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Tax incentives for encouraging R&D activities

Katsiaryna Marmilava

This article highlights important stages and choices in the tax incentive process that policy makers might find useful in their deliberations. It describes the main steps in the design and implementation of R&D tax incentives. The principal aims of tax incentives are reviewed, and the preferred forms and administrative mechanism based on international experience are considered. Furthermore, the accumulated experience in assessment of the effectiveness of R&D tax incentives is summarized, and the advantages and limitations of different assessment methods are clarified.

Keywords: tax incentives, research and development expenditures, forms of tax incentives, tax credit, tax allowances, accelerated depreciation, tax savings, effectiveness of R&D tax incentives

1. Introduction

Due to the contribution that research and development (R&D) makes to long-term economic growth and its significant potential for future positive impact on society, governments are motivated to find appropriate ways to encourage R&D expenditure. Tax incentives are becoming an increasingly important instrument in the policy mix to stimulate private R&D in many countries around the world. Over recent decades the number of OECD countries promoting R&D tax incentive schemes has rapidly increased from 12 in 1996, to 19 in 2006, to 27 in 2012 (OECD 2015a). These vary from country to country, depending on their respective economic and industrial structure, and the social objectives of the state.

When considering the implementation of tax incentives, the following questions should be precisely answered:

1. Which activities, industries, and types of firms are to be encouraged?
2. What forms of tax incentives should be considered?
3. What will the administrative process be?
4. What methods will be used to evaluate the effectiveness of the selected tax incentives?

These four questions will be the focus of this review.

2. Intention of R&D tax incentive policy

Occasionally, countries seek to develop or strengthen specific industries and in such cases tax incentives are devised to benefit the target industry. For example, in Canada special federal and provincial tax credits apply to selected industries including interactive digital media, film and television, video game development, and industries involved in the development of new technologies addressing issues of climate change, clean air, and water and soil quality. Israel provides R&D tax incentives for pharmaceuticals, software and hardware development, energy, and utilities (Deloitte 2015).

Often countries do not limit eligibility to particular industries, but instead define qualifying features of products and services, or designate broad fields to be eligible. In Belgium, the company must certify that the aim of R&D is to develop products and services that are innovative in the domestic market and will not have a negative impact on the environment (or the company has taken steps to mitigate that impact). Ireland categorizes activities that qualify for the credit: natural sciences, engineering and technology, medical science, and agricultural sciences. In the Netherlands technical and scientific research should be conducted in fields such as physics, chemistry, biotechnology, production technology, and information and communications technology to qualify for R&D tax incentives.

Additional key aims of introducing tax incentives policies are to provide support to small and medium-sized enterprises (SMEs); stimulate cooperation between industry and public research institutions and universities; and encourage patenting activity.

Since small business have high innovation potential but greater financial and technical constraints, many countries have more generous tax incentives for small firms (e.g. Canada, France, Japan, Netherlands, United Kingdom, Norway, Korea) (see Table 1). Conversely, countries that provide bigger tax reliefs for large firms (e.g. Hungary) put multinational companies in an advantageous position with respect to domestic firms.

Collaboration between universities and industry is critical for innovation and technology transfer, skills development, and the generation of new enterprises. As such, many countries have adopted policies to stimulate the interaction between academia and industry. For example, in France companies can apply existing tax incentives for contract research expenses (up to 2 million euro and 3 times the amount of other R&D expenses incurred by the company). In Hungary a 200% super deduction is available for subcontracted R&D activities if the partner is a public/non-profit research site. Other countries (Belgium, Italy, Japan) provide more generous tax relief for industry R&D projects contracted to universities and public research institutes. In Italy tax subsidy increases from 25% to 50% for costs of R&D activities outsourced to universities and research centers or to other companies. Meanwhile, Japan provides a 30% tax credit (from 8% up to 12% for other eligible R&D expenditure) for joint R&D with a university or public research institution, or where the R&D is contracted to such entities (Deloitte 2015, OECD 2015c).

Countries can adopt special tax regimes for intellectual property (IP) to increase innovation activities and foster global leadership in patented technology. Furthermore,

Table 1 Targeted R&D tax incentives

Country	**Firm size**	**Activity**
Belgium		Collaboration Patenting activity
Canada	SME	
Italy		Collaboration Patenting activity
Japan	SME	Collaboration
Korea	SME	Patenting activity
Netherlands	SME	Patenting activity
Norway	SME	
Spain		Patenting activity
United Kingdom	SME	Patenting activity
Ireland		Collaboration Patenting activity
Hungary	Large	Collaboration Patenting activity
France	SME	Collaboration Patenting activity

Note: Blank spaces indicate no targeting in these areas.
Source: own construction based on OECD (2015b) and Deloitte (2015)

such regimes can create attractive tax environments for the allocation of IP into the country and promote multinational firms to shift their profits from patents that will bring additional income to the state in the form of taxes. Given the rapid spread of such tax incentives over the last decade their implementation could be a reactive measure to maintain tax competitiveness; however, this may result in overall lower welfare due to loss of tax revenues.

3. Design and implementation of R&D tax incentives

The next question that should be resolved is how to design and implement the best policy mix to encourage R&D investment at an appropriate amount to meet economic and political objectives.

R&D tax incentives can take different forms: tax credits, tax allowances, and accelerated depreciation associated with investments in R&D. Tax credit allows for the deduction of a certain percentage of R&D expenditures from tax liabilities (according to the tax credit rate). It may apply to either the absolute value of a company's R&D expenditures (volume-based approach), to the increase in R&D spending over a calculated base level (incremental-based approach), or to a combination of both.

The incremental approach is less common as it provides limited or no encouragement to businesses whose R&D spending fluctuates or remains at a steady level (for instance in times of macro-economic volatility). Moreover, it has higher administrative and compliance costs and may distort R&D investment planning (it makes a gradual increase in R&D investment more attractive).

Thus, many countries over the last few years have replaced their more complex hybrid volume and incremental-based schemes with simpler and more generous volume-based schemes (for instance, France in 2008, Australia in 2010, Ireland in 2015).

Table 2 R&D tax incentives by type of tax scheme, 2015

	Level of R&D	**Increment of R&D**	**Hybrid**
R&D tax credits	Australia	United States	Spain
	Canada	Italy	Portugal
	United Kingdom	Japan	
	France	Korea	
	Belgium		
	Ireland		
	Austria		
	Iceland		
	Norway		
	Korea		
	Hungary		
R&D allowances	Belgium		Czech Republic
	Netherlands		Slovak Republic
	United Kingdom		
	Hungary		
	Slovak Republic		

Source: own construction based on OECD (2015b) and Deloitte (2015)

R&D tax credit in some countries (e.g. Spain and Portugal) is both incremental and volume-based, even though either of these tax schemes could be mutually exclusive (e.g. Korea).

Tax allowances enable firms investing in R&D to deduct more from their taxable income than they actually spend on R&D. For example, the Netherlands provides a super deduction of 160% of qualifying expenses directly attributable to qualified research activities. In the United Kingdom small and medium-sized companies qualify for a 230% super deduction of qualifying expenses.

Although there is not a big difference between tax credits and tax allowances in the reduction of the after-tax cost of R&D (as they can be made equivalent), tax credits have become a more popular measure. This tendency can be explained from an administrative point of view. As tax allowances vary with the corporate tax rate, they need to be adjusted with these rate changes, thereby causing additional administrative difficulty (Lester–Warda 2014).

As R&D expenditure may precede revenue generated by innovation by several years, it is good practice to provide a carry-over facility and the option to receive the benefit even in the case of a company not being profitable (cash refunds). This is especially relevant for young companies that typically are not profitable in the first years of their operation. For example, in France, a volume-based tax credit may be carried forward for three years. If it is not utilized within this period, the taxpayer is entitled to a refund. Indeed, new companies, young innovative companies, SMEs and companies with financial issues can request an immediate refund of unutilized credits.

Table 3 Treatment of excess claims by country

	Carry-forward	Refund
R&D tax credits	United States Belgium Ireland France Spain Australia Canada Korea	Norway Belgium (after five years) Ireland France (SMEs) Spain Australia (SMEs) Canada (SMEs) United Kingdom (large companies) Austria
R&D allowances	United Kingdom Belgium Netherlands Slovak republic	United Kingdom (SMEs)

Source: own construction based on OECD (2015b)

The United Kingdom provides cash credits for SMEs in a loss position up to 33.35% of qualifying expenditure. Cash credits are available as well as for large companies under the R&D expenditure credit scheme if the company does not have corporate tax liabilities. Unused benefits may be carried forward for utilization in future periods. In Belgium there is no an immediate refund of tax credit. If it is not utilized it can be refunded only after 5 years.

Where a government seeks to maintain control over the budget allocated to tax incentives, it can put a ceiling on the amount that a firm can claim. There are two types of ceilings: a cap on the absolute amount of R&D that can be claimed (Australia, Norway, Canada), or a cap on the maximum amount of the tax incentive that can be deducted (Hungary, Japan, United States, Spain). Limits can be defined as absolute amounts or as a percentage. While the presence of an absolute upper ceiling reduces the overall cost of support by limiting the absolute amount of R&D expenditure or tax relief that a firm can claim, it may also reduce the incentive effect at the margin among large firms, which typically have higher levels of R&D. In contrast, proportional limits reduce tax support for all eligible firms regardless of their size. For example, in Hungary, the R&D tax credit can be applied to reduce up to 80% of tax liabilities. Meanwhile, Norway limits the absolute amount of qualifying expenditures. The maximum base is 15 million NOK in the tax year for projects based on the taxpayer`s own R&D, and 33 million NOK for projects based on R&D purchased from institutions approved by the Research Council. In the case of a rapid increase in R&D activity, the limiting of the maximum amount of tax relief as a percentage of corporate tax liability may reduce the risk of a significant decrease in tax payments and provide a certain level of corporate tax revenues.

Threshold-dependent rates imply a discrete reduction in the size of the R&D tax credit or allowance rate once qualified R&D spending surpasses a pre-defined threshold amount. For example, in Canada, qualified current R&D expenditure by SMEs is completely refundable up to 3 million CAD, whereas above 3 million CAD only 40% is refundable (or there may be no refund at all, depending on certain conditions).

Thus, a ceiling is applied by most of the countries that use R&D tax incentive schemes and serves to spread R&D budgets over time and over subcontractors, and can be an indirect way to target tax incentives based on firm size.

If countries wish to stimulate at least the base amount of a company's R&D investments they can put a floor on R&D expenditure. This type of limitation is less common and used in only a few countries (Australia, Italy). Setting a floor on R&D expenditure can have the practical advantage of avoiding administrative costs that are high compared to the fiscal incentive, but can put young innovative firms at a disadvantage, as they tend to have lower R&D budgets.

Another popular form of tax incentives is accelerated depreciation provisions for R&D capital that allows recovery of the investment more quickly than the underlying economic depreciation of the long-lived asset (an immediate, e.g. in Spain, United Kingdom, or accelerated write-off of expenditures, e.g. in Belgium, France). According to OECD statistics the share of machinery and equipment, and building expenditures is about 10% of total R&D expenditure across OECD countries, which limits the effect of such incentives (OECD 2017).

When designing expenditure-based R&D tax incentives eligible expenses must be defined. They may include current R&D expenditures or parts thereof (for example, wages), capital R&D expenditures or parts thereof (for example, machinery and equipment or buildings), and all expenditures for R&D (current and capital). Qualifying all R&D tax expenditures enlarges the incentive for companies, but increases the public cost of the policy. For example, in Canada only current expenses are eligible for tax credit (salaries and wages for employees in Canada, materials, overhead and some others). In France eligible expenses include general and administrative expenses, depreciation allowances for R&D assets, staff expenses, contract research costs, patent costs and costs of technological monitoring, while materials used in the research process don't qualify. Belgium proposes tax credit for wages paid to qualifying researchers working on R&D projects ("payroll withholding tax credit"). While Spain and France allow accelerated depreciation only for machinery and equipment, in United Kingdom and Belgium it is applied for all capital R&D expenditures.

Tax incentives based on the wage bill paid to researchers can be considered better practice from the point of view of spillover effects (European Commission 2014).

Besides they have a practical advantage in lowering administration and compliance costs.

Government can provide tax incentives in form of a reduced corporate tax rate (for example, “Patent box” or “Innovation box” regime). The types of IP that qualify for preferential tax treatment vary. For instance, in addition to patents, some countries (Hungary, Italy, Spain) include "know-how", trademarks, designs and models as qualified IP for tax benefit purposes.

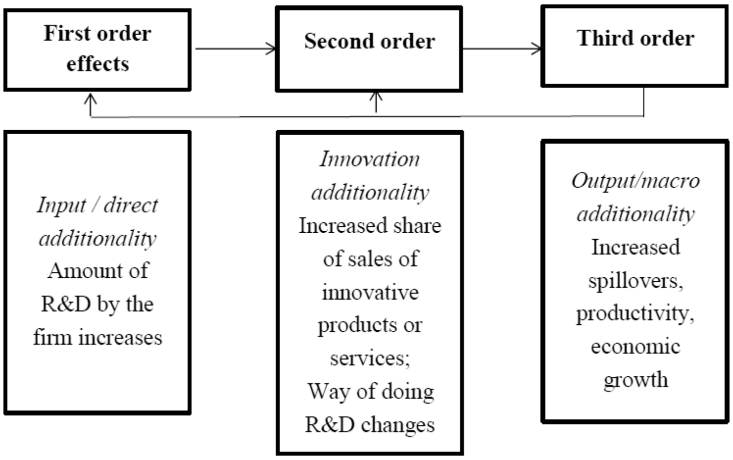
By combining different schemes, government can achieve several policy goals. For instance, the Netherlands offers fiscal incentives on labor costs (WBSO), R&D tax allowances for capital costs and certain current costs (consumables), and Innovation box. Belgium, in addition, also offers accelerated depreciation for assets used in R&D. Thus, some countries simultaneously stimulate R&D investments, patenting activity and spillovers.

After designing tax incentives some important administrative questions should be resolved: the necessity of pre-approval of qualified R&D expenditures, and requirements for mandatory documentation to support the claim. Sometimes usage of pre-approval may be explained by particular features of the R&D tax credit. For instance, in Belgium for the application of an R&D investment deduction applied to R&D investments beneficial to the environment, the taxpayer must file a claim for environmental certification though regional authorities. In Australia, pre-approval is mandatory only for activities that will be physically performed outside the country, and aims to limit unwarranted shifting of R&D abroad. Most countries don’t require initial approval, but oblige firms to maintain supporting evidence (e.g. information, records, documentation) in the event of an audit by tax authorities (for example, Canada, Check Republic, Japan). Other countries have record keeping substantiation requirements only for particular entities, depending on the level of R&D expenses (e.g., France) or size of cash refund (e.g., Spain). The absence of approvals mentioned above lowers administrative barriers to the utilization of tax incentives, but reduces government control of qualifying R&D expenditures.

4. Evaluation of effectiveness of R&D tax incentives

When designing R&D tax incentives, policy makers should already clearly identify which data will be needed for their evaluation, and how to collect these data. Evaluation is essential in monitoring effectiveness of R&D tax incentives. The main question that should be answered is: do tax incentives achieve their objectives and to what extent? John Clark and Eric Arnold (2005) proposed measuring three types of effects (Figure 1).

Figure 1 Effects from fiscal R&D incentives



Source: own construction based on Clark–Arnold (2005)

The first- and second-order effects normally arise at the firm level, while third-order effects happen at the economy or international level. Moreover, all these effects can reinforce each other through a feedback loop.

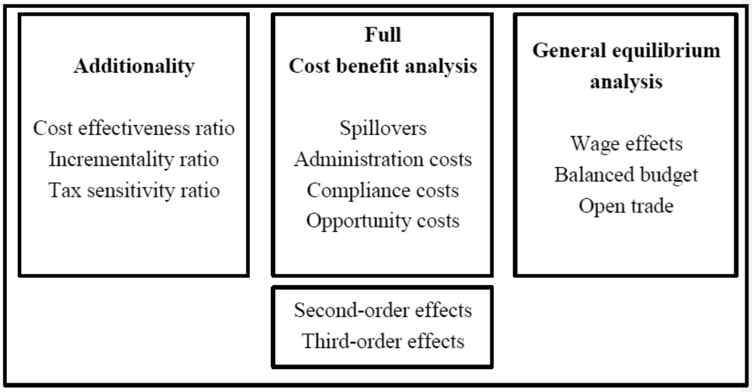
Since the main objective of expenditure based R&D tax incentives is to stimulate private investment, input additionality is a central question. The empirical analysis amounts to comparing the tax expenditures with the additional amount of R&D spent by private firms. The policy is said to lead to additional R&D if firms spend in excess of the amount of tax incentives they receive from the government. The policy is clearly ineffective if investment displacement occurs - that is when firms simply substitute government tax support for private R&D financing.

Beyond the induced R&D, there remains the question of whether this additional R&D is efficient in generating innovation output (innovation additionality) and ultimately improves economic performance and net welfare (macro additionality). There are different approaches and methodologies that can be used in the evaluation of tax incentive effectiveness (Figure 2).

Testing for additionality generally involves the computation of the “bang for the buck” (BFTB). It is measured by dividing the amount of R&D generated by the R&D tax incentives by the net tax revenue loss (tax expenditures or taxes forgone). The BFTB is also known in the literature as the “incrementality ratio”, “cost effectiveness ratio”, “tax sensitivity ratio” or “inducement rate” (Parsons–Phillips 2007).

When calculating tax expenditures, one should consider the change in the firms’ tax positions, since the tax credits can be taxable themselves (Hall–van Reenen 2000).

Figure 2 Reconciling evaluation notions



Source: Mohnen–Lokshin (2008)

To isolate the effect of R&D tax incentives on R&D two main approaches can be used:

1. structural modelling approach;
2. quasi-experimental econometric evaluation approach.

The structural approach has been adopted by institutions such as the U.S. Government Accounting Office (GAO 1989) and the OECD (1997), and it has been developed by several authors such as Hall (1993), Mairesse and Mulkay (2004, 2008) and Lokshin and Mohnen (2007, 2009).

This approach involves the two following steps for estimating the effect of the tax credit on R&D expenditures:

1. computation of the impact of the tax credit on the "effective price of R&D" faced by the firm, or more generally on the "user cost of R&D capital" (actual costs of R&D) for the firm;
2. specification and estimation of an econometric model that relates the changes in the firm's R&D to changes in the effective price of R&D or in the user cost of R&D capital (elasticity coefficient of R&D expenditure with respect to the user cost of capital is estimated).

Structural modelling allows evaluating future reforms and separating short-term (1 year) from long-term effects (5-15 years). The necessity of distinguishing these types of effects arises due to the fact that induced R&D may take time to show up because of adjustment costs in R&D (devising projects, finding scientists and engineers, etc.). In addition, the long-term effect may be larger because an increase in R&D investments adds to the firm's knowledge base, thereby increasing the marginal payoff of future R&D investments.

A difficulty of the structural approach is in reverse causality between the amount of R&D expenditure and the user-cost of R&D (Gaillard-Ladinska et al. 2015). A number of R&D tax credit schemes share the characteristic that the size of the tax credit is dependent on the amount of R&D performed. The user cost of R&D capital thus increases with the level of R&D expenditure, which leads to potential underestimation of the effectiveness of the tax credit. In the absence of a social experiment or suitable instrumental variable, some studies try to reduce this problem by controlling for lagged R&D expenditure and fixed firm effects using a dynamic panel data estimator (examples are Baghana and Mohnen (2009) and Harris et al. (2009)).

Quasi-experimental evaluation approach statistically constructs a control group and compares the growth rate of R&D expenditure from before to after the policy reform, for firms just below and just above the eligibility ceiling. It provides convincing ex-post additionality estimates, but unlike the structural approach, it doesn't allow for the simulation of the impact of changes in the features of the tax credit. Furthermore, it often makes no distinction between short term and long-term effects.

A comprehensive computation of the effectiveness of R&D tax incentives generally requires a *full cost-benefit analysis* that would compute the total (direct and indirect) costs and benefits related to the R&D tax incentive. On the benefit side, it would mean not just computing the amount of additional R&D but also the return on that R&D. This requires looking into the existence of second-order and third-order effects, i.e. the effects on innovation behavior and on an economic performance measure like productivity or profitability. Another kind of secondary effect that should be included is an increased producer surplus accompanying an expanded R&D capital stock. A proper analysis of benefits requires incorporating R&D spillovers which can be positive (knowledge externalities or rent) or negative (market stealing or obsolescence).

The main components of costs are:

1. foregone tax revenues, assessed by taking into account the opportunity cost of public funds;
2. compliance costs of R&D performing firms applying for R&D tax incentives (e. g. hiring consultants, accountants, financial experts);
3. tax administration costs of governmental bodies administering the R&D program (e.g. hiring auditors, tax officers).

The idea of the analysis is not to estimate all of these various elements, but to conduct a sensitivity analysis by simulating the benefit-cost ratio using ranges of reasonable estimates of R&D, to see what patterns of estimates of the various components that matter would produce positive net results. The limits of the approach are thus mainly due to very imprecise estimations of these various components.

While econometric techniques are well suited to capturing effects that may be quantified in a sensible way, they are not appropriate for identifying behavioral additionality, i.e. changes in the way firms understand R&D and how R&D decisions are made. Here, surveys are a more relevant method.

After the assessment of R&D tax effectiveness, a government should reach a decision on whether a tax incentive scheme should be continued, modified or abandoned. Thus, it is necessary to take into account a time gap between the introduction of tax incentive and different types of effects arising (particularly, second- and third-order effects). Frequent and substantial policy changes are likely to strongly reduce the effectiveness of policies – regardless of their design (Westmore 2013).

5. Conclusion

When introducing tax incentives governments should clearly identify the aims and possible results of such policy. The policy effectiveness will depend on the design of the incentives themselves, administrative mechanism, timely and reliable assessment of the effects that will lead to appropriate conclusions, and further improvements. The accumulated international experience should be considered.

By combining different R&D tax incentives schemes, countries may achieve several policy objectives such as growth of R&D expenditures, providing support to small and medium-sized enterprises; stimulating cooperation between industry and public research institutions and universities; and encouraging patenting activity. This will provide diversity of available tax incentives and ensure the tax competitiveness of the country. When introducing or modifying tax incentives the preference should be given to volume-based tax incentives and carry-over provisions. The former will be easier to administer for both firms and tax authorities, while the possibility of carrying over provisions will provide firms with more flexibility in their investment decisions, allowing them to invest in high risk R&D activity with high innovative potential. Countries should also take into account that the lower the corporate tax rate of a country, the higher the tax support provided in the form of tax allowances should be (due to less tax savings), in order to raise their significance.

The evaluation method of the effectiveness of tax incentives will depend on the country-specific context with its particular economic structure, social values, as well as accumulated evaluation expertise, and on the data that can be collected. The survey is the most common and convenient means, while econometric techniques represent a more complicated but objective way to estimate the extent of additionality.

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