# FISCAL POLICY TOWARDS R&D

# IN THE UNITED STATES:

# RECENT EXPERIENCE


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# Fiscal Policy Towards R&D in the United States: Recent Experience

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This short survey has two parts: the first part is a review of the economic rationale behind the arguments that governments ought to have a fiscal policy toward innovative activity by private firms. The second part of the paper focuses on the U.S. experience with the R&D tax credit, which the United States has now had in place for approximately 13 or 14 years.[2] The primary source for the results discussed in the second half of this paper is Hall (1993), a detailed, somewhat academic and technical examination of the performance of the tax credit in the United States.[3] This study covers data that goes through 1991, so that the results are slightly dated, but still of interest. Before presenting them, I will briefly review the market failure argument for government support of Research and Development spending. Professor Albert Link and Dr. John van Reenen have already discussed this argument today; I will expand further on what we mean when we say that the common

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[2]The correct term for this tax instrument is the "Research and Experimentation Tax Credit," but it is commonly referred to as an R&D tax credit.

[3]Hall, Bronwyn H. (1993), "R&D Tax Policy During the 1980s: Success or Failure?" *Tax Policy and the Economy* 7, pp. 1-35.

policy evaluation tool used here, which is to compare induced expenditure with tax cost, doesn't necessarily give us the answer to the question we are really interested in. This discussion is follwed by an overview of the types of government policies that the United States pursues in the Research and Development area because the tax credit is only part of the story. Finally I'll review what we in the United States have learned from our experience with the tax credit.

*The Market Failure Argument for R&D Subsidies*

Figure 1 is intended to show you the basic argument why many economists think that there is a very strong role for government policy in Research and Development. Here I am using R&D spending as a proxy for innovative input.[4] This graph focuses on Research and Development spending in a particular sector or industry, without specifying which one. On the horizontal axis is the dollar amount being spent and on the vertical axis is the marginal return to the last R&D dollar. The downward sloping curve shows the decline in returns as each additional R&D dollar is spent; that is, there are diminishing marginal returns to R&D in each sector (the best projects are chosen first). On the cost side, the assumption is that there is a flat or possibly slightly rising cost of each dollar that will be spent on R&D. A typical firm faces a whole menu of projects that it can undertake and if it is a well-managed firm, it will usually try to undertake the ones with the higher returns first.

[4] As Alain Querveux pointed out during the meeting, R&D spending is only a proxy for innovative activity, it is not the whole story. It is the most quantifiable number we have and many of us who have worked in this field for a long time have spent a great deal of time trying to use other numbers, mainly things like counts of innovations, counts of patents, other types of numbers. Those numbers turn out to be highly correlated with this number. Therefore statements you make about this number (the dollars being spent on Research and Development in a particular sector or a particular industry) usually are statements which you would make if you were trying to measure other innovative inputs or outputs, but not always. Since the tax credit is also targeted toward the R&D spending number, it is the sensible thing to focus on here.

The graph indicates that if the firm does a small amount of R&D, it will choose the best projects first (those yielding high expected rates of return), gradually tracing out the curve as it expands its Research and Development activity up to the point where the cost of that Research and Development is being paid for by the return it expects to receive on the investment. I am abstracting here from all details that have to do with the intertemporal nature of the decision. Firms facing these curves should locate themselves somewhere at point C; they will do exactly the amount of Research and Development that they can pay for with the returns on the margin.

The view of most economists who have investigated the returns to innovative activity is that the returns to society from the research at point C are much higher than those received by the firm. There is a large amount of case study evidence on this in different industries and there is also quite a bit of econometric evidence. What this means is that most firms are not successful in capturing all the returns to their Research and Development, for two reasons: first, other firms learn something from the output of the R&D, become more productive or produce better products, and take away some of their market. Second, in many cases, for example, in the computing hardware industry today in the United States, the people who receive a large share of the returns are the consumers of products in that industry, rather than those who manufacture them. This occurs because the industry is highly competitive and the quality-adjusted price for this particular technology has fallen dramatically over the last ten years. In some other research that I have done with Jacques Mairesse at INSEE, it is clear that most of the technical change in the computer industry has gone to price decreases, and not to returns to the firms that were undertaking research in that industry.[5] What I am trying to underline here is the idea that the returns to society from Research and Development activity in the computing hardware industry (among others) may be quite a bit higher than the returns to individual firms. Figure 1 shows this return as the higher curve and indicates that the optimal *social* level of R&D, the point of intersection of cost and return S, is quite a bit higher than the optimal *private* level of R&D.

[5] Mairesse, Jacques, and Bronwyn H. Hall (1995), "Estimating the Productivity of Research and Development : An Exploration of GMM Methods Using Data on French and United States Manufacturing Firms," forthcoming in van Ark, Bart and Karin Wagner (eds.), *International Comparisons of Productivity Growth.*

That summarizes the basic argument behind our presence here today. What the graph immediately tells you is that were you to try to get firms to undertake the optimal social level of R&D, you would want to figure out the gap between the actual cost of R&D at point S and the private rate of return to that level of R&D (this optimal subsidy is shown on the graph). The point S is a counter-factual point, so it is difficult to figure out the magnitude of the gap precisely and to subsidize each firm by exactly the amount that will cause it to choose the level of R&D spending at point S. Professor Link already referred to something that I think is rather important and which none of the policies I'm familiar with are entirely successful in handling: the magnitude of this gap may vary enormously across countries, industries, and types of technology. It will definitely vary across different kinds of Research and Development. Figure 2 gives a couple of examples of this phenomenon.

Figure 2a shows what I refer to here as basic research or science, but might also be generic technology. This graph is a very extreme picture, where the cost of doing Research and Development of the basic or generic type is always higher than the private return. In this extreme example, the firm will perform no basic research, whereas society would actually like a lot. The alternative is shown in Figure 2b: the development part of Research and Development or the proprietary technology part. This is the part for which firms are quite capable of capturing a large share of the returns (via patents or trade secrets, for example) and you get something where the social return is close to the private return and the gap between the difference in the two levels is going to be rather small, possibly not even of a size to worry a policymaker. These two figures are just illustration of a point that Professor Link was making.[6]

*Alternatives to Tax Policy Towards R&D*

In this section, I briefly review the alternatives to tax policies towards Research and Development; most of these policies exist in practice and work in parallel with fiscal policies. I have

[6] In the design of the tax credit and policy in the United States, this point that some of Research and Development is more worthy, so to speak, of subsidy than other R&D is taken into account via the definition of eligible R&D but the instrument is quite imperfect.

termed these policy solutions for under-investment in Research and Development, but what I've really done here is just categorize the standard economist's response when he or she sees a market failure like the one in Figure 1. The first two policy responses are classed as what economists call "internalising the externality". In other words, create legal structures that let the firms capture the returns completely and keep them from spilling over to each other or consumers. One way to do that is to allow R&D joint ventures. Another possibile response is both older and more widely used: the government creates a property right in the output of innovative activity, such as patents, trademarks, copyrights, in order to allow firms or individuals to keep others from benefitting from their R&D.

The final policy response is the one that we are focusing on today: subsidizing the activity. You will usually get more of it if the government pays for some of it. There are two alternatives here: one of them is direct government subsidy and the other one is tax subsidies, for example, an R&D tax credit. Direct government subsidy is widely used and is an important part of the policy picture in the United States as it is in other countries. It is used for science and basic research (Figure 2a) and also for defense, space, and health Research and Development. My paper is not about direct subsidy, but that is not meant to imply that this is not an extremely important policy area. There is a substantial amount of evaluation evidence, mostly for the United States, that demonstrates that in certain sectors, such as the aircraft sector or the communication satellites sector, there are important spillovers from this type of research for commercial firms.[7]

*Tax Policy and Research and Development*

In the remainder of this paper I focus on tax policy toward research and innovation. One of the points I want to make at the outset is that from the perspective of the firm, the tax system as a whole is very complex. Even the tax treatment of Research and Development has at least four components, of which the R&D tax credit is only part. There are other features of the tax system that have quite a

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[7]See, for example, Hertzfeld, Henry R. (1985), "Measuring the Economic Impact of Federal Research and Development Investments in Civilian Space Activities," or Mowery, David C. (1985), "Federal Funding of R&D in Transportation: The Case of Aviation," Papers commissioned for a Workshop on The Federal Role in Research and Development, National Academies of Science and Engineering, Washington, D.C., November 21-22.

bit of impact on firms for whom technology is important.

The first component of tax policy towards R&D in the United States and in many other countries existed before there was an R&D tax credit and by itself represents a substantial subsidy to Research and Development activity. This is the fact that Research and Development spending may be expensed for tax purposes, corresponding to a 100 per cent writeoff of the expenses associated with an investment that does not generate the corresponding income immediately. This means that R&D is subject to a kind of accelerated depreciation. 100 percent would be the economic depreciation rate only if the returns to Research and Development spending dissipated within one year, which is not a very realistic picture of most R&D. Thus by itself, expensing is already a tax subsidy to R&D activity.

The second component of U.S. R&D tax policy is the treatment of the income and expenses of multinational firms. In the recent past, we have had a rather complex and frequently changing tax law relating to the allocation of Research and Development expense against foreign source income. R&D is a problem for the framers of tax law precisely because of the information property of R&D: as an investment it creates an asset whose use for generating foreign source sales does not preclude its use in generating domestic sales. Therefore it is conceptually unclear how to allocate the associated expense. Allocation rules are an important issue because the tax rate that firms face on foreign source income is sometimes higher and sometimes lower than the tax rate they face on domestic source income. So it makes a difference whether you can deduct R&D expense against that income. It affects the after-tax cost of that R&D. I am not going to discuss these features of the tax system here because they have been carefully reviewed and studied by James Hines of the Harvard Kennedy School of Government in a series of papers.[8] The conclusion he reached from his studies is that because of the way the taxation of foreign source income takes place, this rule tends to operate as a subsidy biasing firms towards doing Research and Development which they can then transfer as

[8] Hines, James R. (1993), "On the Sensitivity of R&D to Delicate Tax Changes: The Case of Multinationals," in *International Taxation,* Alberto Giovannini, R. Glenn Hubbard, and Joel Slemrod, eds. (Chicago: University of Chicago Press). Also, Hines (1994), "No Place like Home: Tax Incentives and the Location of R&D by American Multinationals," *Tax Policy and the Economy,* Volume 8, pp. 65-104, and Hines (1994), "Taxes, Technology Transfer, and the R&D Activities of Multinational Firms," National Bureau of Economic Research Working Paper No. 4932 (November).

technology to foreign locations. In other words, it gives the firms an incentive to do Research and Development that is targeted for sales in foreign countries. So these tax rules have an effect on the composition of R&D, but we have no idea whether it is positive or negative from a social point of view.

The third component of U.S. tax policy that has implications for R&D investment is not commonly thought of in that regard, but I think it could be rather important. Much of industrial Research and Development in the United States in the last twenty years has been performed in the capital equipment industries, broadly speaking, that is, computers, motor vehicles, and almost any kind of machinery or equipment industry. This means that tax subsidies to investment in capital equipment (such as an investment tax credit) have an impact on the demand for the output of the capital equipment industry, and via that route, also have an impact on the demand for industrial Research and Development. This is an aspect of the tax system that's not normally considered in the same breath as R&D, but could be quite important.

The final component of U.S. tax policy toward R&D is, of course, the incremental R&D tax credit, which in the U.S. cuts across all industries and all types of firms, including large firms. I believe that this is an important difference between the U.S. policy and policies in some other countries; the credit is less targeted by firm type. The next section of the paper reviews what we have learned since the credit was installed in 1981.

*The Incremental R&D Tax Credit in the United States*

This part of the paper reviews the evidence given in my (1993) paper on the effectiveness of the R&D tax credit in the United States and then gives some insights into the problems of design and implementation based on what we have learned. For those of you who are not familiar with it, the R&D tax credit in the United States is described in detail in Hall (1993). Table 1 in that paper gives every law change in the U.S. since 1981 when the credit was first enacted. In its initial form it was a 25 per cent tax credit for "incremental" Research and Development: incremental meant the amount that the firm's Research and Development spending increased over the level in the previous year. As time went on this increase was to be measured over the average of the previous three years. Over the 1980s, the rate was tinkered with continuously. From our perspective today the other important feature is that there was an attempt to target it towards what we might call purely technological Research and Development. Certain types of research in the social sciences and humanities were excluded and, as time went by, the definition of eligible R&D expenses was tightened to gear it towards technology; not towards generic or proprietary technology specifically, just towards technology in general. In practice what that has meant is that across most firms about 65 per cent of overall Research and Development spending as reported to the Internal Revenue Service and as reported in the public statements of the companies is actually eligible for the tax credit on average. The eligible portion will vary by firm, but it is difficult from public data to know by how much.

Before I describe you what we have learned from our experience with the R&D tax credit, I want to go back to the figures and illustrate a couple of features of the tax credit using the simple model we started with. First, I will show what it means to have an *incremental* R&D tax credit. Second, I will use the figure to show why it is that when we do policy evaluation here using the best methods we can, in fact we are not answering the question we are really interested in. Figure 3 shows the Return-R&D schedule for a representative firm. The effect of the tax subsidy on the cost of R&D in the United States is first, to lower the average cost of that R&D over the range of R&D spending between the base level and twice the base level, and then to flatten it out after that. Base R&D is a level which is based on the firm's past behavior. In this picture I have assumed that before the subsidy the firm was at point C doing the optimal private amount of R&D. After the subsidy they locate themselves at point T, and perform a somewhat higher level of R&D. The figure is not to scale; I have exaggerated the increase so that we can see it easily. The first point is that if the R&D tax credit were not incremental, the firms would face a lower cost all the way from zero R&D, and the tax revenue loss would be much larger than the shaded rectangle shown. An incremental tax credit is designed to do is something rather sensible from the point of view of fiscal administrators, that is, to give the firm back only a small piece of the R&D, the part that will influence its behavior, and to forget about all the inframarginal spending that is not going to change its decisions but will cost the treasury money.

The second point to be made with Figure 3 is that from the policy perspective, what we would really like to know is whether the social return, equals the social cost at the current level of R&D, not the cost after the tax subsidy, but the cost before. The usual measure for policy evaluation is completely different; it is the amount of incremental industrial R&D compared to the loss in tax revenue. That is only very loosely connected with the magnitude of the gap between the social and private returns at S, if at all. It might be that the social return from additional Research and Development is very high. If it is very, very high one may be willing to give up more tax dollars than the actual industrial R&D induced by the tax subsidy. On the contrary, if the social return is only slightly higher than the private return, more industrial R&D might move thef firm to a point where the social return is actually quite low. 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.

*What Have We Learned?*

The first thing we've learned from our experience in the United States with the tax credit is that it works, in the sense that there is a response of industrial Research and Development to an effective reduction in the cost of that R&D faced by the firm (what we call a tax price). The tax price elasticity of industrial R&D in my results is larger than unity, which means that a 5 per cent effective R&D tax credit leads to a slightly greater than 5 per cent increase in Research and Development at the firm level on average. That number has been confirmed by Hines (1993) using different methods and focusing on the foreign and domestic source allocation rules. It has also been confirmed in work by Martin Baily and Robert Lawrence using macroeconomic data.[9] Unlike the these two papers, which relied on data for approximately 100 multinational corporations and data on two-digit industries respectively, my estimate is based on variation across about 1000 individual firms, mostly the largest US manufacturing corporations. That is, it comes from the fact that the effective benefit of the tax credit firm by firm in the United States is highly variable depending on tax positions of firms, and because of this, some firms will find R&D cheaper to perform than others; the evidence is that these firms actually do more of it, other things equal. The paper itself has a rather dramatic

[9]Baily, Martin Neil, and Robert Z. Lawrence (1987), "Tax Policies for Innovation and Competitiveness," (Washington, D.C.: Study commissioned by the Council on Research and Technology). Also, Baily and Lawrence (1992), "Tax Incentives for R&D: What Do the Data Tell Us?" (Washington, D.C.: Study commissioned by the Council on Research and Technology).

picture which shows the dispersion in effective tax prices. Some firms could see as much as 25 per cent reduction in price from the tax credit, while other firms actually see an increase in price. That is, there are few firms for which the tax credit was perverse; this usually happens when they do not benefit from the credit currently because they are tax-exhausted, but increases in spending raise their future R&D base level, thus costing them the credit in future years.

The incremental design of the tax credit and the variation in rates it produced is good news for the researcher because it makes estimation of responses feasible in a cross section of firms; on the other hand, it is actually bad news for policymakers. That is really not the way you want to run your policy on R&D: to have the impact depend on the tax position of individual firms. The bottom line in my paper was that the tax revenue cost by the late 1980s was about a billion dollars a year, approximately equal to half the incremental industrial R&D induced by the credit (about 2 billion dollars a year). So by the traditional evaluation method, the benefits exceeded the costs.

The second thing we have learned from the R&D tax credit concerns the longer run response of R&D spending. There are two pieces of evidence here: the first is that there is pure econometric evidence (based on the response by firms over time) that the longer term response is larger than the short-term. Second, as the R&D tax credit began to look quasi-permanent, the response was larger in the second half of the time period in the late eighties than it was in the first part of the time period.[10] That is, the firms took some time to learn about and believe in the tax credit. People who are familiar with the process of industrial innovation are very aware of the fact that spending at the firm level is frequently very slow to adjust, for obvious reasons. Half of the spending is on the salaries of highly paid scientists and engineers, whom you cannot hire and fire freely without some of the value of your Research and Development because a great deal of what has been created is knowledge embodied in the scientists and engineers themselves. Therefore we should not find the slowness of response to the tax credit surprising, and we should expect that permanent tax instruments of this kind should be more effective than temporary tax cuts.

A third area in which the United States gained some experience during the past ten years is in

[10]The tax credit is not yet permanent in the US, but it has been renewed every year, often in the omnibus budget reconciliation act for the new fiscal year in September in which Congress tends to tie up the loose ends that they didn't manage to pass into law earlier.

the area of enforcement, or the relabelling of expenses. When you subsidize an activity such as R&D, does it encourage firms to relabel things as Research and Development that weren't really Research and Development, causing a loss to the tax authority without a concomitant actual increase in R&D? The answer here is based on evidence from Internal Revenue Service (Treasury) auditors. Relabelling does occur but the amount is fairly small. I am relying on a study by the Government Accounting Office of the U.S. Government, where they surveyed the auditors of over half the firms in my sample; that is, a very large number of firms actually got audited in fact on the R&D tax credit, but with relatively small result.

The fourth thing we have learned is that incremental design is very difficult. The law as written in the U.S. means that the effective credit that firms faced was a 5 per cent reduction in their expenses on average, even though the targeted number in the legislation was 25 per cent. In fact, a normal firm that pays taxes every year and whose R&D is growing at a slow pace receives a 5 per cent credit on the margin and not 25 per cent. The reason is the incremental design where the base level of R&D is the firm's own past history. Every firm is different and every firm is unique, which makes it difficult to do anything other than use the firm's own data to determine its base level of R&D. It is extremely difficult to establish an industry standard R&D ratio because every firm is in a slightly different industry, has a different mix of products, etc. But once you start using a firm's own R&D pattern to set the base level you get strategic behavior on the part of the firm, which will blunt the effect of whatever tax credit instrument you have designed. In 1989, the U.S. Congress responded to this problem by setting the base at the level of spending for each firm in 1984-1988 and keeping it there. This will work for a few years; in fact the evidence is that it had the desired effect of raising the effective tax credit by eliminating strategic behavior, at least temporarily. The problem is you can't do this forever because the world is changing, firms change what they do, and it is impossible to engrave in stone in the tax code that what these firms did in the late 1980s in Research and Development is what we will use in perpetuity as the base for their R&D. I don't have a clever solution for this. Using industry mean R&D to sales ratios is the only solution that suggests itself.

The final point is that the whole tax system matters. This R&D tax credit interacted with alternative minimum tax in the U.S. system in such a way as to reduce its effectiveness, particularly for firms without profits and particularly during recessions when the AMT was more likely to apply.

It also interacts with the foreign source income allocation rules. Therefore, when you're thinking about this particular policy, at least in the United States, and I suspect also in other countries, you have to think about what's happening in the rest of the tax system too.

Figure 1

The Private and Social Return to R&D

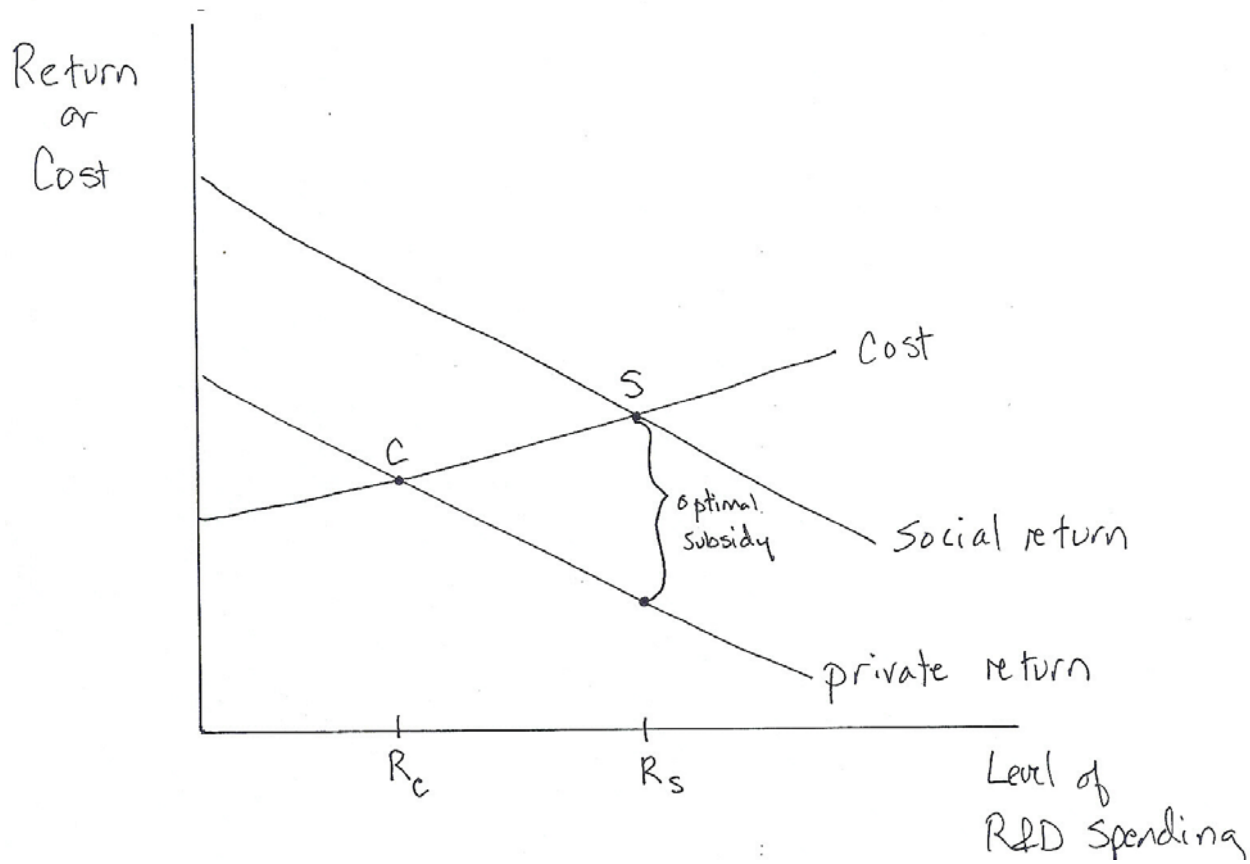
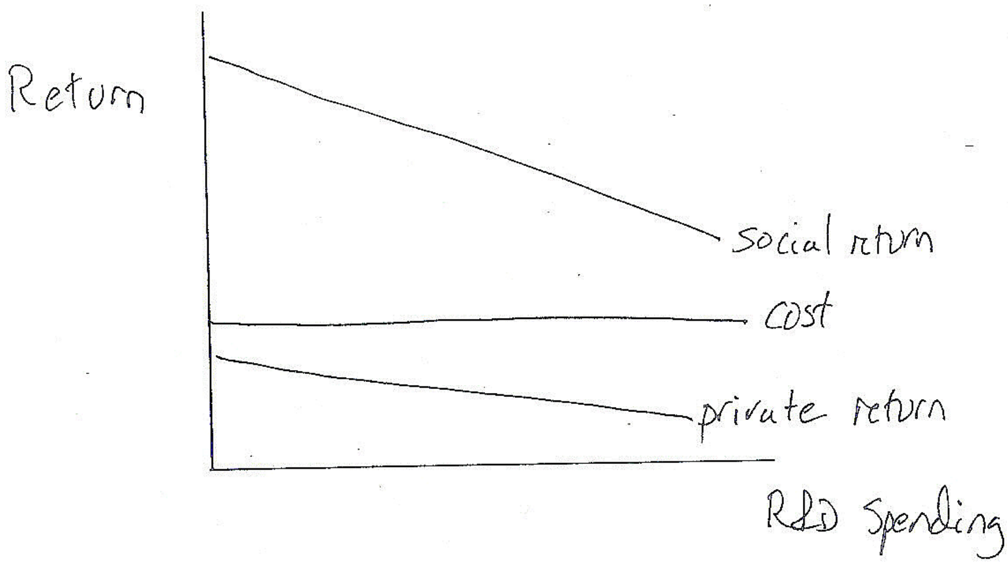


Figure 2

Optimal Subsidy to Different Kinds of Industrial R&D

(a) Basic Research (or Generic Technology)




(b) Development (or Proprietary Technology)

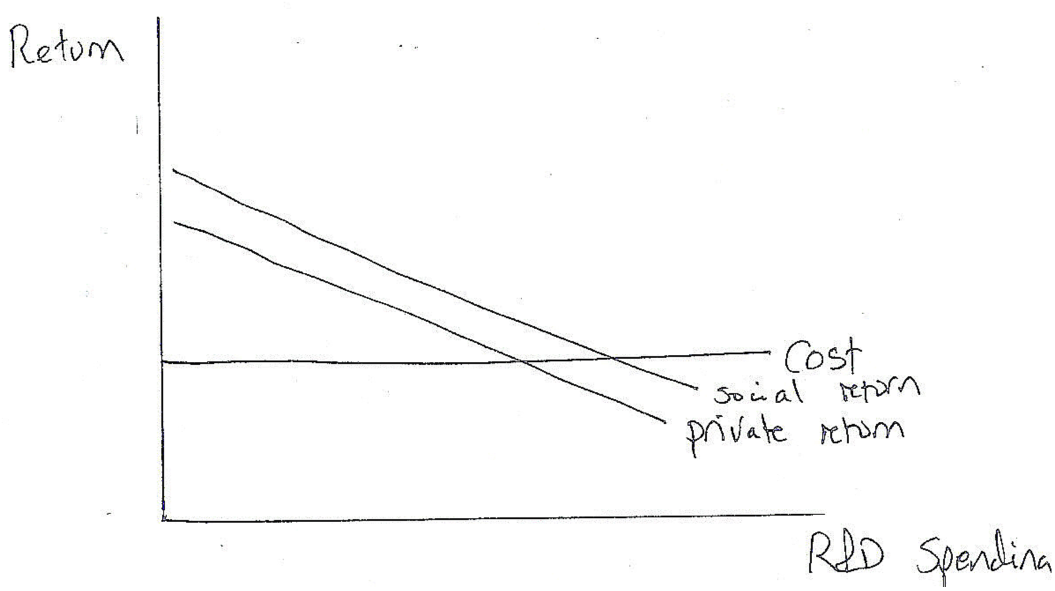


Figure 3

The Incremental R&D Tax Credit