that all firms are facing the same magnitude of credit at any given point in time. In addition, if the variation in the credit dummy is over time, it is very possible that other forces that increase aggregate industrial R&D spending (such as global economic conditions, trade, etc.) and are not included in the R&D equation may lead to a spurious conclusion about the effectiveness of the tax credit.

2) Price Elasticity Estimation. This method is similar to the previous, in that an R&D equation that controls for the non-tax determinants of R&D is estimated, but in this case a price variable that captures the marginal cost of R&D is included in the equation. The estimated response of R&D to this price variable is converted to an elasticity of R&D with respect to price. If the price variable includes the implicit subsidy given by the tax system to R&D, this is a direct measure of the response of R&D to its tax treatment (*Examples:* Baily and Lawrence 1992, Hall 1993, Hines 1993).

Even if the price variable does not contain a measure of the tax subsidy, it is possibly to use the measured elasticity of R&D with respect to price to infer the response induced by a tax reduction of a given size. For example, if we estimate a price elasticity of -0.5 and the effective marginal R&E tax credit is .05, or a 5 percent reduction in cost, then the estimated increase in R&E from the tax credit will be 2.5 percent (*Examples*: Collins 1983; GAO 1989; Mansfield 1986).

The advantage of this method is that it is well-grounded in economic theory and estimates the price response of R&D directly. Thus it will be somewhat more accurate than method (1). Using the tax price elasticity of R&D (the first variant) has a couple of disadvantages: First. because the firm benefits directly from the amount of R&D qualified to receive the tax credit, it is possible that it will relabel some expenses as R&D (legitimately or illegitimately) and the "true" induced R&D will therefore be an overestimate. Second, because the tax credit depends on a variety of firm characteristics, such as its operating loss position, whether it is subject to the Alternative Minimum Tax, how much foreign income it repatriates, and so forth, the R&D investment level and the tax price faced by the firm are simultaneously chosen, and ordinary regression methodology is inappropriate in this situation.[11] For this reason, some, including myself, have relied on instrumental variables to estimate the price elasticity, with the attendant loss of precision in estimation.

The second variant suffers from its own disadvantages: absent variations in tax treatment across firms and time, one is forced to use a constructed R&D price deflator as the price variable in an R&D demand equation. These deflators typically are a weighted average of R&D inputs, of which around half is the wages and salaries of technical personnel, and the other half is some kind of research materials and equipment index. The only real variation in this variable is over time. This is a very thin reed on which to rest the estimation of the price elasticity of R&D demand; the estimates will depend strongly on the other time-varying effects included in the model.

[11]This is because R&D spending and the tax price of R&D are jointly determined in any period by the actions of the firm and market, through their impact on both the cash flow and the tax position of the firm. For example, although a lower tax price might induce more R&D spending, ceteris paribus, more R&D spending may move the firm into an operating loss position, which will tend to increase the tax price. An effect like this would reduce the observed responsiveness of R&D to the tax credit, but the estimated elasticity will not be the true price elasticity, that is, it will not correspond to one that would prevail in an environment with a different structure to the tax credit.

3) Event Study. Event studies typically rely on the assumption that the event being studied (such as the introduction of a tax credit) is a surprise to the economic agents it affects. They are usually conducted using financial market data, although this is not necessary. The method involves comparing behavior before a surprise change in policy is announced with behavior after the announcement in order to deduce the effect of the policy change. In this instance, such a comparison can take the form of comparing the market value of R&D-oriented firms before and after the tax credit legislation was considered and passed, or of comparing R&D investment plans for the same time period before and after the legislation (An example of the former method is Berger 1993 and of the latter is Eisner, as reported in Collins 1983).

4) Interview. This method is like an event study, but it is retrospective. You simply ask the senior managers of industrial firms how their R&D spending has been affected by the introduction of an R&D tax credit (*Example:* Mansfield 1986).

The Cost of the Tax Credit

The second ingredient in doing a benefit-cost analysis of the tax credit is the computation of total cost. The total social cost consists of the net tax revenue loss due to the credit plus the costs of administering it, both to the firm and to the Internal Revenue Service. In practice, the cost computed has been simply the gross tax credit claimed. At best this has been done by simply adding up the credits claimed by the firms that use the credit (Mansfield 1986, Hall 1993), sometimes adding in the unused credits that have been used to offset prior-year liabilities (GAO 1989). Occasionally estimates have been produced relying only on representative or average firm behavior; this method is likely to produce erroneous results given the extreme heterogeneity in the data. Either way, this type of analysis ignores the fact that the existence and use of the R&D tax credit may have implications for the overall tax position of the firm, so that the net change in tax revenue because of the credit is not captured by simply adding up the credits. It is likely that these other effects are relatively small, but by no means certain.

The second omission in the conventional computation is the administrative cost of the tax credit. The GAO Study of 1989, updated in 1995 Testimony before the Subcommittee on Taxation and Internal Revenue Oversight, U.S. Senate Committee on Finance, makes it clear that these costs can be high, but offers no estimate of their magnitude. Difficulties arise in two areas: the definition of qualified R&E expenditures, which requires a distinction between routine and innovative research, and the performance of research by outside subcontractors, where the IRS appears to have taken the position that the tax credit should flow to the organization that will pay for the R&D "in the normal course of events,"[12] rather than to the organization that bears the risk of the investment. Stoffregen (1995) argues that these ambiguities in interpretation of the law also impose costs on the firms, in that they will be unsure whether the R&E they are undertaking will fall within the area delimited by the Internal Revenue Service regulations as legitimate qualified expenditures. The GAO reports that almost 80% of returns claiming R&D credits are audited with an average net IRS adjustment downward of about 20% of the credits claimed.[13]

III.2 United States - Effects of Changes 1981-1994.

Table 3 presents a summary of the results of the many studies of the United States R&E tax credit that have been performed since its inception in 1981.[14] In this table I report my attempt to

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[12]U.S. Government Brief filed September 3, 1993, in Fairchild Industries, Inc. v. United States, 30 Fed. Cl. 839, as quoted in Stoffregen (1995).

[13]GAO (1989) , Table 2.1.

[14]Excellent surveys already exist of this evidence, and thus I will not review these studies in detail here (See Collins (1983), Brown (1984), Baily and Lawrence (1987), Cordes (1989), Harhoff (1994), and Penner, Smith, and Skanderson (1994)). My focus is on a somewhat more

ascertain two standardized results from these quite disparate studies: the price elasticity of R&D (for a typical firm in the sample) and some kind of estimate of the benefit-cost ratio of the credit. In many cases, the data that would allow me to evaluate these numbers were not really complete in the paper, and I was forced to give nothing, or a rough approximation to the quantity desired.

critical review of the methodologies used, in an attempt to see where they might be improved, and on interpreting the many results to find a common consensus.

It is apparent from looking at the table is that the first wave of estimates (those using data through 1983) differ substantially from the second (those using data through 1988 and later) in two respects: 1) They tend to have lower or non-reported tax price elasticities of R&D; only the later study by McCutchen of large pharmaceutical firms is an exception, and the R&D equation in this study appears to be misspecified.[15] 2) They are typically not based on the publicly reported 10-K data maintained by Compustat, but on internal Treasury tax data, surveys and interviews, and, in one case, an early Compustat file. This makes it slightly difficult to ascertain whether the differences in results are because the response to the credit varied over time, or because the type of data used was substantially different.

Unfortunately, the only early study that used a large set of firms from Compustat (Eisner, Albert, and Sullivan 1983), contains an R&D equation that is not well-specified, and does not contain any variable to capture the effect of the tax credit.[16] Thus it is not possible to draw any conclusion about the incentive effect from the regressions published in this report. In order to investigate results using Compustat data in the earlier period, I have re-estimated the equations in Table 6 of Hall 1993 for the time period 1981-82 using ordinary least squares.[17] I find that the

[15]It is difficult to pull the elasticities out of the estimated coefficients in this paper because it appears that R&D intensity was regressed on the absolute size of the claimed tax credit, a specification that implies a very large effect at the high end of the size distribution. McCutchen also presents results using a dummy variable specification, and these seem to indicate a very large, not quite believable, increase of 19% in R&D spending in 1982-1985 over the 1975-1980 period that is attributed to the tax credit. With a marginal effective tax credit of about 5%, this would imply a tax price elasticity of about 4, which seems too high. I suspect that other factors not taken into account also pushed up spending in this industry during the 1980s, and the tax credit variable is being given credit for them.

[16]The equation is specified in levels rather than logarithms, which means the disturbances are very heteroskedastic (so the standard errors are wrong), and there is good reason to think that the right hand side variables are not orthogonal to the disturbance, because they include sales and net income during the year that the R&D spending decision is made. Instrumental variable estimates would have been appropriate in this case.

[17]My sample consisted of about 792 manufacturing firms that had good R&D, sales, and other data on Compustat during the 1980-1982 period, whether or not they claimed a tax credit. It is likely that there is very considerable overlap with the Eisner et al sample of 592 firms, but

estimated tax price elasticity for this earlier period using Compustat data is slightly lower than that using the entire 1980s, but still very significant. In either levels or growth rates, it is approximately -0.6 instead of the -0.85 that I obtain for the whole period. If we multiply this elasticity times the weighted average effective credit rates for 1981 and 1982 shown in Table 3 of Hall 1993, we obtain projected increases in R&D spending during these two years of 2.1 and 2.3 percent respectively; consistent with the relatively low increases reported by Eisner and Mansfield using survey data that covered the same period.

As indicated above, later work using firm-level data all reaches the same conclusion: the tax price elasticity of total R&D spending during the 1980s is on the order of unity, maybe higher. This result was obtained by Berger (1993) using a balanced Compustat panel, Hall 1993) using an unbalanced Compustat panel, Hines (1993) using a balanced Compustat panel of multinationals, and a tax price derived from the foreign income allocation rules for R&D rather than the credit, and by Baily and Lawrence (1987, 1992) using aggregate 2-digit level industry data. All of these researchers specified an R&D demand equation that contained lagged R&D, current and lagged output, and occasionally other variables such as cash flow. Hall and Hines used instrumental variable techniques to correct for simultaneity in the equation.

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there is no way of verifying this at the current time.

Thus I do not think there is any doubt about the story that the firm-level publicly-reported R&D data tell: the R&E tax credit produces a dollar-for-dollar increase in *reported* R&D spending on the margin. However, it took some time in the early years of the credit for firms to adjust to its presence, so the elasticity was somewhat lower during that period.[18] Coupled with the weak incentive effects of the early design of the credit, this low short run elasticity implied a weak response of R&D spending in the initial years, causing researchers to interpret it as zero or insignificant. Thus there is no actual contradiction in the evidence.

[18]This is confirmed by interview data reported in Collins (1983), based on interviews with R&D executives in 14 major R&D-performing companies by the Industry Studies Group, National Science Foundation. Among other findings, they report that "As of Spring 1982, some R&D executives did not fully understand the tax credit." (Collins (1983), page 8).

However, most of the solid evidence we have to date rests upon the response of total R&D spending to changes in the tax price of "qualified" R&E. This qualified R&E typically accounts for anywhere from 50% to 73& of total R&D spending.[19] It also rests on rather shaky tax status data, where the effective tax credit rate faced by the firm is inferred using information in the Compustat files on operating losses and taxable income over the relevant years; where aggregate data is used, no attempt has been made to correct for the usability of the credit. There is reason to believe that inferring the qualified R&E spending by multiplying total R&D on the 10-K by a common correction factor (such as 0.6) and inferring the tax status by looking at the 10-K numbers is somewhat unreliable.[20] The only study that has used the true (confidential) corporate tax data is that by Altshuler (1989) and unfortunately for our purposes here, it focuses on the weak incentive effect implied by the credit design rather than evaluating the actual R&D induced.

Basing our conclusions on the response of total R&D spending to a tax price inferred from Compustat data may suffer from two quite distinct problems that deserve further investigation: First, as discussed above, the estimates based on public data may be quite noisy, and even misleading. Second, because these estimates are based on the response of reported R&D to the credit itself, they may overestimate the true response of R&D spending to a change in price. This is sometimes called the "relabelling" problem. If a preferential tax treatment for a particular activity is introduced, firms have an incentive to make sure that anything related to that activity is now classified correctly, whereas prior to the preferential treatment, they may have been indifferent between labelling the current expenses associated with R&D as ordinary expenses or R&D expenses. There is some suggestive evidence reported in Eisner, Albert, and Sullivan (1986) concerning the rate of increase in qualified R&E expenditures between 1980 and 1981, when the credit took effect. Using a fairly

[19]See U.S. GAO (1989), Altshuler (1989), Penner, Smith, and Skanderson (1994), and Cordes (1989).

[20]Appendix IV of the U.S. GAO 1989 study reports on a match of 800 corporations with IRS data to Compustat, yielding 219 corporations with complete data for 1980-1985. The year-to-year spending growth rates for R&D were found to differ significantly across the two files, leading to significant differences in the estimated credit rate. They did not even consider using the tax status data on Compustat, so we have no comparison using tax numbers.

small sample of firms surveyed by McGraw-Hill, they were able to estimate that the qualified R&D share grew greatly between 1980 and 1981, less so between 1981 and 1982. This is consistent with firms learning about the tax credit, and shifting expenses around in their accounts to maximize the portion of R&D that is qualified. It is also consistent with the tax credit having the desired incentive effect of shifting spending toward qualified activities, although the speed of adjustment suggests that accounting rather than real changes are responsible for some of the increase.

One way around the relabelling problem is to use a method of estimating the inducement effect that does not rely directly on the responsiveness of R&D to the tax credit. This is the method used in U.S. GAO (1989) and in Bernstein's 1986 study of the Canadian R&D tax credit. One takes an estimated price elasticity for R&D, estimated using ordinary price variation and not tax price variation, and multiplies this elasticity times the effective marginal credit rate to get a predicted increase in R&D spending due to the credit rate. For example, if the estimated short run price elasticity is -0.13 (as in Bernstein 1986), and the marginal effective credit rate is 4 percent, the estimated short run increase in R&D spending from the credit would be 0.5 percent. With a longrun elasticity of -0.5 (Bernstein and Nadiri 1989) and a marginal effective credit rate of 10 percent, the estimated increase would be 5 percent. In practice, the difficulty with this method has been that most of the elasticity estimates we have are based on a few studies by Bernstein and Nadiri that rely on the time series variation of an R&D price deflator whose properties are unknown .[21] In addition, they are based on either industry data in the 1950s and 1960s or a very small sample of manufacturing firms. It is unlikely that the R&D demand elasticity with respect to price is constant over very different time periods or countries, so it would be desirable to have more up-to-date estimates in order to use this method. Obviously, one can never be sure that firms will actually respond to a tax incentive in the way implied by the price elasticity and measured credit rate, but it would be useful

[21] I have tried without success to determine the source of the R&D price deflator used in Bernstein and Nadiri (1989). It clearly does not come from the Standard and Poor file, as they claim.

to have this method available as a check on the more direct approach using tax prices.

III.3 International evidence

Few countries have performed as many studies of their incremental R&D tax credit programs as the United States. There are several reasons for this: 1) Most of these schemes have been in place for a shorter time period. 2) They have relied on the U.S. evaluations for evidence of effectiveness. 3) Internal government studies may have been done, but these are hard to come by if you are not connected with researchers within the government in question. The only studies I have been able to find are displayed in Table 4. They cover Australia, Canada, France, Japan, and Sweden, although neither the Canadian nor the Swedish study are currently applicable, as the tax incentives for R&D in these countries have changed substantially since the studies were done.

Only the last two studies in the table make a real effort to estimate the incentive effects of the R&D tax credit econometrically; the others rely on survey evidence or the price elasticity method described above. The most comprehensive and carefully done of these studies is that by the Australian Bureau of Industry Economics; I have only given a hint of the information available in the study.[22] It is noteworthy that the conclusions reached with respect to the tax price elasticity and benefit-cost ratio are similar to those in the recent United States studies. The methodology used compares the R&D growth rates for firms able and unable to use the tax credit for tax reasons. This has the obvious disadvantage that assignment to a control group is endogenous, and that the full marginal variation of the tax credit across firms is not used, only a dummy variable. In general, the survey evidence that asks firms by how much they increased their R&D due to the tax credit is consistent with the econometric evidence.

The French study encountered some data difficulties having to do with matching firms from the enterprise surveys, R&D surveys, and the tax records, so the sample is somewhat smaller than expected, and may be subject to selection bias. The specification they used for the R&D demand

[22]For example, to my knowledge this is the only study that attempts to estimate the administrative cost of the tax credit, at least from the government side. They find that this cost is about 5 percent of the revenue loss.

equation includes the magnitude of the credit claimed as an indication of the cost reduction due to the credit. If all firms faced the same effective credit rate on the margin, it is easy to compute the tax price elasticity from the coefficient of this variable. Unfortunately, this is typically not true in France, so that this equation is not ideal for the purpose of estimating the tax price elasticity. Even so, Asmussen and Berriot obtain a plausible estimate of 0.26 (0.08), which is consistent with other evidence using similar French data and a true tax price.[23]

Few studies have attempted to systematically compare the effectiveness of various R&D tax incentives across countries, perhaps because of the formidable obstacles to understanding the details of each system. McFetridge and Warda (1983) and Warda (1993) have constructed estimates of the cost of R&D capital for the G-7 and other major R&D-doing countries. Using 1989 data, the latest available, these estimates indicated that in Japan, Germany, Italy, Sweden, and the United Kingdom, an R&D project was slightly disadvantaged in cost relative to ordinary investment, whereas such a project was advantaged in the United States, France, Korea, Australia, and Canada. The most advantageous location was Canada with a required pre-tax benefit-cost ratio of 0.657. The least attractive was Italy with a ratio with 1.033.

Given the very substantial variation in tax incentive schemes for R&D around the world, and the availability of fairly standardized R&D expenditure data from OECD, Albert Link and I have proposed using a cross-country regression approach to estimate the effects of R&D incentives over time. The results from this study are not yet available.

The central conclusion at present from studies in other countries is not different from those using U.S. data: the response to an R&D tax credit tends to be fairly small at first, but increases over time. The effect of incremental schemes with a moving average base (France, Japan) is the same as in the United States: they greatly reduce the incentive effect of the credit. The fact that a firm must have taxable income in order to use the credit also diminishes its overall effect, although this is

[23]Isobel Lamare, INSEE/ENSAE, private communication, 1994.

mitigated somewhat in France by the fact that the credit is refundable after 4 years if unused.

III.4 Heterogeneity in R&D Tax Credits and Credit Design

The ink was hardly dry on the original R&D tax credit legislation in the United States when analysts began pointing out the weak incentive effects produced by the moving average base for the computation of incremental R&D, particularly coupled with the fact that only firms with tax liabilities now or in a few adjacent years could use the credit (Collins 1983, Eisner, Albert, and Sullivan 1983, Mansfield 1984). Figure 1 illustrates the problem: it shows the distribution of real tax prices of R&D across R&D-doing firms on Compustat by year since the tax credit was introduced. The two groups apparent on the plot are firms that pay taxes in all years (a tax price slightly less than unity) and firms that are transiting in and out of taxpaying status. The former group face a fairly weak incentive because of the moving base, while the latter group face a substantially lower tax price of R&D in some situations. It is easy to see that the effect of the reform in 1989 that eliminated the moving average base had a substantial effect on the heterogeneity of the credit, although it still left two groups of firms, depending on tax status.

This heterogeneity is a feature of the credit in any country that has a moving base and/or ties it to the existence of taxable income. It may be an unintended feature of the design in many cases. In others, some heterogeneity, such as due to the size of firm or foreign/domestic ownership, may be a deliberate part of the design. In either case, analysis of incentive and revenue effects using aggregate data becomes very inaccurate, as the aggregate response is unlikely to correctly characterize the responses of a group of heterogeneous firms, not is it likely to be robust over changes in the tax credit structure or mix of firms in the economy.

----- this section under development ------

IV. Conclusions and Proposals for Future Work.

This study has reviewed the history of R&D tax credits together with the studies that have been done to evaluate its effectiveness, both here and abroad. The conclusions reached can be summarized in the following way:

1) Typically, R&D tax credits have a tax revenue loss that is slightly larger than the amount of induced R&D. The true social benefit-cost ratio adds administrative costs and other tax effects to the loss and the excess social returns to the induced R&D (above its private cost) to the gains. The former is likely to be substantially smaller than the latter, implying a full benefit-cost ratio above one. However, measures of these corrections are few and far between.

2) The tax price elasticity of R&D appears to be approximately one, as opposed to an ordinary price elasticity of 0.3-0.5. It is unclear whether this is because of measurement and methodological differences and differences in the time periods considered, or because the tax price estimates include the "relabelling" effect.

3) The responsiveness of R&D to the tax credit rises over time, as it has assumed an air of permanence in many countries. It is probably that the longrun effect is larger than the shortrun, both because it takes time to learn about it and because R&D is costly to adjust in response to temporary tax cuts.

4) Heterogeneity of exposure to the tax credit at the firm level is normal in all countries surveyed. This is due to variations in the taxable status of firms, differing carryback, carryforward, and refund provisions, as well as design features that target firms by region, size, or the nature of the R&D program (whether cooperative or not, whether conducted by foreign or domestic firms, and the nature of the technology). Tax credits for R&D are widely used to induce firm-level behaviors that the governments view as desirable, especially outside the United States.

5) There does not seem to be any correlation between the presence of a tax credit and the level of R&D spending or "competitiveness" in the aggregate across countries, although these factors are frequently adduced as reasons for a credit in particular countries.

Proposals for Future Work

In the preceding summary I have indicated areas where there is doubt and we might benefit from further research on this topic. This section of the report makes some suggestions along those lines. I have avoided being too specific before receiving input from others who are more familiar with the internal government data and studies than I am.

The first thing to strike one on reviewing the evaluative evidence is the absence of good econometric studies using what appears to be the most appropriate data set: the individual corporate tax returns used by Altshuler (1989). These data would allow us to focus on the responsiveness of qualified R&E expenditures, rather than using a proxy equal to some average eligibility rate times total (worldwide) R&D; they would also contain much better information on the actual tax status of the firms, their exposure to the Alternative Minimum Tax, and the amount of R&E credit they claimed. It would be extremely desirable to select a sample of firms and repeat the analysis undertaken in my 1993 study. This would improve the estimates of both the induced R&E and the corresponding tax revenue loss. In performing this analysis, it might be necessary to merge in the data from Compustat for some purposes, although a good study could probably be conducted without this step. A second area where internal government data would prove useful is in the evaluation of the administrative cost of the tax credit in the United States. At the present time, it appears that some kind of study has been done, indicating difficulties in auditing firm data for qualified expenditures, but no numerical estimates of the administrative costs of this exercise have been produced. I suspect that some kind of numbers on the hours spent by IRS auditors exist and it would be useful to use these to get a rough idea of costs.

Another way to verify whether the credit is having the desired effect is to examine whether the private return to R&D fell for those firms that used the credit. This is clearly the aim of the credit: to induce firms to increase their R&D to a point beyond the level they would choose in the absence of the credit. If the credit is successful, we should see the private return fall. However, measurement in the aggregate is inappropriate for this exercise, since the *ex post* private return to R&D will vary over time for reasons unrelated to the presence of the credit. The best way to approach this question is to compare the returns to R&D for firms in the same industry that do or do not receive the benefit of the credit because of their particular tax situation. Here is where the existence of the AMT will help us. Computing the private returns can be done using methods described and used in Hall (1993) or Mairesse and Hall (1995), and widely used by others also. Using a sales productivity equation that adjusts for changes in capital and labor inputs, it would be possible to allow R&D to have a differential impact depending on the tax credit position of the firm; the estimated difference in the coefficient is a measure of the difference in the private returns to R&D for the two groups of firms.

A related question is whether the credit had a larger impact for some firms than implied by the prior elasticity estimates because of the direct cash flow effect, as some have suggested.[24] This can be examined by comparing the response of R&D in those firms that received the benefit of the credit immediately with those who were forced to carry it back or forwards.

As I have already suggested, the potential for international comparison has hardly been tapped. At the current time, only macroeconomic estimation seems feasible, given the lack of public data at the individual firm level that adequately captures the information necessary to compute the tax credit for each firm, to say nothing of the detailed knowledge it requires of each tax system. Serious work in this area would require the cooperation of researchers in several countries.

Finally, given the estimated firm behavior from the previous studies suggested, a serious attempt should be made to evaluate the potential effects of various changes in the specification of the base level of R&D expenditures above which the credit can be earned. It is unclear to me whether the heterogeneity in credit rate now observed is intended by the framers of the legislation. Redesign of the credit will depend crucially on its consequences for the benefit-cost ratio, computed in the conventional way. Once a panel of firms with tax data and R&D spending data have been assembled, it will be possible to simulate the effects of changing the base to one indexed by the industry R&D-

[24]See Oosterhuis, Paul, "Tax Policy in the High Tech Sector," in Brown (1984), who reports anecdotal evidence that the credit is a lobbying device for R&D managers who want to increase their budgets.

to-sales ratio, for example. This would be done by recomputing the credit faced by each firm, computing the implied R&E spending at that credit rate, and using these numbers to determine both the increase in R&D and the potential tax revenue loss.

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TABLE 1
History of R&D Tax Treatment in the United States 1981-1999

Period	Credit Rate	Corporate Tax Rate	Definition of Base	Qualified Expenditures	Sect. 174 Deduction?	Foreign Allocation Rules
July 1981 to Dec 1985	25%	46% (.48 in 81)	Max of previous 3-yr average or 50% of current yr	Excluded: Res. done outside U.S.; Humanities and Soc Sci.; Research funded by others	none	100% deduction against domestic income
Jan 1986 to Dec 1986	20%	34%	same	Narrowed def. to "technological" research. Excluded leasing.	none	same
Jan 1987 to Dec 1987	20%	34%	same	same	none	50% deduction against domestic income; 50% allocation
Jan 1988 to Apr 1988	20%	34%	same	same	none	64% deduction against domestic income; 36% allocation
May 1988 to Dec 1988	20%	34%	same	same	none	30% deduction against domestic income; 70% allocation
Jan 1989 to Dec 1989	20%	34%	same	same	-50% credit	64% deduction against domestic income; 36% allocation
Jan 1990 to Dec 1991	20%	34%	1984-88 R&D to sales ratio times current sales (max ratio of .16); .03 for startups.	same	-100% credit	same
Jan 1992 to Dec 1993	20%	34%	same; startup rules modified	same	-100% credit	same
Jan 1994 to June 1995	20%	35%	same	same	-100% credit	50% deduction against domestic income; 50% alloc.
July 1995 to June 1996	0%	35%	none	NA	NA	same
July 1996 to June 1999	20%	35%	1984-88 R&D to sales ratio times current sales (max ratio of .16);	same definition	-100% credit	same

Source: Bronwyn H. Hall. 1993. "R&D Tax Policy During the 1980s: Success or Failure?" Tax Policy and the Economy 7: 1-53, updated.

TABLE 2A

The Tax Treatment of R&D around the World - G-7 Countries

Country (Date Enacted)	R&D Deprec. Rate	R&D Capital Deprec. Rate	Carryback and Carryforward	Definition of R&D for Tax Credit	Tax Credit Rate	Base for Incremental Tax Credit	Credit Taxable?	Special Treatment for SMEs	Foreign R&D by Domestic Firms	R&D by Foreign Firms
Canada (1960s)	100%	100% (not buildings)	7 yr. CF TC refunded	Frascati, excl. soc sci. marketing, routine testing,etc.	20%	0	yes	40% to R=C$200K grant if no tax liab.	0%	20% only?
France (1983)	100%	3-yr SL (not buildings) accelerated	3-yr CF 5-yr for OL TC refunded	Frascati, incl. patent dep. contract R, excl. office expenses &support personnel	50%	(R(-1)+R(-2))/2 (real)	no	yes TC<40MFF	no accel dep unless cons. no credit	?
Germany	100%	30% DB 4% SL - bldgs	1/5 yrs		none	NA	NA			
Italy	100%	accelerated			?	?	?	yes, ceiling		
Japan (1966)	100%	complex; 4yr SL 5% - bldgs	5-yr usual but credit limited to 10%	Frascati, incl. deprec of P&E	20%	max R since 86	no	6%R instead (cap<Y100m)	6% credit for coop with foreign labs	?
UK	100%	100% if "sci. res."	5-yr CF		none	NA	NA			
US (July 1981)	100%	3-yr., 15 yr. for bldgs	3/15 yrs	excl. contract R (for doer), rev. engineering, prod. improv., 35% contract R	20%	avg of 84-88 R	yes	R/S 3% for startups	not eligible	same as domestic

TABLE 2B
The Tax Treatment of R&D around the World - Other Countries

Country (Date Enacted)	R&D Deprec. Rate	R&D Capital Deprec. Rate	Carryback and Carryforward	Definition of R&D for Tax Credit	Tax Credit Rate	Base for Incremental Tax Credit	Credit taxable	Special Treatment for SMEs	Foreign R&D by Domestic Firms	R&D by Foreign Firms
Australia (July 1985)	150%	3-yr SL (not buildings)	3/10 yrs	Frascati, excl. soc sci, some testing, marketing	none	NA	NA	ceiling; reduced credit for small R&D programs	up to 10% of project cost eligible	no special provisions
Austria	105%	accelerated	5 yr CF	Dev. & improv. of valuable inventions	none	NA	NA			
Belgium	100%	3-yr SL 20-yr - bldgs	5 yr CF		?	?	?			
Brazil	100%	like investment	4 yr CF		none	NA				
Denmark	100%?	100%	5-yr CF	Special tech programmes with EC researchers	?					
Korea	100%	18-20% deprec 5.6% - bldgs			10% 25%	0 avg of last 2 yrs	no	yes; special rules for startups	?	no special provisions
Mexico	100%	3-yr SL 20-yr -bldgs			none	NA	NA			
Netherlands (1994)	100%	like investment	8-yrs CF	W&S of R&D leading to prod. dev. (not services)	12.5-25%	0	no	yes; ceiling and higher credit rate		
Norway	100%	like investment	10-yr CF (res. reserve)		none	NA	NA			
Singapore					?	?	?	yes		
Spain	100%	100% or depreciate	5-yr CF - OL 3-yr CF - TC		15% (on cap. R&D)	0				
Sweden (disc. 84)	100%	30% DB 4% SL - bldgs	tax liability		none	NA	NA			
Switzerland	100%	like investment	2-yr CF		subcontracted research	?	?			
Taiwan					?	0	?	yes		

TABLE 3
Empirical Studies of the Effectiveness of the R&D Tax Credit - United States

Date of Study	1983	1983	1986	1992	1993	1987, 1992	1993	1993	1993
Author(s)	Collins (Eisner)	Eisner, Albert, and Sullivan	Mansfield	Swenson	Berger	Baily and Lawrence	Hall	McCutchen	Hines
Period of Credit	1981:2	1981-82	1981-1983	1981-88	1981-88	1981-89	1981-91	1982-85	1984-89
Control period	1981:1	1980	not relevant	1975-80	1975-80	1960-80?	1980	1975-80	not relevant
Data source	McGraw-Hill surveys	McGraw-Hill surveys Compustat, IRS ind.	Stratified random survey	Compustat	Compustat	NSF R&D by ind	Compustat	IMS data and 10Ks	Compustat +
Data Type	99 firms	~600 firms for R&D 3,4-digit ind for tax	110 firms	263 firms (balanced)	263 firms (balanced)	12 2-digit inds.	800 firms (unbalanced)	20 large drug firms	116 multinationals
Methodology	*(3) Event* Compare pre-ERTA est. R&D to post-ERTA spending	*(1) Dummy* R&D equation compared pre- and post-ERTA; same for R&D above/below base	*(4) Survey* Asked if R&D tax incentive increased spending	*(1) Dummy* Log R&D demand eqn. FE spec.	*(1),(3)* R&D intensity eqn. FE spec.	*(1),(2)* Log R&D demand eqn with tax price or credit dummy	*(2) Elasticity* Log R&D demand eqn with tax price var.	*(1) Dummy* Research intensity eqn by strategic grp with tax credit	*(2) Elasticity* R&D demand eqn with tax price for sec 861-8
Controls		R&D lag 1&2, Current & lag sales, CF		Log S, change in LTDebt lag 1&2	Lag R/S, Ind. R/S, Inv/S, Ind. Inv/S CF/S,Tobin's q, GNP	Lag R&D, current and lag output (logs)	Lag R&D, current and lag output (logs)	Past NCEs, Divers. CF/Sales, %drug sales	Dom. & for. tax price Dom. to for. sales Ind, firm dummies
Estimated Elasticity	insig.	insig.	0.35?	?	1.0-1.5	0.75 (0.25)	1.0-1.5	0.28-10.0?	1.2-1.6
Estimated Benefit-Cost	< 1.0	NA	0.30 to 0.60	NA	1.74	1.30	2.00	0.29-0.35	1.3-2.00
Comments	Also used survey evidence, OTA computations	Not a good experiment and too early; insuff. control for TC, poor functional form	Increases get larger as time passes.	Credit dummies depend on usability Stratified by tax status	Usability measures problematic	Tax price assumes firm is taxpayer	Response larger in 86-91 IV estimation for expectations	Higher response for low cash flow firms; problem with eq - nonhomothetic	Compares firms w and w/o foreign tax credits (different experiment)

See the text for a more complete description of methodologies (1)-(4).

TABLE 4
Empirical Studies of the Effectiveness of the R&D Tax Credit - Other Countries

Country	Canada	Canada	Sweden	Canada	Japan	Australia	France
Date of Study	1983	1985	1986	1986	1988	1993	1993
Author(s)	McFetridge and Warda	Mansfield and Switzer	Mansfield	Bernstein	Goto and Wakasugi	Australian BIE	Asmussen and Berriot
Period of Credit Control period	1962-82 NA	1980-83 not relevant	1981-1983 not relevant	1981-88 1975-80	1980	1984-1994 non-users	1985-89
Data source Data Type	Statistics Canada aggregate	Stratified survey interview 55 firms (30% of R)	Stratified random survey 40 firms	prior estimates firms?		ABS R&D survey IR&D board >1000 firms	INSEE: EAE, DGI, and MRT data 339 firms
Methodology	*(2) Elasticity* Use elasticity of 0.6 and tax price of R&D	*(4) Survey* Asked if R&D tax incentive increased spending	*(4) Survey* Asked if R&D tax incentive increased spending	*(2) Elasticity* Multiply prior elasticity estimate times credit rate		*(1), (4)* Log R&D demand eqn with credit dummy control/no control	*(1) Demand* R&D demand eqn with log(credit)* Indicator for ceiling
Controls	NA	No control years, unclear if these are total increases from tax credit	NA			Lag R&D, Log Size Growth, tax loss dummy Gov support dummy	Logs of gov subsidy, size size sq, concentration, immob per head
Estimated Elasticity	0.6	0.04-0.18	small	0.13		~1.0	0.26 (.08)
Estimated Benefit-Cost	0.60	0.38-0.67	0.3 to 0.4	0.83-1.73		0.6-1.0	?
Comments	Elasticity comes from Nadiri (1980) "tentative"	Elasticity estimated from McF&Warda tax credit of 20% and observed R increase	Increases get larger as time passes.	Larger figure includes output effects	increased R&D by 1%	Elasticity is combination of survey evidence and control group analysis	Estimated elasticity is credit elasticity divided by elasticity of tax price wrt credit

See the text for a more complete description of methodologies (1)-(4).

Tables and Figures

FIGURE 1

UNITED STATES MANUFACTURING FIRMS

EFFECTIVE REAL TAX PRICE BY YEAR