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AN INTERNATIONAL COMPARISON OF TAX ASSISTANCE FOR RESEARCH AND DEVELOPMENT: ESTIMATES AND POLICY IMPLICATIONS†

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SUMMARY

Business spending on research and development (R&D) is generally recognized as a private activity providing broader economic benefits that justify government support. But subsidizing R&D has costs as well as benefits, and governments need to exercise judgement to ensure that subsidies are set at a level that results in a net economic benefit for society as a whole, not just for the recipients of the assistance. A key finding of the international comparison undertaken in this paper is that Canada and nine other of the 36 countries in the comparison group are providing R&D subsidies that are likely too high to generate a net economic benefit. Subsidy rates in this group of countries range from 25 to 45 per cent. The risk of excessive subsidization is confined to small firms in Canada, which receive a subsidy of almost 41 per cent through the tax system. Canada's subsidy rate for small firms is the third highest, behind Chile and France. Other countries providing subsidy rates close to 40 per cent are Spain and India.

This paper also assesses several design features of tax assistance measures, including enhanced benefits for small and young firms, refundability of benefits and incentives based on increases in R&D spending above a base level.

While the best policy for R&D subsidies may be a uniform rate for all businesses regardless of age or size, the case for favouring young firms is somewhat stronger than for favouring all small firms. Focusing on young firms avoids providing benefits to small firms that are not growth-oriented; but, it is difficult to design a program that can be completely restricted to young firms since entrepreneurs would have an incentive to create new firms to avoid losing higher benefits. Even with this "leakage", however, an age-dependent incentive could be more cost-effective than size-dependent enhanced benefits.

There is a particularly strong case for providing refundability to young firms, which are unlikely to have taxable income while the first round of R&D is undertaken

While refundability for large firms has the advantage of increasing the effective subsidy rate on R&D to its target level, it runs the risk of revenue losses as multinational firms have less incentive to 'book' taxable income in Canada. A reasonable compromise would be to adjust the value of unused credits and deductions to maintain their present value.

International comparisons of tax assistance for R&D typically highlight country rankings and express satisfaction with the most generous regimes. This paper draws attention to the possibility of providing too much of a good thing, a warning that governments in Canada should keep in mind when preparing next year's budgets.

† The authors wish to acknowledge the helpful comments of the anonymous referees.

INTRODUCTION

Business investment in research and development (R&D) is widely recognized as providing benefits to the broader economy that exceed the benefits to the firms undertaking the investment. As a result of this externality or spillover, many governments provide assistance to firms undertaking R&D in order to encourage more of it. Assistance is provided in the form of contracts, loans, grants and tax incentives. All members of the Organisation for Economic Co-operation and Development (OECD) provide some form of government assistance for business investment in R&D; 27 of the 34 members provide tax credits for investment in R&D or tax-depreciation allowances that exceed the value of the spending on R&D.

This paper presents an international comparison of tax assistance for R&D. Most OECD member countries and four key emerging and transition economies are included in the comparison, which is based on how tax incentives affect the user cost of R&D instead of the more commonly used "B-Index" approach. The B-Index is calculated assuming that R&D should be expensed rather than capitalized, which understates the amount of assistance provided and leads to the anomalous outcome where failure to allow expensing results in a negative subsidy. Adopting the user-cost framework has the additional advantage of allowing the impact of income-based tax incentives, such as patent boxes, to be assessed along with expenditure-based measures, although that extension is not undertaken in this study.

This paper measures the impact of tax incentives on the marginal incentive to invest in R&D. This requires a careful assessment of the base for tax incentives and an evaluation of how caps and thresholds affect the value of assistance provided. For example, Norway's 18 per cent tax credit available to larger firms is capped at 5.5 million kroner (US$625,000), so that for firms spending more than this amount, there is no incentive to undertake additional R&D — the marginal effective subsidy rate is zero for firms subject to the cap.

Within the comparison group of countries, the median subsidy rate calculated for large firms is 13.4 per cent, while the subsidy rates in the top quartile range from 24 per cent to 42 per cent. The median subsidy rate for small firms is almost 5 percentage points higher and the top rate is 45 per cent. Such high subsidy rates should give rise to concerns about excessive subsidization. Simulations with a model developed to analyze the Canadian R&D tax credit[1] suggest that for subsidy rates in excess of 25 per cent there is considerable risk that the social costs of providing assistance will exceed the benefits. The risk of excessive subsidization is of particular concern for small firms since they have substantially higher administration and compliance costs per dollar of subsidy received, making it more likely that social costs will exceed benefits at a given subsidy rate.

The OECD periodically undertakes international comparisons of tax assistance for R&D, the most recent of which was published in 2013.[2] The subsidy rates in the OECD study are calculated using the B-Index approach. In addition, the OECD study generally shows the maximum subsidy rate available rather than attempting to capture the impact of caps on the amount of assistance provided. These methodological differences have roughly offsetting impacts on the median subsidy rate, but there are substantial differences for specific countries in the two studies.

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[1] See John Lester, "Benefit-Cost Analysis of R & D Support Programs," *Canadian Tax Journal* 60, 4 (2012): 793-836.

[2] See "R and D tax incentives" in Organisation for Economic Co-operation and Development (OECD) 2013b Science, Technology and Industry Scoreboard 2013: Innovation for Growth, OECD Publishing. http://dx.doi.org/10.1787/sti_scoreboard-2013-16-en.

THE USER COST OF R&D CAPITAL

There are two approaches to calculating the user cost of R&D capital. In the standard approach, inputs to the R&D process are implicitly treated as R&D capital in and of themselves: user costs are calculated for each input using tax parameters and asset-specific depreciation rates. Capital inputs are assumed to depreciate at the same rate as when used in other applications, while current inputs are assumed to depreciate at the same rate as the intangible asset they are used to create. The standard approach has been rightly criticized as ad hoc by McKenzie,[3] who develops a methodology that takes explicit account of the microeconomic foundations of R&D in order to aggregate the cost of the inputs used to produce R&D capital. In this approach, the after-tax cost of each input (labour, materials, equipment and facilities) is aggregated using an R&D production function and the user cost of R&D capital is obtained by multiplying this cost by the sum of the cost of finance and the depreciation rate of the R&D capital. The depreciation rate is determined by the revenue stream expected to be generated by R&D capital; it is independent of the economic depreciation of the capital inputs used to create the R&D capital. The estimates in this paper are based on McKenzie's approach.

Three key assumptions are made when implementing the user-cost approach. The first is that the user cost is calculated for a marginal investment, one that earns just enough to provide suppliers of financial capital their minimum required return, adjusted for risk. The second important assumption is that firms have enough taxable income to use non-refundable credits as they are earned. This is unlikely to be true in practice, but there is not enough information available to make credible adjustments for the decline in value of credits caused by delays in claiming them. Finally, the benchmark for comparing the impact of tax incentives is the net-of-tax user cost of capital, which is assumed to be the same for all countries.

The economic parameters used in this study comprise the risk-adjusted supply price of financial capital, the inflation rate, a debt-asset ratio, the weights used to determine the composition of a typical R&D investment, and the depreciation rate of R&D capital. The risk-adjusted return on debt is assumed to be equal to the average rate of return on 10-year government bonds in G7 countries; the risk-adjusted return on equity is linked to this rate via tax-arbitrage conditions. The marginal supplier of financial capital is assumed to be a taxpayer facing the average personal income tax rates in the G7, and is common to all countries. Rates of return in the model are expressed in real terms, using an assumed inflation rate of two per cent. The cost of finance to firms varies by country since it is calculated from the supply price of capital, the debt-asset ratio and country-specific corporate income tax rates. The debt-asset ratio is set at 40 per cent, based on Canadian data. The shares of R&D inputs (wages, other current costs and capital) are based on average shares for 21 OECD countries in 2005. R&D capital is assumed to depreciate at 15 per cent per year, which Hall[4] describes as the consensus view.[5] Additional information on the economic parameters is provided in Annex 1.

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[3] Kenneth McKenzie, "Measuring Tax Incentives for R&D," *International Tax and Public Finance* 15 (2008): 563-581.

[4] Bronwyn Hall, "Measuring the Returns to R&D: The Depreciation Problem" (National Bureau of Economic Research Working Paper 13473, October 2007).

[5] While Hall describes a 15 per cent depreciation rate as the consensus view, some of her own empirical work suggests that a higher rate could be appropriate.

Income tax rates are obtained primarily from the OECD Tax Data Base while the primary source for tax allowance rates is Finance Canada.[6] R&D tax incentives for which legislation has been passed as of February 2014 are included in this study, with the exception of Québec's 20 per cent reduction in tax assistance for R&D that was announced in the June budget. Deloitte[7] is a key source of information for these incentives; other sources are noted in the relevant annexes.

R&D TAX INCENTIVES IN THE COMPARISON GROUP OF COUNTRIES

This study examines tax assistance for investment in R&D in 32 of 34 OECD member countries[8] and four key emerging and transition economies: Brazil, Russia, India, and China. The key features of tax incentives in these countries are summarized in Table 1. From the table, it can be seen that:

- Eighteen of the 36 countries provide tax credits for investment in R&D. In 14 of these countries, tax credits are deductible from corporate income tax liabilities and in four they are deducted partially or wholly from payroll-tax withholdings of R&D personnel.
- In most countries corporate-income-tax-based credits are non-taxable: they do not reduce the base for calculating tax-depreciation allowances or otherwise affect taxable income, which increases the amount of assistance provided. In contrast, credits based on withholdings increase the taxable income of the beneficiaries.
- Tax credits are based on wholly or partially on incremental spending in six countries.
- Credits against corporate income tax are refundable for all eligible firms in six countries and refundable for small firms only in three other countries. Tax credits based on payroll-/social-security-tax withholdings are effectively refundable, so just over half of all countries providing tax credits make them refundable for all firms.
- Twelve countries provide super-deductions for all firms and four of these countries provide tax credits as well.
- Benefits are capped or subject to a threshold in 14 countries.
- Six countries provide enhanced benefits for SMEs and three provide enhanced benefits for young firms and startups. Caps and thresholds create preferences for small firms in five other countries.

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[6] Finance Canada, "An International Comparison of Tax Assistance for Investment in Research and Development" *Tax Expenditures and Evaluations* 2009 (2009), http://www.fin.gc.ca/taxexp-depfisc/2009/taxexp0902-eng.asp#part2.

[7] Deloitte Touche Tohmatsu Ltd., *Global Survey of R&D Tax Incentives* (2013).

[8] Slovenia and Estonia are not included in the comparison.

TABLE 1: SUMMARY OF TAX INCENTIVES

Corporate Income Tax			Payroll/Social Security Witholdings
Tax Credits		Super-Deductions	Tax Credits
Level	Incremental/Hybrid		
Taxable: Australia, Canada, United Kingdom **Non-Taxable:** Austria, Chile, France, Iceland, Norway	**Taxable:** United States **Non-Taxable:** Ireland, Japan, South Korea, Portugal, Spain	Belgium (equipment only), Brazil, China, Czech Republic, Finland, Greece, Hungary, India, Netherlands, Russia, Turkey, United Kingdom	**Taxable:** Belgium, Hungary, Netherlands, Turkey
Refundability			
Australia (small), Austria, Canada (small), France (small), Iceland, Norway, United Kingdom	Hungary, Ireland	United Kingdom	Belgium, Hungary, Netherlands, Turkey
Preferential tax-incentive rates for small companies or young firms			
Australia, Canada, Norway	Japan, South Korea, Portugal (startups)	United Kingdom	France (young innovative firms), Netherlands (startups)
Two-level Incentive Rates			
France			Netherlands
Caps on Benefits			
Australia (small), Canada (small), Chile, Iceland, Norway	Japan, Portugal, Spain, United States	Finland, Hungary	Netherlands

ISSUES IN MODELLING R&D TAX INCENTIVES

In this study, considerable effort has been made to transform statutory investment tax-credit (ITC) rates and accelerated tax-depreciation rates into marginal effective rates by considering the impact of eligibility criteria, caps, thresholds, base effects and other design features of the incentives. This section provides an overview of the issues in modelling these incentives; additional detail is provided in Annex 2.

While the most common situation is for countries to make all current spending (wages, salaries, materials and overhead) and investment in equipment eligible for tax incentives, many countries adopt a narrower definition of eligible spending. For example, the Netherlands has a wage-based credit, while the incentive base is wages and materials in Hungary, Norway, Singapore, Turkey and the United States. A summary of incentive bases by country is provided in Annex 3.

Governments offer volume and incremental tax credits to encourage firms to increase their level of R&D expenditures. Volume credits apply to firms' total qualified expenditures in the current year so that, for tax-paying firms, the average and marginal credit rates are equal to the volume credit rate. Incremental credits apply to an amount of spending in excess of a specific base. They are implemented with the intention of raising the marginal credit rate above the average rate — that is, to reduce the cost of stimulating additional investment in R&D by not offering a credit on infra-marginal investment. Note, however, that spending above the base that would have occurred in the absence of the incentive is also infra-marginal.

For a number of reasons, the marginal rate is likely to be less than the statutory incremental rate. For example, if the base is defined with respect to past R&D investment, the marginal rate is substantially lower than the statutory rate since investment in the current period raises the base in the future. As shown in Annex 2, the marginal rate associated with a 20 per cent incremental credit would fall to under two per cent with an averaging period of three years using the discount rate of 4.7 per cent in the user-cost model. This difference in modelling affects the estimates for Brazil, Korea, Portugal, Spain and the US, who offer incremental credits based on past spending.

France's investment tax credit is unusual in that a higher rate is available on spending up to 100 million euros by all firms — there are no asset or sales tests to determine eligibility for the higher credit. As a result, there are two ways to view the incentive effects for large firms in France. One view is that the marginal incentive for firms performing more than 100 million euros worth of R&D is determined by the credit rate on spending that exceeds this threshold, in this case five per cent. But for large multinational firms, the entire R&D operation in France could be considered their marginal investment: the incentive to locate or remain in France would be determined by the weighted-average credit rate, with the weights being the share of spending above and below the threshold. Data published by the French government[9] indicates that the average subsidy rate for firms affected by the threshold is about 22 per cent. Since the share of R&D spending by large firms affected by the 100 million euro threshold in total spending by large firms is about 45 per cent, the weighted-average "marginal" effective subsidy rate for large firms would be about 26 per cent.[10] This is the subsidy rate used in this study.

Twelve countries in the comparison group cap the benefits available from their tax incentives. The most common approach is a cap on either eligible spending or the value of the tax incentive (Canada, Chile, Finland, Iceland, the Netherlands, Norway, Portugal and the U.K.), but caps are also expressed in terms of sales revenue (Australia) as a percentage of R&D spending (the U.S.), as a percentage of tax liabilities (Spain) and as a function of R&D intensity (South Korea). For example, Norway has an 18 per cent credit for large firms that is capped at 5.5 million kroner (US$625,000) million in eligible spending, so the marginal incentive to undertake R&D is 18 per cent for firms not subject to the cap and zero for other firms; the weighted average of the two rates would be the best indicator of the credit's overall impact on investment incentives. Of the 12 countries imposing caps, four (Finland, Norway, the U.K. and the U.S.) provide sufficient information to estimate their impact on marginal incentives. The impact of the caps in the other countries has been approximated using other data sources, as discussed in Annex 2. The impact of caps and thresholds on marginal effective subsidy rates used in this study is presented in Table 2.

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9 See Ministère de l'enseignement supérieure et de la recherche, "Le crédit d'impôt recherché en 2010" (May 2012).

10 Calculated as (21.7*0.458 + 30*0.542).

TABLE 2: THE IMPACT OF CAPS AND THRESHOLDS ON MARGINAL EFFECTIVE CREDIT RATES[1] (PER CENT)

	Statutory Rate		Marginal Effective Rate	
	Small Firms	Large Firms	Small Firms	Large Firms
Australia[2]	45	40	45	40
Canada – Federal[2]	35	15	35	15
Chile	35		35	7.8
Finland (tax credit equivalent)	32.4		32.4	4.4
France[3]	50/30/5		31.5	26.2
Iceland[4]	20		20	
South Korea		6.0		5.3
Netherlands[5]	50/18		29.2	18
Norway	20	18	16	10.6
Portugal (incremental credit)	50		50	10
Spain[6]	25.7		9.4	19.6
U.K. (tax credit equivalent)	21.5		17.9	
U.S. – Federal[7] (incremental credit)	20		12.4	

1. *Rates applicable to spending eligible for the credit.*
2. *Caps on access to enhanced benefits for small firms are not binding and there is not enough information available to calculate the impact on other firms.*
3. *Tax credit is 30 per cent on first 100 million euros of spending and 5 per cent on spending above this threshold. Young firms are eligible for a 50 per cent tax credit. The rate shown for small firms includes the extra benefit for young firms.*
4. *Caps on small and large firms are assumed not to bind.*
5. *Tax credit is 50 per cent on first 250,000 euros in spending on wages and 18 per cent thereafter; 14 miliion euro cap is assumed not to bind.*
6. *Statutory volume credits plus effective incremental credit.*
7. *Eligible spending capped at 50 per cent of the value of current-year spending.*

As noted above, even in the absence of these explicit caps, delivering assistance through the tax system means that the effective incentive rate will be less than the statutory rate for countries providing non-refundable credits and allowances. For example, in Canada delays in claiming the 20 per cent large-firm credit[11] were estimated to reduce its present value to about 17 per cent.[12] The impact of tying the benefit to taxable income will vary across countries since it depends on the profitability of firms and the rules for carrying forward credits and allowances.[13]

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[11] The large-firm, or regular credit was reduced to 15 per cent in Budget 2012, effective 2014.

[12] Expert Panel Review of Federal Support to Research and Development, "Assessing the Scientific Research and Experimental Development Tax Credit" (Expert Panel Working Document, 2011), 13, http://rd-review.ca/eic/site/033.nsf/vwapj/4_Assessing_the_SRED_Tax_Credit-eng.pdf/$FILE/4_Assessing_the_SRED_Tax_Credit-eng.pdf

[13] In its latest international comparison the OECD presents an "experimental indicator" of tax assistance that reduces the value of non-refundable tax credits to account for the fact that they cannot always be claimed as they are earned. However, the adjustment is the same for all countries and is not empirically based.

RESULTS

The percentage reduction in the net-of-tax user cost (the subsidy rate) arising from R&D tax incentives is shown in Chart 1. For large firms, the median value of the subsidy rate is 13.4 per cent and rates range from approximately two per cent for countries providing only immediate deductibility of current expenses to almost 42 per cent for Spain, which provides a large credit.

Most countries providing tax credits against corporate income tax liabilities do not require firms to reduce tax-depreciation allowances by the amount of the credit received — tax credits are non-taxable except in Australia, Canada, the U.K. and the U.S. This treatment raises the subsidy rate by one quarter on average in the 14 countries that provide non-taxable credits, or about 6.5 percentage points. The impact varies with the corporate income tax rate: in Spain and France, which have corporate income tax rates well above the average for the comparison group, non-taxable treatment raises the large-firm subsidy rate by about 15 percentage points. In Canada, non-taxable credits would cause the subsidy rate to rise about 6 percentage points. Australia's treatment of tax credits is unique: expenditures benefiting from the investment tax credit cannot be deducted from income. This approach reduces Australia's subsidy rate from about 40 per cent to about 16 per cent.

Chart 1 reveals substantial differences in the subsidy rates for large and small firms[14] for 12 countries. Five of these countries (Australia, Canada, South Korea, Norway and the U.K.) have incentives that are more generous for small and medium-sized firms than for other firms.[15] Caps in Chile and Finland result in a larger subsidy for small firms than for larger firms as do the two-level incentive rates in France and the Netherlands. In addition, a cap on benefits in Norway increases the gap in statutory rates between small and large firms. Spain's cap is based on a percentage of tax liabilities; since R&D intensity declines with firm size, this cap is more of a constraint for smaller than for larger firms. Brazil and Hungary provide super-deductions at the same rate for all firms, but small firms receive less benefit because of a lower corporate income tax rate.

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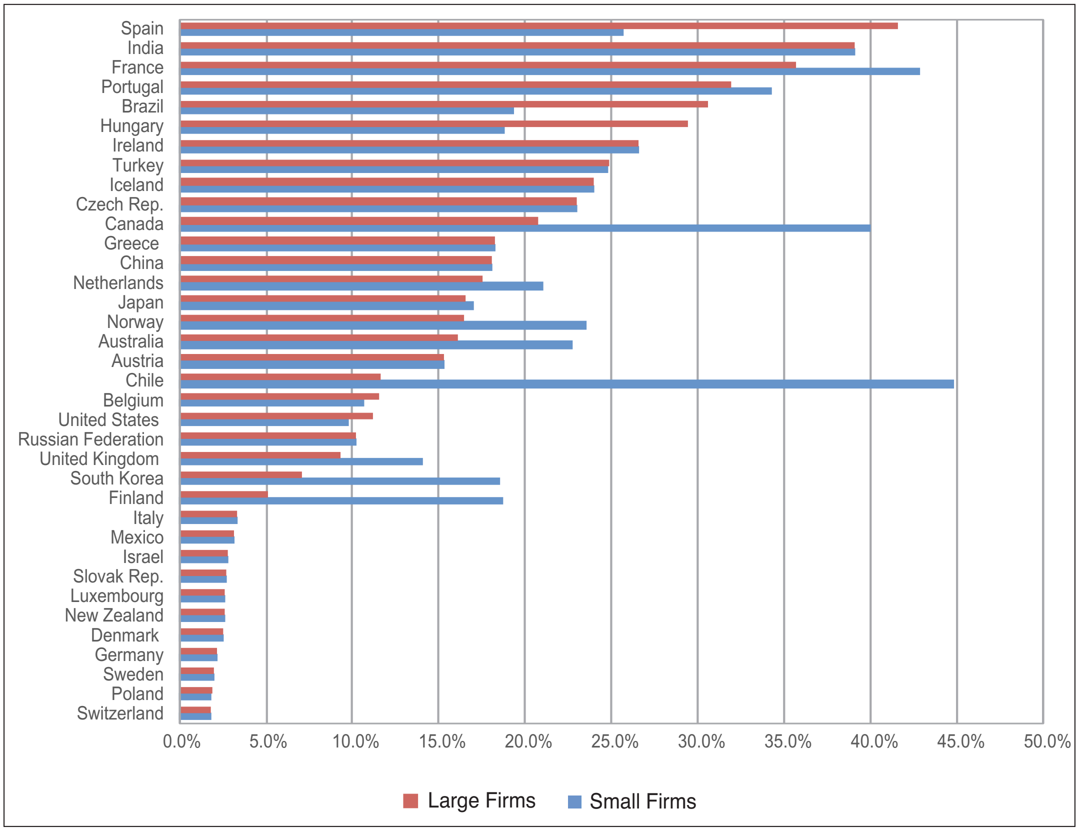
[14] The default definitions of small, medium-sized and large firms in this study are: fewer than 50 employees, between 50 and 249 employees, and at least 250 employees, respectively. Unless otherwise stated, the "large-firm" category includes medium-sized firms.

[15] Japan also provides a more generous tax credit for small firms, but the increase relative to large firms is a relatively small two percentage points.

CHART 1: SUBSIDY RATES FOR LARGE AND SMALL FIRMS



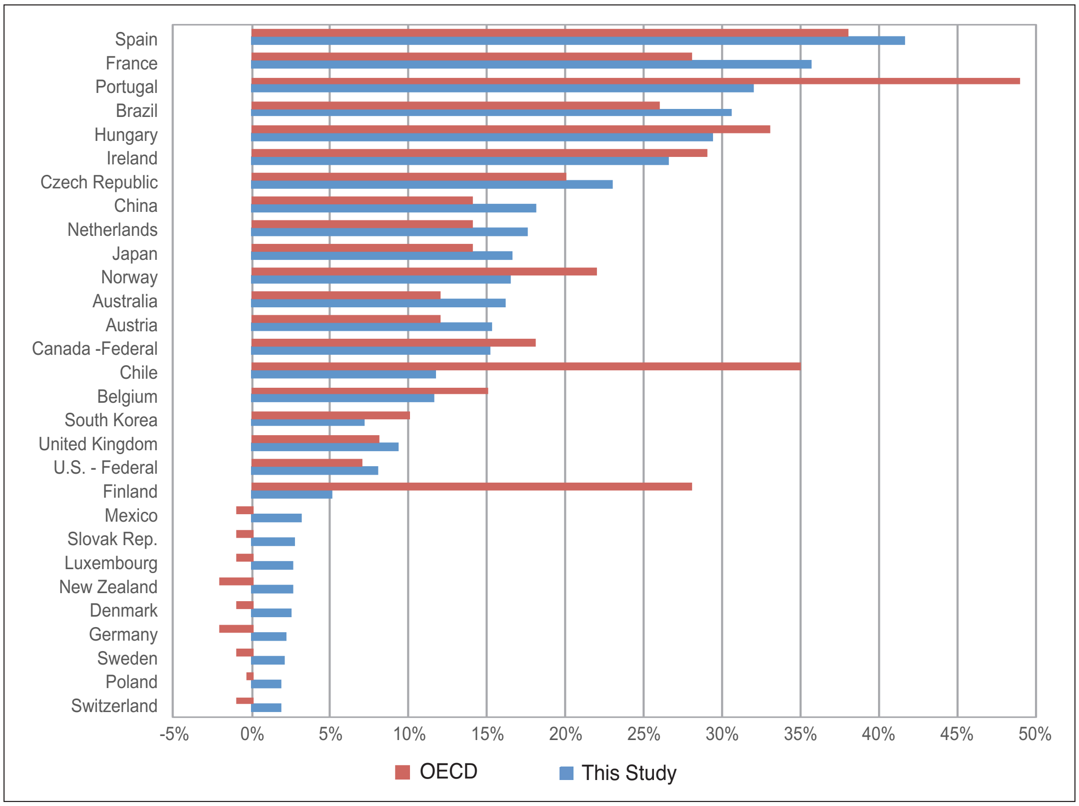
Comparison with the B-Index

The user-cost framework used in this study differs from the B-Index in two respects. First, it includes the tax on the net return to investment in R&D. Second, R&D inputs are used to create a knowledge asset that depreciates over time based on the revenue stream it is expected to generate. The impact of tax-depreciation allowances on the cost of undertaking R&D is assessed by comparing the economic-depreciation rate of the knowledge created by R&D with the tax- depreciation rate of R&D inputs. In contrast, the B-Index approach does not explicitly recognize R&D as a capital asset and assumes that all R&D inputs should be expensed, which was a deliberate simplification when the B-index was developed approximately 25 years ago. As a result, subsidy rates calculated using the B-Index formulation understate the amount of support provided to firms from tax-depreciation allowances.

As a result of these two offsetting differences, the large-firm subsidy rates calculated from the user-cost approach are on average almost three percentage points higher than those obtained using the B-Index framework. Although over half of the countries change rank when the B-Index is used, most of the countries that change rank have low levels of tax assistance for R&D. The results are similar for small firms. Detailed results are presented in Annex 4.

Comparison with OECD estimates

CHART 2: COMPARISON OF SUBSIDY RATES FOR LARGE FIRMS



The OECD periodically publishes estimates of subsidy rates arising from tax assistance for R&D in member countries. Chart 2 compares the large-firm subsidy rates for the 29 countries included in both the OECD report and this study. The latest OECD estimates, published in 2013,[16] are based on the B-Index formula so they would be expected to be, on average, several percentage points lower than the estimates in this study. On the other hand, the OECD estimates generally do not account for the caps and thresholds imposed by some countries. For example, the subsidy rates for Chile, Finland, Portugal and Norway are much higher in the OECD report, reflecting the impact of caps on benefits received by firms. The OECD estimate is lower for France. The estimate is based on a calculated-weighted-average tax credit of 20 per cent for large firms compared to the 26 per cent rate used in this study. The OECD estimate appears to be too low given that the average subsidy rate for large firms subject to the 100 million euro threshold is almost 22 per cent and that slightly more than half of R&D spending by large firms is not affected by the threshold.[17]

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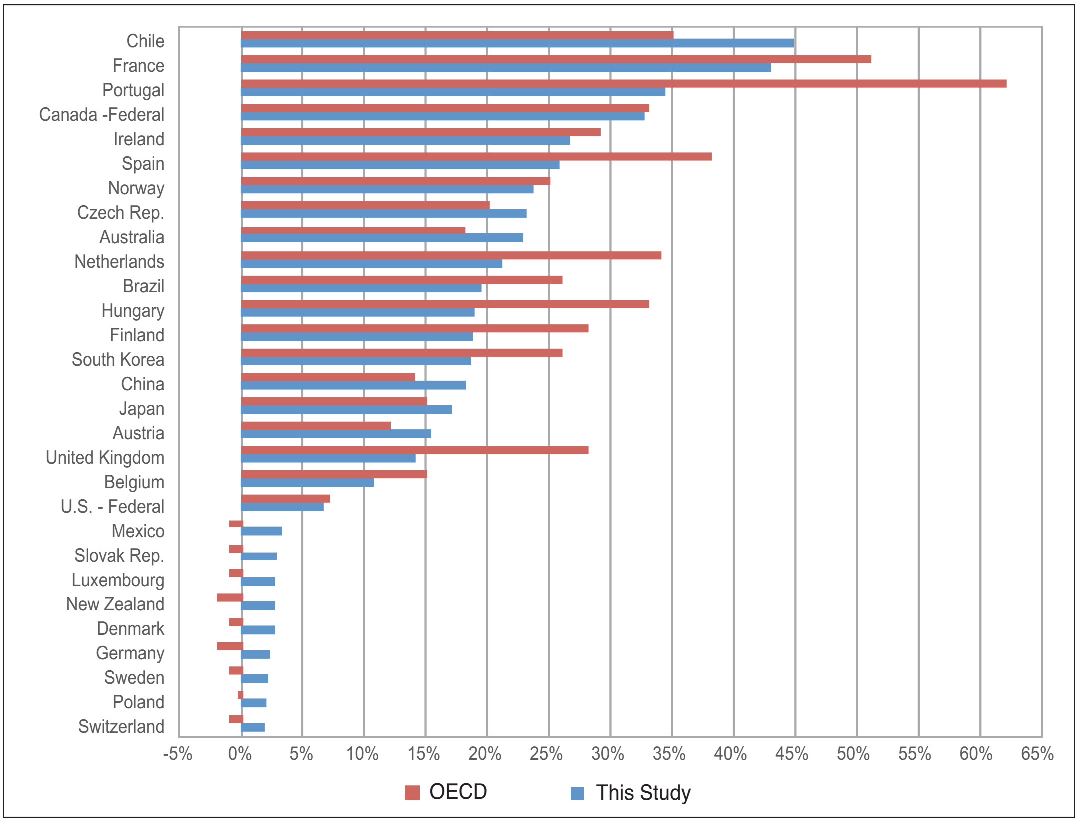
[16] See OECD, "Scoreboard 2013."

[17] Calculated from information presented in tables 1 and 3 of Ministère de l'enseignement supérieure et de la recherche, "Le crédit."

CHART 3: COMPARISON OF SUBSIDY RATES FOR SMALL FIRMS



For small firms, caps result in substantially lower user cost estimates for Finland, Portugal, Spain, and the U.K. (Chart 3). The user-cost estimates are also substantially lower for Brazil and Hungary, possibly reflecting the assumption in this study that the typical small firm values super-deductions at a preferential rate.[18] The lower user-cost estimate for South Korea appears to reflect an overstatement of the base for the 25 per cent credit by the OECD.[19] The OECD estimate for small firms in France applies to young innovative firms, which are exempt from a number of social security charges that raise the credit rate to approximately 50 per cent from the 30 per cent credit available to other small firms. Young innovative firms account for about eight per cent of R&D spending by all small firms in France, so this study uses a weighted-average marginal tax credit rate of 31.5 per cent for small firms. Finally, the OECD subsidy rate for small firms in the Netherlands applies to young firms, while the subsidy rate in this study applies to all small firms and takes account of the cap on benefits. The user-cost subsidy rate is higher for Chile than in the OECD report, possibly reflecting different assumptions about the taxability of Chile's credit.

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18 According to the OECD Tax Data Base (http://www.oecd.org/tax/tax-policy/tax-database.htm#C_CorporateCaptial), the corporate income tax rate for small firms in Hungary is 10 per cent on the first 500 million forint in taxable income (US$3.9 million), compared to 19 per cent for large firms. In Brazil, net income under 240,000 Brazilian real (about US$130,000) is exempt from a 10 per cent corporate income tax surcharge; given the value of Brazil's super-deduction and the preferential income tax rate of 24 per cent, the exemption is sufficient to eliminate tax liabilities on US$770,000 of spending on R&D. In this study, it is assumed that all small firms spend less than that amount.

19 According to Deloitte (*Global Survey*, 2013), South Korea's 25 per cent credit applies only to wages and materials. Combined with a 10 per cent credit for equipment, the overall credit rate is estimated to be approximately 16 per cent in this study compared to 26 per cent in the OECD analysis.

POLICY IMPLICATIONS

The international comparison of tax assistance for R&D draws attention to a number of instrument-design and general policy issues. These include:

- The relative merits of incremental and level-based (or volume) incentives;
- Choosing between tax credits and super-deductions;
- The case for making incentives refundable;
- The case for enhanced benefits for small, young or domestically-oriented firms; and,
- The risk of excessive subsidization.

Incremental versus level-based assistance

It is often argued that applying tax incentives to an increase in spending relative to some pre-defined base is more cost-effective than providing incentives on the observed level of spending.[20] The argument advanced is that incremental incentives avoid subsidizing expenditures that would have occurred without the incentive — they target marginal rather than infra-marginal spending. This argument can be demonstrated more formally by considering the cost-effectiveness, defined as the increase in R&D induced by the incentive relative to the forgone tax revenue.

The cost-effectiveness of a level-based incentive is given by $-\varepsilon/(1-s\varepsilon)$, where ε is the elasticity of R&D with respect to its cost and s is the subsidy rate (see Box 1). With no underlying growth in R&D, the cost-effectiveness of an incremental credit is given by $1/s$, so that a 20 per cent investment tax credit has a cost-effectiveness ratio of 0.833 in level form and five as an incremental credit. When R&D is growing, the cost-effectiveness of an incremental credit falls sharply because spending eligible for the credit increases while the amount of spending induced by the credit does not change. A relatively low rate of underlying growth will push the cost-effectiveness of incremental credits down to the same range as level credits. For example, if the trend growth rate of R&D averages 4.2 per cent, the cost-effectiveness of the incremental credit will be the same as for the level credit, assuming a five per cent discount rate. Given that incremental credits are more costly to apply for and to administer, and that they encourage firms to introduce a cycle into R&D spending in order to maximize the benefits from the credit, the case for incremental credits is far from compelling.

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[20] See for example, Pierre Mohnen and Boris Lokshin, "What Does It Take For An R&D Tax Incentive Policy To Be Effective?" (Institut d'Economia de Barcelona, Working Paper, 2009); and Organisation for Economic Co-operation and Development (OECD), *Supporting Investment in Knowledge Capital, Growth and Innovation* (OECD Publishing: 2013), 91, http://dx.doi.org/10.1787/9789264193307-en

Box 1: Cost-Effectiveness of Level and Incremental Investment Tax Credits

Cost-effectiveness is defined as the increase in R&D induced by the incentive per dollar of tax revenue forgone. The cost-effectiveness ratio (CER) for a level-based credit can be expressed as a function of the elasticity of R&D with respect to its cost (ε) and the subsidy rate, *s*.

(1) $CER = \Delta R\&D / sR\&D_1$ ($R\&D_1$ is the post-policy level of spending on R&D)

(2) $\Delta R\&D = -\varepsilon s\, R\&D_0$

(3) $R\&D_1 = R\&D_0\,(1 - s\varepsilon)$

(4) $$CER = \frac{-\varepsilon s R\&D_0}{sR\&D_0(1 - s\varepsilon)} = \frac{-\varepsilon}{1 - s\varepsilon}$$

For an incremental credit, the tax revenue forgone is determined by applying the statutory rate to the increase in R&D relative to its base value, which consists of an underlying growth component ($R\&D^T$) and the amount induced by the credit.

(5) $$CER = \frac{-\varepsilon as\, R\&D_B}{s(R\&D^T - \varepsilon as\, R\&D_B - R\&D_B)}$$

Where *a* is the factor that converts the statutory incremental credit rate (*s*) to an effective credit rate by accounting for the base effects discussed in the text.

$R\&D^T$ can be calculated as:

$(1 + g)^k\, R\&D_{-k}$, where *k* is the number of years in the averaging period used to define $R\&D_B$ and *g* is the average growth rate of R&D spending over the previous *k* years.

$R\&D^T$ can also be calculated as:

$(1 + g')\, R\&D_B$, where *g*' is a function of *g* and *k*.

Using the second definition of $R\&D^T$ in equation 5 gives:

(6) $$CER = \frac{-\varepsilon as\, R\&D_B}{s((1 + g')\, R\&D_B - \varepsilon as\, R\&D_B - R\&D_B)} = \frac{-\varepsilon a}{g' - \varepsilon as}$$

when $g' = 0$, the cost-effectiveness ratio of an incremental credit is $1/s$, which is many times larger than the CER for a level credit. When $g' = a$, equations 4 and 6 are equal — the cost-effectiveness ratios are the same for both types of credit. Equation A2-1 in Annex 2 implies that *a* equals 0.11 when the base for the incremental credit is defined as a four-year moving average of past spending and the discount rate is 5 per cent. With this definition of the base, the level of spending in the current year is 11 per cent higher than the base ($g' = a$) when the average growth rate of R&D spending over the preceding four years (*g*) is 4.2 per cent.

Note that *a* moves in the same direction as the discount rate. With a 10 per cent discount rate, trend growth would have to be about 7.5 per cent for g to equal *a*. In contrast, the underlying growth rate required to equate the cost-effectiveness of the two types of credit is not very sensitive to the averaging period for the base: the adjustment factor *a* increases with the averaging period, but there is an offsetting rise in *g* as the base gets smaller relative to spending in the current year.

Tax credits versus super-deductions

As noted above, 18 countries subsidize R&D through tax credits, 12 provide super-deductions and five provide both. Super-deductions have a key disadvantage over tax credits: the value of a super-deduction varies with the corporate income tax rate.[21] As a result, as countries raise or lower corporate income taxes, they should also adjust super-deduction rates in order to keep subsidy levels constant. Further, countries that provide uniform super-deductions along with lower corporate income tax rates for smaller firms (i.e., Brazil and Hungary) end up providing a lower level of support for smaller firms, which may not have been the intended outcome.[22] Countries using super-deductions should consider changing them to tax credits with the same value, or in some cases, with their intended value.

Varying support by firm characteristics

Six countries in the comparison group (Australia, Canada, Japan, South Korea, Norway and the U.K.) provide enhanced incentives for small firms. South Korea and Canada stand out in the amount of additional support provided. In South Korea the statutory volume tax credit rate is 25 per cent for small firms and three to six per cent for large firms while in Canada the statutory federal tax credit rate is 20 percentage points higher for small and medium-sized firms than it is for large firms. In the other four countries the additional support for small firms ranges from two to five per cent.

Enhanced support for small firms is frequently justified by the need to help these firms overcome financing constraints. The existence of financing constraints reinforces the argument in favour of refundability made below, but providing a higher subsidy to deal with a capital-market imperfection will be less cost-effective than implementing measures that deal directly with the market failure. Further, the financial-market failure is more likely to be age-dependent than size-dependent.[23]

Enhanced support for small firms would be justified if the spillovers from R&D undertaken by small firms are higher than the spillovers from large firms, or if small firms respond more strongly to a reduction in costs than do large firms. There is no empirical analysis of how spillovers vary by the firm-size categories considered in this paper and the predictions from economic theory are ambiguous,[24] so it would not be prudent to base policy on the existence of higher spillovers for small firms. The response to R&D subsidies by size of firm has been assessed directly or indirectly in seven empirical studies; the findings are not uniform, but on balance lend some support to the view that small firms are more responsive to changes in the cost of R&D than large firms.[25]

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[21] Note that in the absence of refundability, a lower corporate income tax rate reduces the value of tax credits by making it more difficult to use the credits as they are earned.

[22] Some other countries providing super-deductions also have preferential income tax rates for small firms, but the amount of income eligible for the special rate is very small.

[23] See International Tax Dialogue "Taxation of Small and Medium Enterprises," (Background paper prepared by International Monetary Fund staff for the International Tax Dialogue Conference, Buenos Aires, October 2007), 13, for a discussion of this point.

[24] See Lester, "Benefit-Cost," for a more detailed discussion. Nicholas Bloom, Mark Schankerman and John Van Reenen 2013. "*Identifying technology spillovers and product market rivalry*" Econometrica Volume 81, Issue 4, 1347–1393, for examine spillovers by firm size and find that spillovers increase with firm size. However, their study includes only public corporations with more than 500 employees.

[25] See Lester, "Benefit-Cost," for a brief review of the literature.

Another argument made for providing additional support for small or young firms undertaking R&D is that spillover benefits arise when such firms become large, successful enterprises. These spillovers arise to extent that these firms earn rents in the form of above-normal profits or above-normal wages to employees that can be taxed. This tax revenue is shared by society generally, which would justify government support.

On the other hand, there are social costs associated with providing extra support for small or young firms. Since firms receive a subsidy on all the R&D they undertake, not just on the additional R&D resulting from the subsidy, the cost-effectiveness (the increase in R&D per dollar of subsidy) falls as the subsidy rate rises (see equation 4 in Box 1), which implies that social costs (the distortions from raising taxes) are rising faster than social benefits (knowledge spillovers from R&D). In addition, the private rate of return required to undertake R&D projects gets lower as the subsidy rate rises, which means that the private value of R&D projects diminishes as the subsidy gets bigger. Note also that enhanced support for small firms is likely to impose a static-efficiency cost by encouraging small-scale R&D.

The above considerations suggest that additional support for R&D undertaken by small firms could be justified, but that the "premium" should be determined by careful evaluation of the evidence.

The case for providing enhanced support for young firms is somewhat stronger than that for all small firms, for three reasons. First, enhanced support would provide an offset to barriers to entry arising from the patenting activities of incumbents.[26] Second, as argued by the OECD, young firms may be more likely to introduce radical new innovations than are older firms, although there does not appear to be any empirical evidence to support this point. Third, to the extent that transitions from small to large firms result in spillover benefits for society, the probability of making a successful transition is probably higher for young firms than it is for all small firms. In other words, focussing on young firms avoids providing benefits to small firms that are not growth-oriented. On the other hand, it is likely to be difficult to design incentives that can be successfully restricted to young firms since entrepreneurs would have an incentive to create new firms to avoid losing higher benefits. Even with this "leakage," however, an age-dependent incentive could be more cost-effective than size-dependent enhanced benefits. Further, it may be possible to deny "serial entrepreneurs" access to the enhanced benefits.

The OECD has argued that multi-national enterprises (MNEs) are receiving higher-than-intended subsidies because of their ability to shift income to avoid paying taxes on the net return to R&D.[27] When assessing this argument, it is important to bear in mind that with immediate deductibility of current spending and deductibility of debt-interest payments, the marginal effective tax rate on the income earned from investing in R&D is negative. In the presence of the typical 18 per cent tax credit or super-deduction, the subsidy equals 110 per cent of the net return on the investment. With a negative marginal effective tax, MNEs have an incentive to diversify in order to maintain sufficient taxable income in the country where the R&D is performed in order to be able to use the R&D incentives as they are earned. Even if an

[26] See Organisation for Economic Co-operation and Development (OECD), *Supporting Investment in Knowledge Capital, Growth and Innovation* (OECD Publishing: 2013), 91, http://dx.doi.org/10.1787/9789264193307-en, for a brief summary of the literature on this point.

[27] Ibid., 144.

MNE is able to shift income from the R&D-performing location to another jurisdiction with a zero tax rate, the MNE will not have any incentive to do so until all of its deductions and credits have been used to reduce its tax liabilities to zero in the R&D-performing location.

Refundability

Tax credits in more than half of the countries in the comparison group are refundable. The general argument made in favour of refundability is that the inability to use credits (or deductions) as they are earned reduces their value, which is inconsistent with the motivation for subsidizing R&D. The appropriate subsidy rate should be determined by considering the size of the spillover benefit from R&D and the costs of providing assistance; the subsidy rate should not vary with the tax status of the firm.

There is a particularly strong case for providing refundability to young firms, which are unlikely to have taxable income while they undertake the first round of R&D; further, as discussed above, if the effective tax rate on R&D is negative as a result of the subsidy, commercialization of the R&D will not generate sufficient income to make use of the subsidy as it is earned. Failure to provide refundability reduces the effective subsidy rate for young firms relative to established ones; this creates a barrier to entry that can hurt economic performance.[28]

There are advantages and disadvantages of making assistance to large firms refundable. With refundability, the tax-minimizing amount of income shifting will increase because the value of deductions and credits earned in the R&D-performing location will decline. On the other hand, refundability has the advantage of increasing the effective subsidy rate on R&D to its target level for firms that are non-taxable firms for reasons other than income shifting between jurisdictions, such as a cyclical downturn, unusual investment spending or other firm-specific events. Refundability also addresses an anomaly arising when MNEs are resident in countries, such as the U.S., that operate a credit system for foreign taxes. Tax incentives for R&D reduce tax liabilities in the host country, but under a credit system this tax saving can be lost when earnings are repatriated: the benefit from the tax incentive is shifted from the firm to the foreign treasury. A refundable tax credit would be treated as a grant by U.S. tax authorities, so the “treasury transfer” effect would be eliminated. Note however, that U.S. MNEs use tax planning to substantially reduce the amount of taxes payable when earnings are repatriated. As a result, refundability would not have a dramatic effect on the effective subsidy rate for U.S.-owned MNEs.

Adjusting the value of unused credits and deductions to maintain their present value is an option worth considering for large firms. “Indexing” would have the advantage of maintaining the target value of the tax assistance for firms that cannot use credits and deductions as they are earned for entirely legitimate reasons without affecting the incentives to shift income across jurisdictions.

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[28] Bravo-Biosca et al find that more generous R&D tax incentives are associated with a narrower distribution of firm growth in R&D-intensive industries. Firms both expand and contract at a slower pace, suggesting that R&D incentives are protecting incumbents and slowing down the reallocation process, particularly when the effective rate is lower for young firms. It is worth noting, however, that in half of the 10 countries included in the analysis tax assistance is refundable for all firms or for small and medium-sized firms. See Bravo-Biosca, Albert, Chiara Criscuolo and Carlo Menon 2014. “What drives the dynamics of business growth? Nesta Working Paper No. 14/03, http://www.nesta.org.uk/sites/default/files/1403_what_drives_the_dynamics_of_business_growth.pdf

The risk of excessive subsidization

The median subsidy rate calculated in this study for large firms is 13.4 per cent and 18.1 per cent for small firms. The range for the top ten subsidy rates including both small and large firms is 24.8 per cent to 44.7 per cent (Table 3). Based on a benefit-cost analysis of the Canadian R&D tax credit, these subsidy rates should give rise to concerns about excessive subsidization, in the sense that the costs of providing assistance could exceed the benefits.

TABLE 3: TOP TEN SUBSIDY RATES

	Per cent[1]
Chile	44.7
France	42.8
Spain	41.6
Canada	40.0
India	39.0
Portugal	34.2
Brazil	30.5
Hungary	29.3
Ireland	26.5
Turkey	24.8

[1]. *Highest rate in each country.*

The key benefit of intervention arises from the additional knowledge spillovers that occur as firms increase R&D in response to the subsidy. The importance of spillovers depends not only on the spillover rate but also on the responsiveness of R&D to a subsidy. The key costs of intervention are the harm caused by raising taxes to finance the subsidy, the reduction in the private value of subsidized output and the costs of applying for and administering the incentive.

In order to provide a perspective on the risk of excessive subsidization, Table 4 summarizes simulations with a stylized benefit-cost model developed to analyse the Canadian R&D tax credit.[29] The table shows the spillover rate required to generate a zero net benefit assuming a 25 per cent subsidy rate, a price elasticity of -1 and various assumptions about the cost of financing with distortionary taxation as well as compliance and administration expenses. Solving the model for the required value of spillovers emphasizes their importance in the net-benefit calculation as well as the wide range of estimates of the spillover rate found in the literature.[30]

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[29] See Lester, "Benefit-Cost."

[30] In a review of the extensive empirical work on spillovers, Hall, Mairesse and Mohnen concluded that there is evidence of major spillovers of research from one industry to another, but that the estimates range from "close to zero to a full 100 per cent (or even larger in a few cases)." See Hall, Bronwyn, Jacques Mairesse and Pierre Mohnen 2009. "Measuring the Returns to R&D" NBER Working Paper No. 15622, 30, http://www.nber.org/papers/w15622.pdf.

The sensitivity analysis is undertaken with three values for the marginal excess burden of taxation: 20, 40 and 60 cents per additional dollar of revenue raised. Choice of this range was motivated in large measure by calculations of the marginal cost of public funds (MCF) by Barrios et al.[31] for 24 members of the European Union and by Kleven and Kreiner[32] for 23 OECD member countries. (Note that when the marginal excess burden is defined per dollar of revenue raised, as it is in this study, it is equal to the MCF minus one.) Barrios et al use a computable general equilibrium (CGE) model to calculate the MCF for proportional labour taxes and find estimates ranging from 1.14 in Ireland to 1.78 in France, with the MCF generally rising along with the level of taxation in each country. (See Annex 5 for detailed results.) The unweighted average of the MCFs is 1.38; 20 of the 24 estimates are in the 1.2 to 1.6 range.[33] Kleven and Kreiner use a partial equilibrium model to calculate the MCF for taxes on labour income, including consumption taxes; in contrast to Barrio et al., their model includes progressive taxation and extensive (participation rate) as well intensive (hours worked) labour- supply effects. Their estimates for European countries cover roughly the same range and have approximately the same average as in the paper by Barrios et al. Estimates for Japan, New Zealand, the U.S., Australia and Canada range from approximately 1.09 to 1.19.[34]

Given that capital is more mobile than labour, there is a theoretical expectation that the MCF for corporate income taxes will be higher than it will be for taxes on labour income. There is some empirical work that confirms this expectation. Dahlby and Ferede[35] estimate the MCF for indirect, personal and corporate income taxes for the Canadian federal government; they report MCFs of 1.11, 1.17 and 1.71 for the three taxes. Baylor and Beauséjour[36] use a CGE model of the Canadian economy to assess the efficiency cost of these taxes, finding a marginal excess burden of 0.10 for indirect taxation, 0.3 for personal income taxes and 0.4 for corporate income taxes.

Table 4 also reports results for values for administration and compliance costs ranging from five per cent to 20 per cent of the subsidy received. Based on a survey of claimants for the Canadian federal Scientific Research and Experimental Development (SR&ED) tax credit, administration and compliance costs are likely to amount to five to10 per cent of the value of the subsidy received by large firms and 15 to 20 per cent of the subsidy received by small firms.[37]

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[31] Salvador Barrios, Jonathan Pycroft and Bert Saveyn, “The marginal cost of public funds in the EU: the case of labour versus green taxes” (European Commission Taxation Papers, Working Paper N.35 – 2013, 2013).

[32] Henrik Kleven and Claus Kreiner, “The Marginal Cost of Public Funds in OECD Countries: Hours of Work Versus Labor Force Participation” (CESifo Working Paper No. 935, 2003).

[33] See Barrios, Pycroft and Saveyn, “The marginal,” Table 11. Note that the range cited in the text is based on estimates of the MCF obtained when it is assumed that the additional revenue raised is returned to households via a lump-sum transfer. The standard “closure rule” used in the model is that the additional revenue is transferred to the rest of the world — i.e., there is no benefit to domestic households from the additional revenue. This assumption results in higher MCFs.

[34] Barrios, Pycroft and Saveyn, “The marginal,” Table 11. Estimates excluding benefits, which represent a minimum value for the MCF, were used.

[35] B. Dahlby and E. Ferede, “The effects of tax rate changes on tax bases and the marginal cost of public funds for Canadian provincial governments,” *International Tax and Public Finance* 19 (2012): 844-883.

[36] Maximilian Baylor and Louis Beauséjour “Taxation and Economic Efficiency: Results from a Canadian CGE Model” (Finance Canada, Working Paper 2004-10, 2004).

[37] See Lester, “Benefit-Cost,” 808-811, for additional detail.

TABLE 4: SPILLOVER RATE (IN PER CENT) REQUIRED TO GIVE A NET ECONOMIC BENEFIT OF ZERO (SUBSIDY RATE = 25 PER CENT; PRICE ELASTICITY = -1)

	Sum of Administration and Compliance Costs (Per cent of Subsidy Received)			
Marginal Excess Burden of Taxation[1]	0.05	0.10	0.15	0.20
0.2	42.7	49.3	56.0	62.9
0.4	64.4	71.3	78.3	85.5
0.6	84.2	91.3	98.6	106.0

1. *Efficiency loss per additional dollar of tax revenue raised (dollars).*

The key messages from Table 4 are:

- Under the most favourable assumptions about the costs of financing with distortionary taxation (row 1 of the table) and a 25 per cent subsidy rate, the minimum spillover rate required to generate a net economic benefit of zero is over 40 per cent for large firms and well over 50 per cent for small firms, due to their higher administration and compliance costs.
- Using mid-range values for the marginal excess burden of taxation (row 2), the minimum spillover rates rise to about 65 and 75 per cent for large and small firms, respectively.
- Using the high end of the range for the marginal excess burden of taxation (row 3), the minimum spillover rates rise to approximately 85 and 100 per cent.

It is worth emphasizing two points. First, the range of values for the marginal excess burden of taxation was developed from empirical work assessing the distortionary impact of raising taxes on labour income and consumption. A good case can be made that the opportunity cost of R&D subsidies is lower corporate income taxes; in this case, the marginal excess burden of taxation would likely be at the high end of the range shown in Table 4 for most countries and could easily be well above 0.6 for many countries. Second, Table 4 shows critical values for spillovers assuming that the subsidy rate is 25 per cent; in a half-dozen countries, subsidy rates are above 35 per cent, which implies that even higher spillover rates are required to obtain a net economic benefit of at least zero.

The results in Table 4 are highly sensitive to assumptions about the price elasticity of demand for R&D. While there appears to be a consensus on -1 as a central value for the long-run price elasticity of demand for R&D,[38] there is a wide range of estimates in the literature. If the price elasticity is assumed to be -0.5 instead of -1, the minimum spillover rates required to generate a net economic benefit of zero with a 25 per cent subsidy increase sharply (Chart 4). For example, with a marginal excess burden of taxation of 40 cents per additional dollar of revenue raised and the sum of administration and compliance costs amounting to five per cent of the subsidy received, the critical value for spillovers rises from about 60 per cent with a price elasticity of -1 to over 100 per cent with a price elasticity of -0.5. On the other hand, if the price elasticity is -1.5, the required spillover rates range from 50 to 65 per cent.

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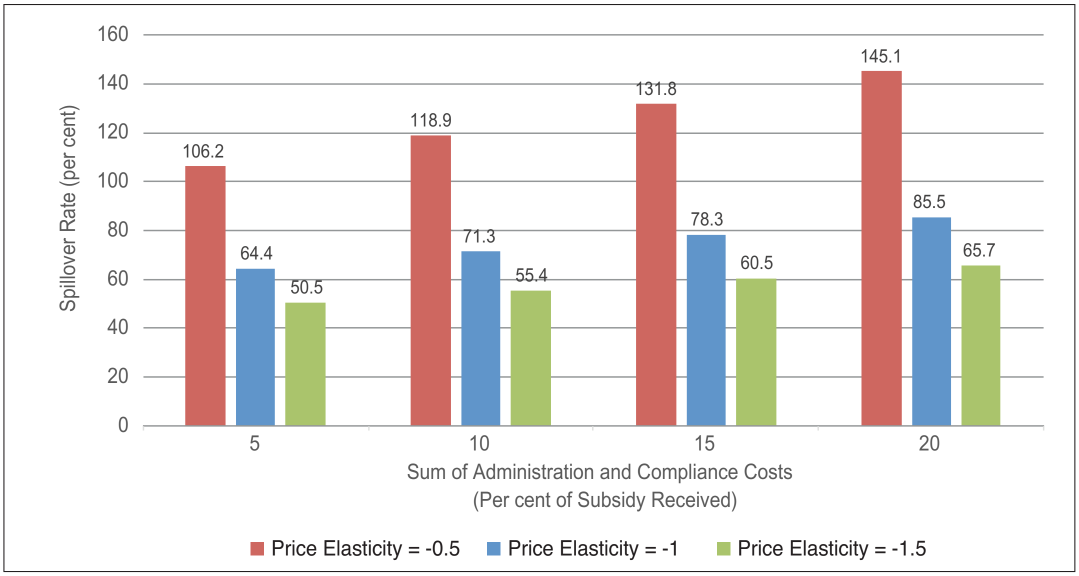
[38] For reviews of the literature, see Hall, Bronwyn, John Van Reenen, 2000, "How effective are fiscal incentive for R&D? A review of the evidence" *Research Policy* Volume 29, Issues 4-5, 449-89; Mark Parsons and Nicholas Phillips "*An Evaluation of the Federal Tax Credit for Scientific Research and Experimental Development,*" 2007, Finance Canada Working Paper 2007-08; and Donald McFetridge,2011, "Evidence on the Responsiveness of Business R&D Spending and/or Innovation to Direct and Indirect (Tax-based) Government Financial Assistance" unpublished manuscript.

It was noted above that there is some empirical support for the proposition that small firms are more responsive to R&D subsidies than are larger firms. A higher (absolute) price elasticity would offset the impact of higher administration and compliance costs on the net benefit from subsidizing small firms. For example, an increase in the price elasticity for small firms to -1.35 from -1 would be sufficient to prevent a rise in the critical value of the spillover rate when administration and compliance costs rise from five per cent to 15 per cent of the subsidy received.[39]

Two qualifications should be made to the foregoing analysis. First, the "generic" analysis should be supplemented by an assessment using country-specific values for spillovers, the marginal excess burden of taxation, administration and compliance costs and the price elasticity of demand. Second, the model used to assess the issue is highly stylized. In particular, it does not capture the impact of international transactions on the net benefit from subsidizing R&D. For example, some of the subsidy provided to domestic R&D performers will be transferred to non-residents through lower prices of R&D-intensive output and higher profits of foreign-owned corporations. While these effects reduce the net benefit to a specific country, world welfare would be enhanced by a co-ordinated approach to subsidizing R&D. In addition, the model does not capture any benefits arising from encouraging more transitions from small to large firms.

CHART 4: SPILLOVER RATE REQUIRED TO GIVE A NET ECONOMIC BENEFIT OF ZERO (MARGINAL EXCESS BURDEN OF TAXATION = 0.4; SUBSIDY RATE = 25 PER CENT)



[39] With respect to the entries in row 2 of Table 2, there would be no change in the spillover rate as a result of moving from column 1 to column 3 if the price elasticity is increased from -1 to -1.35.

CONCLUSION

This paper has presented an international comparison of tax assistance for R&D based on the user-cost framework instead of the more-standard B-Index methodology and discussed some of the policy implications of providing such assistance. Switching to the user-cost framework permits a more accurate assessment of the amount of assistance provided and avoids the anomalous situation of treating the failure to provide expensing of R&D inputs as a penalty. The user-cost framework also has the advantage that it can be used to assess income-based measures, such as patent boxes, along with expenditure-based incentives. Another contribution of this study is a careful evaluation of how eligibility criteria, caps, thresholds, base effects and other design features of the incentives affect their impact on the decision to increase investment in R&D. This analysis is not, however, definitive since in some cases, the information required to accurately model the incentives is not available.

The paper has reviewed a number of policy issues, including the relative merits of incremental and level-based (or volume) incentives; the case for enhanced benefits for small, young or domestically-oriented firms; the case for making incentives refundable; and the risk of excessive subsidization.

- The analysis undertaken in the paper suggests that incremental credits will not always be more cost-effective than level credits, as is sometimes argued, largely because when firms are growing, incremental credits also end up subsidizing R&D that would have occurred in the absence of the credit.
- While the best policy may be to set a uniform subsidy rate, the case for enhanced support appears to be strongest for young firms. Such firms may be more likely to introduce radical new innovations than would older firms. In addition, enhanced support would provide an offset to barriers to entry created by established firms. Finally, if the objective is to reap spillover benefits by encouraging transitions from small to large firms, the probability of making a successful transition is likely to be higher for young firms than it would be for all small firms.
- Theoretical considerations suggest that R&D subsidies should be refundable. As a practical matter however, refundability for large firms gives rise to concerns about loss of revenue from income shifting. These concerns could be dealt with by adjusting the value of incentives that cannot be used as they are earned to maintain their present value.
- The analysis undertaken in this paper suggests that subsidy rates in excess of 25 per cent should give rise to concerns about excessive subsidization; at these rates the costs of intervention could easily exceed the benefits. However, further analysis using country-specific parameter values is required before firm conclusions can be drawn.

ANNEX 1: THE USER-COST MODEL

This annex presents a formal development of the model used in this study to estimate subsidy rates arising from tax preferences for investment in R&D. It also provides a comparison of the user-cost and B-Index approaches to measuring tax assistance for R&D.

Theoretical development

The after-tax cost of capital inputs (equipment and buildings) used to create R&D capital is shown in equation A1-1.

(A1-1) $ATC_k = (1 - c)(1 - uz)\, P_k$

In equation A1-1, c is the tax credit rate applicable to spending on R&D, u is the corporate income tax rate, z is the present value of tax-depreciation allowances on an input costing one dollar[40] and P_k is the purchase price of the asset. If P_k is normalized on one, the after-tax cost represents a proportion of the purchase price. In addition, some countries levy sales taxes on capital inputs and impose taxes on the stock of capital used by the firm.[41] The focus in this paper is on taxes that are specific to R&D, so these taxes are not included in the estimates presented in this paper.

Equation A1-1 reflects the assumption that the base for tax-depreciation allowances is reduced by the amount of the credit. In most of the countries in the comparison group, the tax-depreciation base is not reduced by the amount of the credit (in this case, the credit is sometimes described as "non-taxable"), raising its impact on the after-tax user cost of capital. Non-taxable credits are modelled by "grossing up" z by one minus the tax credit rate (as in equation A1-4, below).

McKenzie[42] includes sales and excise taxes on materials used to perform R&D as well as an estimate of the portion of payroll and personal income taxes on wages that is borne by business. Given the focus on R&D-specific measures in this paper, these taxes are not included in the user-cost estimates. For current inputs (ci), $z = 1$, so their after-tax cost is:

(A1-2) $ATC_{ci} = (1 - c)(1 - u)$

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[40] Future flows of tax depreciation allowances are specified in nominal terms and decline at the tax depreciation rate α. As a result, their present value is calculated using the firm's nominal cost of finance adjusted for their declining value over time so that flows of tax depreciation allowances are specified in nominal terms and decline at the tax depreciation rate α. As a result, their present value is calculated using the firm's nominal cost of finance adjusted for their declining value over time so that $z = \alpha/(\alpha+r_f)$.

[41] Canada and the U.S. are the only OECD countries that impose retail sales taxes on capital goods while eight OECD countries, along with India, impose capital taxes or duties.

[42] Kenneth McKenzie, "Measuring Tax Incentives for R&D," *International Tax and Public Finance* 15 (2008): 563-581.

Assuming a fixed-proportions production function, the after-tax input costs can be aggregated as a share-weighted sum to obtain the overall after-tax cost of inputs. Firms purchase these inputs in order to create an intangible asset that generates a revenue stream over time, so the user cost is obtained by factoring in the financial cost of capital and the depreciation rate of R&D capital. The gross of corporate-income-tax user cost is shown in equation A1-3, where S represents the share of the input in total costs, r_f is the nominal cost of finance, π is the inflation rate, and δ is the depreciation rate of R&D capital.

$$\text{(A1-3)} \qquad UC = (\Sigma_{ci}\ ATC_{ci}\ S_{ci} + ATC_k\ S_k)(r_f - \pi + \delta)/(1 - u)$$

With interest deductibility, the nominal financing cost to the firm, r_f, equals $\beta(1-u)i + (1\text{-}\beta)\varrho$, where i is the interest rate, ϱ is the return on equity and β is the share of debt in total assets.

Replacing the after-tax cost of inputs with their definitions in equations A1-1 and A1-2 gives:

$$\text{(A1-4)} \qquad UC = (1 - c)(1 - uz / (1 - c')) (r_f - \pi + \delta) / (1 - u)$$

Where z is a share-weighted average of the values used in equations A1-1 and A1-2, and c' equals c for non-taxable credits, and zero otherwise.

Equation A1-4 can be rearranged to decompose the user cost into its tax and non-tax components.

$$\text{(A1-5)} \qquad UC = [r - \pi + \delta] + \left[\frac{u}{(1-u)}(r - \pi - \beta i)\right] + \left[\frac{u}{(1-u)}(\delta - (r_f - \pi + \delta)\frac{uz}{(1-c')}\right]$$
$$-\left[c\left(\frac{(r_f - \pi + \delta)(1 - uz' / (1 - c'))}{1 - u}\right)\right]$$

The first term in square brackets in equation A1-5 is the non-tax component of the user cost; the second bracketed term is the tax on the net return to investment in R&D less interest deductibility (β is the share of debt in the capital structure of firms and i is the interest rate on this debt); the third bracketed term is economic depreciation less tax-depreciation allowances; and the fourth bracketed term shows the impact of tax credits on the user cost of R&D capital. Note the use of z' in the fourth term; it equals z when $z \leq 1$, and 1 otherwise, in order to correctly calculate the impact of a tax credit in the presence of a "super-deduction" for R&D spending.[43]

In this study, the benchmark for comparing the impact of tax incentives is the net-of-tax user cost of capital $(r - \pi + \delta)$, which is assumed to be the same for all countries. More specifically, the impact of R&D tax incentives is measured by the percentage change in the net-of-tax user cost. An alternative would be to suppress the tax on the net return along with interest deductibility (r replaces r_f). This is shown in equation A1-6, normalized on the net-of-tax user cost.

[43] The Netherlands, Hungary and Turkey provide both tax credits and super-deductions. Without the adjustment to equation A1-5, the base for a non-taxable tax credit would exceed the acquisition cost of the asset.

$$(A1\text{-}6) \quad IUC = \left\{(r-\pi+\delta) + \frac{u}{(1-u)}\left(\delta-(r-\pi+\delta)\frac{z}{(1-c')}\right) - c\left(\frac{(r-\pi+\delta)(1-uz'/(1-c'))}{1-u}\right)\right\}/(r-\pi+\delta)$$

which equals:

$$(A1\text{-}7) \quad IUC = 1+\frac{u}{(1-u)}\left(\delta/(r-\pi+\delta) - z/(1-c')\right) - \frac{c(1-uz'/(1-c'))}{(1-u)}$$

Note that in this formulation, $\delta/(r-\pi+\delta)$ is the present value of economic depreciation on a one-dollar investment, which is directly comparable to z, the present value of tax-depreciation allowances. The subsidy rate is calculated as 1-*IUC*.

Comparison with the B-Index

The B-index can be derived from equation A1-7 by assuming that the present value of the economic depreciation rate on R&D assets is 1; i.e., that R&D assets should not be capitalized.

$$(A1\text{-}8) \quad BI = 1+\frac{u}{(1-u)}\left(1 - z/(1-c')\right) - \frac{c(1-uz'/(1-c'))}{(1-u)}$$

With this simplification, the impact of tax-depreciation allowances is determined solely by the value of z; there is no explicit comparison with economic depreciation. When z equals one, the B-index equals $1-c$ (for a taxable credit). If, however, z is less than one — that is, if spending is capitalized for tax purposes — there will be upward pressure on the B-index. For example, if $c = 0$, $z = 0.9$ and $u = 0.25$, then the B-index takes on a value of 1.033. The subsidy rate is calculated as 1-*BI*, so in this case the subsidy rate is -0.033.

Adopting the user-cost framework therefore has a clear advantage over the B-Index in measuring tax-subsidy rates. The user-cost framework has the further advantage of including the tax on the net return to investment in R&D, which allows income-based incentives such as “patent boxes” to be assessed alongside expenditure-based tax credits and tax allowances. For example, a 50 per cent reduction in the tax rate on the income generated by commercializing R&D could be modelled by multiplying the second bracketed expression in equation A1-5 by 0.5. While the tax-subsidy rates in this paper are based on equation A1-5 (normalized on the net-of-tax user cost), income-based incentives are not modelled.

Implementing the user-cost approach

This section reviews the economic parameters used in the user-cost model, which comprise the return required by suppliers of financial capital, the financial cost of capital to firms, inflation, debt-asset ratios and the weights used to aggregate the inputs used to create the R&D asset. Most of the economic parameters used in the model are obtained by averaging values in a number of countries, such as the G7 countries or a broader grouping of OECD countries, but in some cases Canadian data are used.

The required return to suppliers of financial capital (investors) is developed with the aid of two assumptions. First, it is assumed that investors require a premium for investing in risky assets, but expect to obtain, in the long run, the same real, risk-adjusted rate of return on all investments. The risk-adjusted nominal rate of return on debt is proxied by the return on government bonds. The risk-adjusted rate of return on equity is not observable, but by assumption must equal the risk-adjusted return on debt, after adjustment for personal income taxes. Second, consistent with globalized financial markets, the marginal supplier of financial capital to large firms undertaking R&D is assumed to be an investor facing the average G7 top marginal rates. As a result, the risk-adjusted return is calculated as the average return on 10-year government bonds in G7 countries over the 10-year period ending in 2007[44] and the long-run equilibrium condition linking debt and equity returns (equation A1-9) makes use of G7 average personal income tax rates.

(A1-9) $\varrho = i(1 - m)/(1 - e),$

where ϱ is the gross of tax return on equity, i is the 1998–2007 average return on G7 10-year government bonds, m is the tax rate on interest income, and e is the effective tax rate on income from equity holdings (dividends and capital gains). The personal income tax rates m and e are GDP-weighted sums of rates imposed in 2010 on capital income received by G7 investors on foreign investments.[45] Since $m = 33.1$ per cent, $e = 22.8$ per cent and $i = 5.8$ per cent, the nominal risk-adjusted return on equity, ϱ, is 4.9 per cent.

The nominal cost of finance to firms is the weighted average of the interest rate on debt, adjusted for interest deductibility, and equity. The weights are determined by the share of debt to debt-plus-equity (the "debt ratio") for Canadian non-financial firms, as calculated from data in Statistics Canada's Quarterly Financial Statistics survey. Over the 10 years ending in 2007, the debt ratio averaged approximately 40 per cent. The nominal cost of finance to firms varies with the corporate income tax rate, but averages 4.7 per cent for all countries in the comparison group.

R&D Spending Shares

The OECD collects data from 19 member countries on R&D spending by input, presenting information on labour costs, other current costs, instruments and equipment, and land and buildings. The most recent data are for 2005. Estimates for Canada and the U.S. are not included in the OECD data set; these gaps were filled with data from public sources in Canada and the U.S.[46] Many countries define eligible expenditures for incentives at a greater level of detail than what is presented in the OECD data set. As a result, the "other current costs" category was split into materials and overhead using shared data from Canada and the U.S. The results are shown in Table A1-1.

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[44] This averaging period excludes the exceptionally low rates associated with the 2008 financial crisis and its aftermath.

[45] The tax rates are from the OECD Tax Data Base, supplemented by country sources to determine the rates applied to investment income from foreign sources.

[46] See Expert Panel Review of Federal Support to Research and Development, "Assessing the Scientific Research and Experimental Development Tax Credit" (Expert Panel Working Document, 2011), 4, http://rd-review.ca/eic/site/033.nsf/vwapj/4_Assessing_the_SRED_Tax_Credit-eng.pdf/$FILE/4_Assessing_the_SRED_Tax_Credit-eng.pdf; and National Science Foundation, "Research and Development in Industry: 2005" (2010), Table 6, http://www.nsf.gov/statistics/nsf10319/.

TABLE A1-1: SPENDING ON R&D BY INPUT
(PER CENT DISTRIBUTION, AVERAGE FOR 21 OECD COUNTRIES)

Wages	Other Current Costs			Total Current	Equipment	Land and Buildings	Total Capital
	Materials	Overhead	Total				
0.505	0.114	0.288	0.402	0.907	0.062	0.031	0.093

Source: OECD and authors' calculations.

ANNEX 2: MODELLING INVESTMENT TAX CREDITS AND ACCELERATED DEPRECIATION

This Annex provides background information on how statutory investment tax credit (ITC) rates and accelerated depreciation rates were transformed into marginal effective rates by considering the impact of eligibility criteria, base effects, thresholds, caps and other design features of the incentives. Marginal effective ITC rates indicate how ITCs affect the cost of spending an additional dollar on R&D and hence the decision to invest.

Tax incentives based on incremental activity

Seven countries — Brazil, South Korea, Portugal, Spain, Turkey, the U.S. and Ireland — provide tax incentives based on incremental activity.

- In Brazil, a 160 per cent super-deduction is increased to 170 per cent for firms that experience up to five per cent growth in R&D personnel and to 180 per cent if the growth rate exceeds five per cent.
- South Korea allows small and medium-sized firms (SMEs) to choose the greater of a 25 per cent credit on current spending or a 50 per cent credit on the excess of current- year spending over its four-year moving average. Other firms in Korea may choose the greater of a credit calculated as three per cent plus 50 per cent of the firm's R&D-to-revenue ratio (this credit is capped at six per cent) and 40 per cent of the excess of current-year spending over its four-year moving average.
- Spain and Portugal provide incremental credits (42 and 50 per cent, respectively) on current R&D spending that exceeds a two-year rolling average of investment, in addition to volume credits. Spain also provides a 40 per cent reduction in social contributions for newly-hired researchers.
- Turkey allows R&D centres with at least 500 researchers to deduct from taxable income 50 per cent of the year-to-year increase in R&D spending. This deduction is in addition to a 200 per cent super-deduction and a credit against personal income tax withholdings of R&D workers.
- The U.S. has two incremental credits, one of which defines the expenditure base in terms of R&D intensity.
- In Ireland, a 25 per cent credit is available on the first 100,000 euros of eligible spending (current plus scientific equipment). Spending above that level is eligible for the credit if it exceeds the level of spending in 2003, or the first year a claim is made, whichever occurs later.

As demonstrated by Eisner et al.,[47] when the base is defined using a past average of spending, an adjustment is needed to the statutory ITC or depreciation rate to account for the fact that current-year spending increases the base in future years and therefore reduces the effectiveness of the incentive.

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[47] R. Eisner, S. H. Albert and M.A. Sullivan, "The new incremental tax credit for R&D: incentive or disincentive?" *National Tax Journal* 37 (1984): 171–183.

$$\text{(A2-1)} \quad c' = c\left[1 - \frac{1}{k}\sum_{t=1}^{k}(1 + r_f)^{-t}\right],$$

where c' is the before-tax marginal credit rate and c is the statutory credit rate, k is the number of years used to calculate the moving average of past expenditures, t is time, and r_f is the discount rate. Equation A2-1 states that the effective tax credit is calculated as the credit on the current-year increment of one dollar less the present value of the foregone credits as a result of the increase in the base in future years. For example, if a Spanish firm increases current spending by a dollar in the current year, it will receive an additional 42-cent ITC, but because the base for calculating the credit rises, the firm will forgo a 21-cent credit in each of the following two years. Using the 4.7 per cent average cost of financing for firms calculated in this study as a discount rate, the present value of the forgone credits is 39.2 cents, which implies that the ITC reduces the cost of investing an additional dollar in R&D by just 2.8 per cent (42 per cent-39.2 per cent).

The results for South Korea, Portugal, Spain and the U.S. are presented in Table A2-1. Note that for most SMEs in South Korea, the volume credit will be more valuable than the incremental credit: an SME would have to be growing at a sustained rate of at least 35 per cent per year for the incremental credit to provide superior benefits. Large firms in South Korea with an R&D-to-revenue ratio in excess of 2.5 per cent would also obtain a larger benefit from the volume credit.

TABLE A2-1: MARGINAL EFFECTIVE CREDIT RATES ASSOCIATED WITH INCREMENTAL CREDITS[1] (BASE IS A MOVING AVERAGE OF PAST INVESTMENT)

Moving average (years)	Statutory credit rate on incremental spending (per cent)				
	14 U.S.[2]	40 South Korea[3]	42 Spain	50 Portugal	50 South Korea[4]
2			2.8	3.3	
3	7.6				
4		4.3			5.4

1. *The discount rate is 4.7 per cent.*
2. *The base for the credit is 50 per cent of a three-year moving average of past investment.*
3. *Large firms.*
4. *SMEs.*

The corporate income tax rate in Turkey is 20 per cent, so the 50 per cent incremental deduction is equivalent to an investment tax credit of 12.5 per cent (0.2/(1-0.2)*0.5) on the year-to-year increase in R&D spending. Applying equation A2-1, the effective credit rate becomes 4.5 per cent. It is assumed, however, that the minimum size (500 full-time researchers) means that few firms in Turkey are able to take advantage of the measure and the effective rate is set to zero. Similar calculations for Brazil's additional incremental deduction indicate that its maximum effective value is less than a one per cent investment tax credit.

In the U.S., there are two investment tax credits available for R&D. The regular incremental credit (RIC) is available to firms that increase their R&D intensity (R&D spending divided by sales revenue) relative to a base-period average.[48] With this formulation, there will be a negative "base effect" only to the extent that R&D investment raises sales by enough to lower R&D intensity below its base-period average. As demonstrated by Watson[49] and Hall,[50] the negative base effect is small enough that there is no need to adjust the 20 per cent statutory credit rate. However, since investment eligible for the credit cannot exceed 50 per cent of investment in the current year, the ITC rate is capped at 10 per cent for firms that are above this ceiling. Only firms with spending that is above the base and below the ceiling can claim a 20 per cent credit.

An Alternative Simplified Credit (ASC) has also been available in the U.S. since 2006. The base for the ASC is 50 per cent of the average level of spending in the preceding three years.[51] As a result, the base effect is much smaller when a simple rolling average of past spending is used: the 14 per cent statutory rate is equivalent to a 7.6 per cent marginal ITC.[52]

TABLE A2-2: CALCULATION OF THE U.S. FEDERAL WEIGHTED MARGINAL INVESTMENT TAX CREDIT RATE IN 2010

	Share [1]	Marginal Rate	Weighted Marginal Rate
Qualified Research Expenditure (QRE) that is :			
Eligible for the RIC – Between floor and ceiling	8.1%	20.0%	1.6%
Eligible for the RIC – Above ceiling	25.1%	10.0%	2.5%
Eligible for the ASC (14% statutory rate) [2]	55.2%	7.6%	4.2%
Not eligible for either credit	11.6%	0.0%	0.0%
Weighted average federal credit rate on QRE			8.3%
Effective rate on total R&D spending [3]			4.8%

RIC: Regular Incremental Credit; ACS: Alternative Simplified Credit

1. *Calculated from IRS statistical tables (www.irs.gov/uac/SOI-Tax-Stats-Corporation-Research-Credit). The share of spending not eligible for a credit is determined residually.*
2. *The marginal rate for the ASC is calculated as the credit available for the current year less the present value of the credits forgone as a result of the increase in the average expenditure base in future years.*
3. *QRE excludes overhead and capital expenses. It accounts for 57 per cent of domestic R&D spending by firms as reported by the National Science Foundation.*

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48 Base spending on R&D for the current year is determined by multiplying base-period R&D intensity by the average level of sales in the preceding four years.

49 H. Watson, "The 1990 R&D Tax Credit: A Uniform Tax on Inputs and a Subsidy for R&D," *National Tax Journal* 49, 1 (1996): 93-103, http://hermes-ir.lib.hit-u.ac.jp/rs/bitstream/10086/19219/1/HJeco0520100130.pdf.

50 Bronwyn Hall, "The United States Research and Experimentation Credit" (Manuscript, August 2008).

51 Firms that have not undertaken any R&D in the preceding three years can use current-period spending as the base but must use a lower ITC rate.

52 If a firm spends an extra dollar on R&D in the current year, it will receive an additional credit of 14 cents, but will lose 2.33 cents (0.5*14/3) in credits in each of the following three years because of the increase in the base for calculating the credit. The present value of the forgone credits is 6.4 cents, which implies a 7.6 per cent marginal ITC.

Data available from the Internal Revenue Service, along with certain assumptions, can be used to calculate the combined marginal ITC rate for the RIC and the ASC (Table A2-2). The calculations presented in the table indicate that in 2010, the latest year of data availability, the federal marginal ITC rate was 8.3 per cent for qualified R&D. The marginal ITC rate on all R&D spending (i.e., the marginal effective ITC rate) is substantially lower — 4.8 per cent — because qualified research expenses account for just under 60 per cent of total R&D.

A review of information provided by U.S. states revealed that as of February 2014, 32 states provide general R&D investment tax credits. Twenty of these states follow the federal rules for the RIC; for these states, weighted marginal tax credit rates were calculated using state-specific statutory rates and the weights in Table A2-2 for eligible spending above the ceiling and between the ceiling and the floor. Another 10 states have incremental credits using a three- or four-year rolling average of spending as the base. The statutory rates were converted to effective rates using equation A2-1. Only two states have level or volume credits. The weighted-average state tax-credit rate on eligible R&D spending is 4.6 per cent. The effective rate on total R&D spending is 2.7 per cent, which gives an overall (federal-state) marginal effective investment tax credit rate of 7.5 per cent.

Ireland's ITC is subject to substantially less erosion from base effects than is an incremental credit based on a rolling average of past spending, but there will still be some firms who do not maintain their R&D spending above their base levels, making them ineligible for the credit. In order to mitigate this impact on smaller firms, the 2012 budget made the first 100,000 euros in R&D investment eligible for a 25 per cent credit, independently of base-year spending. Unfortunately, there is no information on the share of R&D performed by firms that do not qualify for the credit, so it is not possible to calculate a weighted-average marginal effective tax rate — that is, the weighted sum of zero and the 25 per cent statutory rate.

Capped incentives

As noted in the text, tax incentives cannot generally be claimed in their entirety as they are earned, which diminishes their value by varying amounts across countries. In addition to this implicit cap, tax incentives are explicitly limited in 12 of the countries in the comparison group. Chile, Finland, Iceland and Portugal impose caps of a specific value on the credit or spending levels per firm. Canada, the Netherlands, Norway and the U.K. also impose caps on spending levels per firm, but these countries also have variable incentive rates, which are discussed in the next section. As discussed above, Australia limits access to enhanced benefits based on sales revenue, the U.S. imposes a cap determined as a percentage of R&D spending while South Korea's cap is a function of the firm's R&D intensity. Finally, Spain limits its tax credit to a certain percentage of tax liabilities.

In the presence of a cap, the marginal effective credit rate would be zero for firms spending more than this amount and the weighted-average marginal effective credit rate would be obtained by multiplying the statutory credit rate by the share of R&D undertaken by firms not subject to the cap. Further, in most cases, the cap has different impacts on small (fewer than 50 employees) and large firms. Accurately modelling the impact of these caps on the marginal incentive to invest in R&D requires information on the distribution of R&D spending by size and, for Spain, the distribution of tax liabilities. Norway, the U.K. and the U.S. provide the required information, so the impact of the caps in other countries has been approximated using other data sources.

Chile's 35 per cent credit applies to spending up to the equivalent of US$1.25 million per firm. Small firms account for about a third of R&D spending in Chile and are assumed to be unaffected by the cap. Spending by other firms is split 45-/55 per cent by medium-sized firms (50 to 249 employees) and large firms; it is assumed that half of the spending by medium-sized firms and all of the spending by large firms are affected by the cap, which implies an effective credit rate of 7.8 per cent on eligible spending. Finland's double deduction for salaries of R&D personnel is capped at 400,000 euros (US$440,000)[53] in tax relief, or about 1.6 million euros in wage spending given a corporate income tax rate of 24.5 per cent. Data provided by the Finnish government suggest that approximately 22 per cent of spending on R&D will not be affected by the cap. Small firms account for about nine per cent of spending on R&D; assuming that no small firms are affected by the cap, about 13 per cent of spending by other firms will be unaffected by the cap. As a result, the marginal effective super-deduction rate on wage costs for the large category is 113.5 per cent.[54] Iceland caps benefits from its 20 per cent tax credit at 100 million kroner (US$725,000). It is assumed that no firms are subject to the cap. Portugal's incremental credit is capped at 1.5 million euros (US$2.5 million) in spending. Small firms account for 11 per cent of R&D spending and the remainder is split 30-/70 per cent between medium-sized and large firms. It is assumed that a third of the spending by medium-sized firms and all of the spending by large firms is affected by the cap, which reduces the effective incremental credit rate applicable to (medium-sized and) large firms from 3.25 per cent to 0.65 per cent.

Spain imposes a cap related to the tax liabilities of firms making use of the incentive.[55] Spain's volume credit rate is 25 per cent on all eligible current expenditures and eight per cent on equipment. As discussed above, the effective rate on the incremental credit is 2.8 per cent.[56] As a result, the weighted effective credit rate on R&D that can be claimed against corporate income tax liabilities is 25.7 per cent.[57] But Spain's credit claims are limited to a share of corporate income tax payable: if the amount of qualified R&D exceeds 10 per cent of tax liabilities (net of R&D credits), the cap is 50 per cent of gross corporate income tax liabilities; otherwise the cap is 35 per cent. It appears that the 50 per cent cap would apply to most firms.

In Spain, the taxes paid on the typical innovative product or service developed and commercialized by a large firm amount to 4.5 per cent of the capital costs incurred.[58] In this case, the nominal credit rate of 25.7 per cent would be capped at one-half of the tax liabilities,

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[53] All of the U.S. dollar amounts used in this section are based on purchasing power parity exchange rates in 2013.

[54] Calculated as: (0.215-0.093)/(1-0.093)*100 +100, where 0.215 is the share of total spending not affected by the cap, 0.093 is the share of spending by small firms and 100 is the additional deduction provided.

[55] From 2009 until 2011, Hungary provided an additional deduction of 10 per cent of R&D salaries that was capped at 70 per cent of corporate income tax payable.

[56] There is an additional 17 per cent credit on salaries of full-time researchers that is claimed against personal income tax withholdings.

[57] Calculated as 27.8*0.908+8*0.061, where the weights represent the share of R&D spending eligible for the credits.

[58] The formula used is: $u*(Rf-\pi-\delta)*(1-uz)/(1-u)$, which equals 4.5 per cent using parameter values for Spain. That is, corporate income tax liabilities amount to 4.5 per cent of the user cost of capital, or equivalently, the marginal product of capital for non-diversified firms.

or 2.25 per cent of R&D spending. Diversified firms obtaining less than about nine per cent of their revenue from the exploitation of R&D would not be constrained by the cap.[59] Information on the distribution of firms by R&D intensity (R&D divided by revenue) is required to assess the extent to which the cap is binding. Such information is not available for Spain, but Falk[60] provides the distribution of Austrian firms by R&D intensity. The Austrian distribution implies that about 65 per cent of firms are sufficiently diversified to avoid being affected by the cap and that the "capped" effective credit rate for large firms is 19.6 per cent.[61] An estimate for small firms was developed assuming that R&D intensity rises as firm size declines, as found by Statistics Canada[62] for Canada and by Park[63] for the U.S. More specifically, it was assumed that small firms have R&D intensities that are equal to or greater than the 50th percentile of the Austrian distribution for all firms. This illustrative assumption results in a "capped" effective credit rate of 9.4 per cent for small firms.

As discussed above, spending eligible for the U.S. regular incremental credit cannot exceed 50 per cent of investment in R&D in the current year and the South Korean volume credit on current spending is three per cent plus 50 per cent of the R&D-to-sales ratio, with a cap of six per cent. The typical large firm in South Korea is assumed to have an R&D intensity of 4.5 per cent, which results in an effective credit rate of 5.25 per cent.[64]

Two-level incentive rates

In France, there is a 30 per cent ITC for R&D expenditures up to 100 million euros (US$120 million) plus five per cent for expenditures exceeding that amount. The incentive to undertake additional R&D is therefore either 30 per cent or five per cent, depending on the level of investment undertaken by a firm. Data provided by the French government[65] can be used to calculate the weighted-average marginal credit rate for large firms. Large firms spending more than 100 million euros account for 20 per cent of total spending by large firms, so the marginal ITC rate for large firms is 25 per cent (0.80*0.30 + 0.20*0.05) on eligible spending, and the marginal effective rate is 20.9 per cent on total spending. This is not the only way to view the

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59 The cap is not binding when total corporate income tax liabilities relative to spending on R&D are two times the effective credit rate of 25.7 per cent, or 51.4 per cent. For this to occur, spending on R&D has to fall to 8.75 per cent of total investment (4.5%/51.4%=8.75%). Assuming that revenues are proportional to investment, this result implies that the cap will not bind for firms with an R&D intensity (R&D divided by revenues) of 8.75 per cent or less.

60 Falk, Martin 2012. "Quantile estimates of the impact of R&D intensity on firm performance" Small Business Economics Vol. 39 Issue 1, 6.

61 The effective rate was calculated as the weighted average across the distribution of spending by R&D intensity, so the capped effective rate is greater than 65 per cent of the 25.7 per cent effective rate.

62 Statistics Canada, *Industrial Research and Development: Intentions 2011* (Catalogue no. 88-202-X, 2012), Table 6–4.

63 Sophie (So-Hyung) Park, "R&D Intensity and Firm Size Revisited" (Manuscript, 2011), http://www.econ.ucla.edu/jobmarket/2011/ParksPaper.pdf

64 Information on the distribution of firms by R&D intensity is only available for the U.S. and Austria. The median R&D intensity is 4.1 per cent in the U.S. and 4.6 per cent in Austria. See Bronwyn Hall, "The United"; and Martin Falk, "Quantile estimates."

65 Ministère de l'enseignement supérieure et de la recherche "Le crédit d'impôt recherché en 2010", mai 2012.

incentive effects of the credit. For large multinational firms, the entire R&D operation in France could be considered their marginal investment; for these firms the incentive to locate or remain in France would be determined by the weighted-average credit rate, which is 21.7 per cent. For all large firms, the weighted-average marginal rate would be just over 26 per cent.[66]

The Netherlands provides a tax credit for wage expenses as well as a 140 per cent super-deduction for non-wage current spending and equipment. A 50 per cent tax credit is available for the first 220,000 euros (US$266,000) in R&D labour expenses and 18 per cent on expenses above that level. The credit is deductible from payroll tax liabilities, making it effectively refundable. Based on spending patterns by small firms in the U.S., the cap on the 50 per cent tax credit would be binding for most small firms in the Netherlands. In the U.S., small firms spending less than US$266,000 on R&D wages and salaries accounted for about 35 per cent of all R&D spending by small firms.[67] Assuming this share applies in the Netherlands, the marginal subsidy rate on labour costs for small firms is 29.2 per cent. The value of the credit is capped at 14 million euros (US$16.6 million) per taxpayer. Few firms are affected by the cap,[68] so the marginal subsidy rate on labour costs for large firms is assumed to be 18 per cent.

Tax credits based on personal income tax liabilities

In Belgium, as of 2013 firms may claim an ITC equal to 80 per cent of income taxes withheld on salaries paid to researchers with either a PhD or a Master's degree. A government guide to the R&D tax credit states that the previously available 75 per cent credit reduced the wage bill by 15-20 per cent.[69]

In Turkey, firms receive a tax credit equal to 80 per cent of the income tax withheld on salaries paid to R&D workers (90 per cent for researchers with a PhD). An effective subsidy rate was calculated by assuming that R&D researchers earn 167 per cent of the average salary, that the tax rate applicable to this income is 15.5 per cent[70] aand that the average credit rate is 85 per cent of taxes withheld.

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[66] Calculated as (21.7*0.458 + 30*(1-0.458)), where 0.458 is the share of spending by large firms subject to the threshold in total R&D spending by large firms.

[67] This share was estimated from information presented by the U.S. National Science Foundation, "Business Research and Development and Innovation: 2008–10," data tables 99 and 138, http://www.nsf.gov/statistics/nsf13332/content.cfm?pub_id=4160&id=2.

[68] Tom Poot et al., "Evaluation of a major Dutch Tax Credit Scheme (WBSO) aimed at promoting R&D" (undated), 4, http://ftp.zew.de/pub/zew-docs/evaluationR%26D/EBrouwer.pdf.

[69] Belgian Government, "Guide for Mobile Researchers – R&D Incentives from a company point of view" (2011), 11.

[70] Source: Organisation for Economic Co-operation and Development (OECD), *OECD Tax Data Base* (OECD Publishing: 2011), http://www.oecd.org/document/60/0,3746,en_2649_34533_1942460_1_1_1_1,00.html#C_CorporateCaptial.

Special incentives for small firms

Six countries in the comparison group have incentives that vary by size of firm. The size thresholds vary considerably by country, which reduces the international comparability of incentives for small and medium-sized firms. In this study, small firms are those with fewer than 50 employees, medium-sized firms have between 50 and 249 employees and large firms have at least 250 employees. Unless otherwise stated, the large-firm category includes medium-sized firms.

In Australia, companies with less than $20 million Australian (US$13.6 million) in revenue qualify for a 45 per cent credit while other firms receive a 40 per cent credit on eligible spending. The larger credit is assumed to apply to all small firms and to none of the firms in the large category.

In Canada, Canadian-controlled private corporations (CCPC) are eligible for a 35 per cent federal refundable ITC on up to $3 million (US$2.4 million) of eligible R&D spending, provided that the firm has prior-year taxable income less than $500,000 (US$406,500) and less than $10 million (US$8.1 million) in assets. The expenditure limit is reduced as a CCPC's taxable income for the previous year increases from $500,000 to $800,000 (US$650,000) and prior-year taxable capital increases from $10 million to $50 million (US$40.6 million). All small firms (i.e., firms with fewer than 50 employees) qualify for enhanced benefits, but some firms in the medium-sized to large category will be subject to the cap. Unfortunately, there is not enough information publicly available to determine the effective credit rate for firms in the phase-out zone, so the weighted average effective rate for the large-firm category is overstated.

Japan provides a 12 per cent ITC for small and medium-sized firms that have less than 100 million yen (US$970,000) in assets and fewer than 1,000 employees. Firms exceeding these thresholds benefit from an eight to10 per cent tax credit, depending on their R&D intensity. In the absence of detailed data for Japan, the marginal ITC rate on eligible spending for large firms is assumed to be nine per cent, (8.7 per cent marginal effective rate).

In South Korea, SMEs (i.e., firms with up to 249 employees) will generally claim a 25 per cent credit on most current expenditures while larger firms have access to a credit on most current spending that has a capped value of 5.3 per cent. Medium-sized firms account for 15.8 per cent of spending on R&D by firms in the medium-large category, so the weighted-average marginal effective credit rate for firms in this category is 8.4 per cent.

Norway provides a 20 per cent ITC for small and medium-sized firms and an 18 per cent credit for large firms. The thresholds for the 20 per cent credit are less than US$4.6 million in sales, assets of less than US$7.1 million and fewer than 100 employees. In addition, eligible expenditures are capped at 5.5 million kroner[71] (US$0.625 million) of in-house research spending (doubled for research purchased from a qualified research institution) so the marginal ITC for some firms will be zero. Information from the Norwegian government indicates that approximately 20 per cent of small firms are affected by the cap, so the weighted marginal ITC rate is 16 per cent (15.5 per cent marginal effective) for small firms.[72] Medium-sized and large

[71] The government has proposed increasing the cap to 8 million kroner, but it is not clear if the legislation has been passed.

[72] Officials in the Tax Policy Department of the Norwegian Ministry of Finance provided a breakdown of R&D expenditures in the business-enterprise sectors by large and small firms.

firms could receive a marginal ITC of 20 per cent, 18 per cent or zero, due to the cap. Based on information provided by the Norwegian government, the weighted marginal credit rate is 10.6 per cent on eligible spending by firms in the large category.

In the U.K. enhanced benefits are available for firms meeting three conditions: fewer than 500 employees, less than 100 million pounds in sales (US$144 million) and less than 86 million pounds (US$124 million) in assets. Qualifying firms receive a super-deduction of 225 per cent (i.e., 125 per cent in addition to the immediate expensing of R&D spending). The extra deduction is equivalent to a tax credit of 31.25 per cent.[73] But the benefit from the super-deduction is subject to a cap of 7.5 million pounds (US$10.8 million) in deductions. Further, the value of the extra deduction is reduced for firms in the phase-out range for the small-profits tax rate. Finally, firms may choose to receive the tax benefit obtained from the super-deduction in cash, payable at 11 per cent of the value of the deduction, which is equivalent to a 13.75 per cent credit rate. The share of refundable benefits is 44 per cent, so the weighted-average "statutory" credit rate is 21.5 per cent. In contrast, large firms have access to a 10 per cent refundable (and taxable) investment tax credit.[74]

Data published by HM Revenue and Customs[75] for the 2010–11 fiscal year, when the super-deduction was 175 per cent, suggests that the combined impact of the cap and the phase-out of the small-profits rate was to reduce the benefit from the super-deduction by about 16 per cent for firms claiming the deduction. There is not enough information publicly available to perform the same calculation for firms making use of the refundable benefit, so the same percentage reduction is assumed to apply to those firms. The weighted-average effective credit rate therefore falls to 17.9 per cent, which is equivalent to an effective additional deduction of 71.75 per cent compared to the 125 per cent statutory rate.

Finally, note that the two-stage incentives in France and the Netherlands as well as the capped incentives in Chile and Portugal provide more assistance to small firms than large ones. In contrast, Spain's cap, which is based on corporate tax liabilities, affects small firms to a greater extent than it does large firms since small firms are less diversified. Similarly, super-deductions in Brazil and Hungary provide a lower benefit to small firms because they face a lower corporate income tax rate.

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[73] Calculated as (0.2/(1-0.2)*125), where 0.2 is the corporate income tax rate.

[74] In 2014, large firms can choose between the tax credit and a non-refundable super-deduction of 130 per cent, the credit-equivalent value of which is nine per cent.

[75] HM Revenue and Customs, "Research and Development Tax Credits Statistics" (August 31, 2012), http://www.hmrc.gov.uk/stats/corporate_tax/rd-introduction.pdf.

ANNEX 3: TAX PARAMETERS

TABLE A3-1: INTERNATIONAL COMPARISON OF BASES FOR R&D INCENTIVES [1]

Weights	0.500	0.114	0.288	0.061		0.031	
Country	**Wages and Salaries**	**Materials and Supplies**	**Overhead**	**Scientific Equipment**		**Buildings**	
				Spending	**Depreciation**	**Spending**	**Depreciation**
Australia [2]	x	x	x		x		Plant only
Austria	x	x	x	x		x	
Belgium	x			x			
Brazil	x	x	x				
Canada	x	x	x	x			
Chile	x	x	x	x		x	
China	x	x	x		x		x
Czech Republic	x	x	Utilities only		x		
Denmark	x	x	x	x			
Finland	x						
France	150%				175% inclusion		175% inclusion
Germany				No tax incentives			
Greece	x	x	x				
Hungary	x			x			
Iceland	x	x	x				
India	x	x	Utilities only				
Ireland	x		x	x		x	
Israel				No tax incentives			
Italy				No tax incentives			
Japan	x	x	x	x			
South Korea	x	x	Limited [3]	x			
Luxembourg				No tax incentives			
Mexico				No tax incentives			
Netherlands	x						
New Zealand				No tax incentives			
Norway	x	x	x	x			x
Poland				No tax incentives			
Portugal	x	x		x			
Russian Federation	x	x			x		x
Slovak Republic				No tax incentives			
Spain	x	x	x	x			
Sweden				No tax incentives			
Switzerland				No tax incentives			
Turkey	x	x		x			
United Kingdom	x	x	Utilities only				
United States	x	x					

Sources: Deloitte Touche Tohmatsu Ltd., Global Survey of R&D Tax Incentives (2013), Pierre Therrien, R&D Tax Incentives and Government Forgone Tax Revenue: a Cross-Country Comparison (Paris: OECD, Oct. 26, 2010) and government web sites.

1. *Incentives comprise tax allowances in excess of 100 per cent and investment tax credits.*
2. *Amounts claimed as credits cannot be deducted from taxable income.*
3. *Only "miscellaneous" overhead expenses included.*

TABLE A3-2: R&D TAX INCENTIVES FOR LARGE FIRMS[1]

	Statutory Corporate Income Tax Rate (%)	Investment Tax Credit (%)			Tax Allowances		Cap[3]
		Statutory Rate		Taxable[2]/ Refundable	Super-Deduction (Statutory Rate)	Present Value (Current/ Equipment/ Buildings)	
		Volume	Incremental				
Group of Seven							
Canada	26.1			YES/–		100/100/57.7	
Federal only	15	15		YES/NO			
France	34.4	30/5[4]		NO/YES[5]		100/81/50.6	
Germany	29.6	–				100/64.9/39.6	
Italy	31.4						
Japan	38.0	8-10		NO/NO		100/85.1/37.8	
United Kingdom	23.0	10		YES/YES		100/100/100	
United States	39.2	–		YES/NO		100/88.2/48.1	
Federal Only[6]	32.7		20/14	YES/NO			Base for incremental credit <50% of current year R&D
Smaller Developed Economies							
Australia[7]	30	40		YES/NO		0/0/23.9	
Austria	25	10		NO/YES		100/85.0/48.3	
Belgium	33.99	14.6[8]		NO/YES[9]	122.5[10]	100/107.6/52.3	
Denmark	25	–				100/83.3/62.2	
Finland	24.5	–			200	100/100/80	Tax relief of €0.4 m/US$0.44 m
Greece	26	–			150	103.3/91.2/72.9	
Iceland	20	20		NO/YES		100/80.3/44.6	ISK 100m/US$725,000
Ireland[11]	12.5		25	NO/YES		100/100/100	
Israel	25					100/89.3/79.6	
Luxembourg	29.22	–				100/82.4/41.9	
Netherlands[12]	25	50/18		NO/YES[9]	140	118/140/56.3	€14 m/US$16.9 m
New Zealand	28	–				100/85.3/41.8	
Norway	28	18		NO/YES		100/80.1/44.7	NOK 5.5 m/US$0.625 m
Spain[13]	30	25/42/8	42	NO/NO		100/100/30.3	35-50% of corporate income tax
Sweden	22	–				100/82.6/36.8	
Switzerland	18.01	–				100/88.7/43.9	
Emerging Economies							
Brazil	34	–			160	160/100/57.5	
Chile	20	35				100/85.5/69.2	$US1.25 m
China	25	–			150	150/115.2/69.2	
Czech Rep.	19	–			200	200/100/61	
Hungary	19	28.5[14]		NO/YES[9]	200	167.6/200/35.7	
India	33.99	–			200	172/200/65.8	
South Korea[15]	24.2	3-6/10	40	NO/NO		100.0/85.5/34.3	see footnote 15
Mexico	30	–				100/86/73.2	
Poland	19	–				100/100/41.9	
Portugal	26.5	32.5	50	NO/NO		100/87.4/45.3	€1.5 m/US$2.5 m[16]
Russian Federation[17]	20				150	133.8/121.8/72.8	
Slovak Rep.	23	–				100/100/69.9	
Turkey	20	7.3[18]		NO/YES[9]	200	135.2/135.2/79.9	

1. *Generally defined as firms with at least 50 employees; exceptions comprise Canada, South Korea and the U.K.. Special incentives for small firms are shown in Table A4-3*
2. *An ITC is described as taxable if firms are required to reduce the base for tax deductions by the amount of the credit received.*
3. *The cap is on eligible spending unless otherwise noted.*
4. *Firms are eligible for the 30 per cent ITC on the first 100 million euros (US$115 million) of eligible expenditures and 5 per cent on the expenditures exceeding that amount.*
5. *Credits not utilized after three years are refundable.*
6. *Firms may choose between the regular incremental credit, which has a statutory rate of 20 per cent, and the Alternative Simplified Credit, which has a 14 per cent statutory rate that applies to a different base. The base for the regular incremental credit is capped at 50 per cent of current year investment.*
7. *Expenses for which a credit has been received cannot be deducted from taxable income.*
8. *The base for the credit is income taxes withheld on salaries paid to researchers with advanced degrees. The statutory rate is 75 per cent and the effective rate on labour costs is 14.6 per cent.*
9. *Incentive is credited against personal income or payroll-tax-withholdings or social security contributions, making it effectively refundable.*
10. *The superdeduction applies to equipment; it is calculated as 1.215 times the normal tax allowance rate.*
11. *The base for the credit is spending in 2003 or the first year a claim was made, whichever occurs later. Unused credits are refundable, with the refund paid over three years.*
12. *The ITC is available on labour expenses only and the superdeduction is available on other expenses. The 50 per cent ITC is payable on the first 220,000 euros in expenses. The value of the ITC is capped.*
13. *Labour expenses receive a 42 per cent volume ITC and other current expenses qualify for a 25 per cent volume ITC. All current expenses are eligible for a 42 per cent incremental ITC. Scientific equipment expenses qualify for an 8 per cent volume ITC.*
14. *Corporations employing researchers with academic credentials receive a credit equal to the social tax and the training tax (27 per cent and 1.5 per cent of wages, respectively.)*
15. *Most current spending is eligible for a credit ranging from three to six per cent, depending on R&D intensity while equipment is eligible for a 10 per cent credit.*
16. *The cap appplies to the incremental credit.*
17. *Software developers pay a reduced rate of social security contributions. The base rate is 30 per cent up to a cap and 10 per cent above the cap; the reduced rates are 14 per cent and zero.*
18. *The base for the credit is income tax withholdings on wages. The statutory rate is 80 per cent (90 per cent for workers with PhDs) and the effective rate on wage costs is 7.3 per cent.*

Note: all US$ figures have been adjusted for 2011 purchasing power parities.

Sources: Deloitte Touche Tohmatsu Ltd., Global Survey of R&D Tax Incentives (2013); Deloitte Touche Tohmatsu Ltd., Global Survey of R&D Tax Incentives (2012); Deloitte Touche Tohmatsu Ltd., Brazil Upstream Guide Corporate Taxation (2010), http://www.deloitte.com/assets/Dcom-Brazil/Local%20Assets/Documents/Ind%C3%BAstrias/Petr%C3%B3leo%20e%20G%C3%A1s/CorporateTaxation.pdf; Finance Canada, "An International Comparison of Tax Assistance for Investment in Research and Development" Tax Expenditures and Evaluations 2009 (2009), http://www.fin.gc.ca/taxexp-depfisc/2009/taxexp0902-eng.asp#part2; Christoph Spengel et al., "The Computation and Comparison of the Effective Tax Burden in Four Asian Countries," Hitotsubashi Journal of Economics 52, 1 (2011): 13-39, http://hermes-ir.lib.hit-u.ac.jp/rs/bitstream/10086/19219/1/HJeco0520100130.pdf; Pierre Therrien, R&D Tax Incentives and Government Forgone Tax Revenue: a Cross-Country Comparison (Paris: OECD, Oct. 26, 2010); and calculations by the authors.

TABLE A3-3: R&D TAX INCENTIVES FOR SMALL FIRMS[1]

	Statutory Corporate Income Tax Rate (%)	Investment Tax Credit (%)			Tax Allowances		Cap[3]
		Statutory Rate		Taxable[2]/ Refundable	Super-Deduction (Statutory Rate)	Present Value (Current/ Equipment/ Buildings)	
		Volume	Incremental				
Group of Seven							
Canada	15.5			YES/YES		100/ 100/ 57.7	
Federal only	11	35		YES/YES			C$3 m/ US$2.4 m
Japan	24.8	12		NO/NO		100/ 85.1/ 37.8	
United Kingdom	20				225	190/ 100/ 100	£7.5m/ US$10.8 m[4]
Smaller Developed Economies							
Australia[5]	30	45		YES/YES		0/ 0/ 23.9	
Norway	28	20		NO/YES		100/ 80.1/ 44.7	NOK 5.5m/ US$0.625m
Emerging Economies							
South Korea[6]	10	25	50	NO/NO		100.0/ 85.5/ 34.3	

1. *The definition of small is not consistent across countries. See the discussion on page 13 of the text.*
2. *An ITC is described as taxable if firms are required to reduce the base for tax deductions by the amount of the credit received.*
3. *Cap is on eligible spending unless otherwise noted.*
4. *Cap is on the value of the tax deduction.*
5. *Expenses for which a credit has been received cannot be deducted from taxable income.*
6. *Firms can choose either the volume or the incremental credit, both of which apply to current spending. The base for the incremental credit is a four-year moving average of spending. The effective rate is 5.4 per cent.*

Note: all US$ figures have been adjusted for 2011 purchasing power parities.

Sources: Deloitte Touche Tohmatsu Ltd., Global Survey of R&D Tax Incentives (2013); Deloitte Touche Tohmatsu Ltd., Brazil Upstream Guide Corporate Taxation (2010), http://www.deloitte.com/assets/Dcom-Brazil/Local%20Assets/Documents/Ind%C3%BAstrias/Petr%C3%B3leo%20e%20G%C3%A1s/CorporateTaxation.pdf; Finance Canada, "An International Comparison of Tax Assistance for Investment in Research and Development" Tax Expenditures and Evaluations 2009 (2009), http://www.fin.gc.ca/taxexp-depfisc/2009/taxexp0902-eng.asp#part2; Christoph Spengel et al., "The Computation and Comparison of the Effective Tax Burden in Four Asian Countries," Hitotsubashi Journal of Economics 52, 1 (2011): 13-39, http://hermes-ir.lib.hit-u.ac.jp/rs/bitstream/10086/19219/1/HJeco0520100130.pdf; Pierre Therrien, R&D Tax Incentives and Government Forgone Tax Revenue: a Cross-Country Comparison (Paris: OECD, Oct. 26, 2010); and calculations by the authors.

ANNEX 4: COMPARISON OF USER COST AND B-INDEX ESTIMATES

TABLE A4-1: COMPARISON OF USER-COST AND B-INDEX ESTIMATES — LARGE FIRMS

Country	Subsidy Rate			Ranking		
	B-Index	User Cost	Difference	B-Index	User Cost	Difference
Spain	39.5%	41.6%	-2.0%	1	1	0
India	36.3%	39.0%	-2.7%	2	2	0
France	33.1%	35.7%	-2.6%	3	3	0
Portugal	29.7%	31.9%	-2.2%	4	4	0
Brazil	27.4%	30.5%	-3.1%	6	5	1
Hungary	27.6%	29.3%	-1.7%	5	6	-1
Ireland	25.3%	26.5%	-1.2%	7	7	0
Turkey	22.8%	24.8%	-1.9%	8	8	0
Iceland	22.1%	23.9%	-1.8%	9	9	0
Greece	15.4%	22.9%	-7.5%	10	10	0
Czech Rep.	21.0%	20.7%	0.3%	11	11	0
Canada	18.0%	18.2%	-0.2%	12	12	0
China	15.4%	18.0%	-2.7%	13	13	0
Netherlands	14.8%	17.5%	-2.7%	14	14	0
Japan	12.5%	16.5%	-4.0%	18	15	3
Norway	13.4%	16.4%	-2.9%	15	16	-1
Australia	12.8%	16.1%	-3.3%	16	17	-1
Austria	12.6%	15.2%	-2.7%	17	18	-1
Chile	9.3%	11.6%	-2.2%	19	19	0
Belgium	7.6%	11.5%	-4.0%	21	20	1
United States	6.5%	11.2%	-4.6%	23	21	2
Russian Federation	7.8%	10.1%	-2.3%	20	22	-2
United Kingdom	6.5%	9.2%	-2.7%	22	23	-1
South Korea	4.2%	7.0%	-2.9%	24	24	0
Finland	2.0%	5.0%	-3.0%	25	25	0
Italy	-0.7%	3.3%	-4.0%	31	26	5
Mexico	-0.7%	3.1%	-3.8%	30	27	3
Israel	-0.4%	2.7%	-3.2%	27	28	-1
Slovak Rep.	-0.3%	2.6%	-2.9%	26	29	-3
Luxembourg	-1.2%	2.5%	-3.7%	35	30	5
New Zealand	-1.1%	2.5%	-3.6%	34	31	3
Denmark	-0.7%	2.4%	-3.2%	32	32	0
Germany	-1.7%	2.1%	-3.8%	36	33	3
Sweden	-0.9%	1.9%	-2.8%	33	34	-1
Poland	-0.6%	1.8%	-2.4%	29	35	-6
Switzerland	-0.5%	1.7%	-2.3%	28	36	-8

TABLE A4-2: COMPARISON OF USER-COST AND B-INDEX ESTIMATES — SMALL FIRMS

Country	Subsidy Rate			Ranking		
	B-Index	User Cost	Difference	B-Index	User Cost	Difference
Chile	43.5%	44.7%	-1.3%	1	1	0
France	40.6%	42.8%	-2.2%	2	2	0
Canada	38.8%	40.0%	-1.2%	3	3	0
India	36.3%	39.0%	-2.7%	4	4	0
Portugal	32.2%	34.2%	-2.0%	5	5	0
Ireland	25.3%	26.5%	-1.2%	6	6	0
Spain	23.3%	25.6%	-2.3%	7	7	0
Turkey	22.8%	24.8%	-1.9%	8	8	0
Iceland	22.1%	23.9%	-1.8%	9	9	0
Norway	20.9%	23.5%	-2.6%	11	10	1
Czech Rep.	21.0%	22.9%	-1.9%	10	11	-1
Australia	19.7%	22.7%	-3.0%	12	12	0
Netherlands	19.0%	21.0%	-2.0%	13	13	0
Brazil	16.8%	19.3%	-2.5%	16	14	2
Hungary	17.7%	18.7%	-1.0%	14	15	-1
Finland	16.0%	18.6%	-2.6%	17	16	1
South Korea	17.5%	18.4%	-1.0%	15	17	-2
Greece	15.4%	18.2%	-2.8%	18	18	0
China	15.4%	18.0%	-2.7%	19	19	0
Japan	14.5%	16.9%	-2.4%	20	20	0
Austria	12.6%	15.2%	-2.7%	21	21	0
United Kingdom	11.7%	14.0%	-2.2%	22	22	0
Belgium	7.7%	10.6%	-2.9%	24	23	1
Russian Federation	7.8%	10.1%	-2.3%	23	24	-1
United States	7.4%	9.7%	-2.3%	25	25	0
Italy	-0.7%	3.3%	-4.0%	31	26	5
Mexico	-0.7%	3.1%	-3.8%	30	27	3
Israel	-0.4%	2.7%	-3.2%	27	28	-1
Slovak Rep.	-0.3%	2.6%	-2.9%	26	29	-3
Luxembourg	-1.2%	2.5%	-3.7%	35	30	5
New Zealand	-1.1%	2.5%	-3.6%	34	31	3
Denmark	-0.7%	2.4%	-3.2%	32	32	0
Germany	-1.7%	2.1%	-3.8%	36	33	3
Sweden	-0.9%	1.9%	-2.8%	33	34	-1
Poland	-0.6%	1.8%	-2.4%	29	35	-6
Switzerland	-0.5%	1.7%	-2.3%	28	36	-8

ANNEX 5: ESTIMATES OF THE MARGINAL COST OF PUBLIC FUNDS FOR EUROPEAN UNION COUNTRIES

TABLE A5-1: ESTIMATES OF THE MARGINAL COST OF PUBLIC FUNDS IN EUROPEAN UNION COUNTRIES[1]

	Disposition of Additional Tax Revenue	
	Lump-sum Transfer to Domestic Households	Transfer to Rest of World
Ireland	1.14	1.33
Netherlands	1.15	1.57
Estonia	1.18	1.30
Lithuania	1.21	1.45
Latvia	1.25	1.42
Belgium	1.28	1.98
Czech	1.29	1.49
Hungary	1.31	1.53
Bulgaria	1.32	1.56
Slovakia	1.34	2.19
Finland	1.36	1.61
Poland	1.37	1.63
Romania	1.37	1.43
Slovenia	1.37	1.66
United Kingdom	1.37	1.81
Italy	1.38	1.68
Austria	1.39	1.82
Spain	1.40	1.79
Denmark	1.41	2.31
Sweden	1.41	2.06
Portugal	1.45	1.82
Greece	1.48	1.59
Germany	1.64	1.96
France	1.78	2.41
Average – GDP Weighted	**1.48**	**1.90**
Simple Average	**1.36**	**1.73**
Coefficient of Variation	**10.40%**	**17.40%**

Source: Salvador Barrios, Jonathan Pycroft and Bert Saveyn, "The marginal cost of public funds in the EU: the case of labour versus green taxes" (European Commission Taxation Papers, Working Paper No.35 – 2013), Table 11.

[1.] *Based on increases in proportional taxes on labour income.*

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