

AN INTERNATIONAL COMPARISON OF TAX ASSISTANCE FOR R&D: 2017 UPDATE AND EXTENSION TO PATENT BOXES

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SUMMARY

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 that perform the R&D. As a result of this externality or spillover, most governments provide support for R&D in order to encourage more of it. In 2017, 29 of the 35 members of the Organisation for Economic Co-operation and Development (OECD) provided tax incentives for spending on R&D. That's up slightly since 2014, when we last prepared an international comparison of tax assistance for R&D. On the other hand, average support levels edged down from 2014 to 2017.

In addition to these expenditure-based measures, 15 OECD countries provide preferential tax treatment for the income generated by commercializing R&D and other innovative activities. These income-based measures are often described as patent boxes, since they first applied to income realized from patented products and processes. In most cases, the qualifying patents did not have to be based on R&D performed in the country offering the incentive, so patent boxes were criticized for creating an incentive to shift taxable income without encouraging additional R&D. Recently, however, most countries have accepted the OECD recommendation that both the R&D and the income from its commercialization must be located in the same jurisdiction before an income-based incentive can be provided.

With this linkage, income-based incentives can be a useful policy tool, particularly for large firms. Income- and expenditure-based incentives are likely to have similar impacts on the amount of R&D undertaken by large firms, but income-based measures have the advantage of providing a greater incentive to commercialize R&D in the implementing jurisdiction. They also blunt the incentive to shift the taxable income generated by commercializing R&D to lower-tax jurisdictions. However, smaller firms, who are more likely to be cash-flow constrained, will respond less strongly to income-based measures since the

subsidy is available with a delay. Further, small firms have limited opportunities to shift taxable income across international borders.

Should the federal government implement an income-based tax incentive for R&D performed by large firms? A key consideration is what happens to tax revenue on income from commercialization of R&D. If a lower tax rate results in higher revenue as a result of tax base shifting effects, income-based measures have a clear advantage over their expenditure-based counterparts. Some competing jurisdictions have very low corporate income tax rates, so feasible reductions in federal tax rates may not generate tax base shifting effects large enough to make the policy a success. More information on how multi-national enterprises shift intellectual-property income out of Canada is required before proceeding with income-based tax incentives for R&D.

INTRODUCTION

In our 2014 paper (Lester and Warda 2014), we presented an international comparison of tax assistance for expenditure on R&D in most OECD member countries and four key emerging and transition economies. This paper updates that comparison and extends it to income-based incentives for undertaking R&D, more commonly known as patent boxes. As in our 2014 paper, comparisons are based on how tax incentives affect the user cost of capital rather than the “B-Index” framework used by the Organization for Economic Co-operation and Development (OECD) in its analysis of tax assistance for R&D. 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.

Since 2014, three countries, Italy, Poland and Sweden, have introduced expenditure-based tax incentives while Finland did not proceed with a pilot program. As a result, 29 of the 35 OECD member countries now provide expenditure-based R&D tax incentives. Measures in Austria, Belgium, the Netherlands, Norway and Turkey were made more generous. On the other hand, Australia, India, Greece, Korea and the two largest Canadian provinces have reduced the generosity of their tax incentives. Corporate income tax reductions in 10 countries have also reduced subsidy rates through their impact on the value of tax-depreciation allowances. After controlling for changes in methodology, the net impact of these initiatives was a small reduction in overall support levels from 2014 to 2017.

In addition to expenditure-based measures, 15 OECD countries¹ as well as India and China provide preferential tax treatment for the income resulting from commercialization of R&D and other innovative activities. In total, 85 countries, including all countries with income-based incentives, have endorsed the OECD recommendation that there be a link or a “nexus” between the income taxed at a preferential tax rate and the expenditures undertaken to generate that income. With the nexus approach, income-based measures become a method of subsidizing R&D that will promote retention of commercialization activity and the associated taxable income in the implementing jurisdiction, without encouraging profit shifting from other jurisdictions. We have modified the user-cost framework to calculate the subsidy rates arising from both expenditure- and income-based tax incentives.

The impact of income-based incentives on the user cost of eligible R&D capital depends primarily on the gap between the regular and incentive tax rates and the treatment of expenses. Current expenses, such as interest, incurred to earn the tax-favoured income can be deducted at the incentive or regular income tax rate. In addition, the tax deduction associated with past R&D expenses can be maintained or recalculated using the incentive tax rate. Completely symmetric treatment of income and expenses results in a lower subsidy rate, reflecting the result that when tax depreciation exceeds economic depreciation by a wide enough margin, a reduction in the income tax rate increases the effective tax rate.

Of the 13 countries in our comparison group providing income-based incentives, only the Netherlands applies a completely symmetric approach. The U.K. recalculates the value of the tax deduction for R&D expenses, causing it to have the second-least-generous regime. Spain and France require current expenses to be deducted at the incentive rate, but this treatment is offset by large gaps between the regular and incentive tax rates. All other countries allow

¹ We model regimes in 12 of the larger OECD economies as well as India.

expenses to be deducted at the regular rate. Subsidy rates range from -2.4 per cent in the Netherlands to 7.4 per cent in Belgium, but almost half of the subsidy rates are in the narrow range of 5.7 to 6.5 per cent.

If income-based tax incentives for R&D conform to the OECD's nexus requirement, they can be a useful policy instrument. For risk-neutral firms, an income-based incentive with the same present-value gross cost as an expenditure-based incentive will have the same impact on R&D. However, the income-based measure will encourage the retention in the implementing jurisdiction of the real activity and taxable income associated with commercialization of the R&D. As a result, income-based measures are likely to be more cost-effective and there may be additional social benefits from the retention of commercialization activity, particularly if the quality of jobs created is higher than average.

On the other hand, countries with income-based incentives or those considering implementing them should carefully consider several factors. First, if the competition for taxable income from commercialization comes from countries with very low tax rates, it may not be possible to offset the direct revenue loss by a substantial amount through tax-base shifting. Second, countries should be wary of excessive subsidization. In 2017, six countries had subsidy rates for large firms that may be high relative to the net spillover benefits from R&D.² Five of the six countries have income-based incentives. Third, startups and most established small firms are likely to respond differently to upfront and deferred subsidies. Differential treatment of small and large firms appears to be required to maintain effective subsidy rates at the same level.

PREFERENTIAL TAX TREATMENT OF INCOME FROM R&D AND OTHER INNOVATIVE ACTIVITIES

Preferential tax treatment of income derived from the commercialization of R&D was introduced by France in 1971, with a reduced rate for income from patents.³ Ireland followed suit in 1973. In 2001, Turkey provided an incentive tax rate on income from all R&D, but restricted application to firms in its "Technology Development Zones." Hungary in 2003 expanded the scope of income-based incentives beyond R&D-based intellectual property. There was a large increase in the number of countries offering incentives starting in 2007; by 2017, an additional 13 countries taxed income from intellectual property at a preferential rate.

Income-based measures are often described as patent boxes, reflecting the earliest restriction on eligibility and the fact that claimants checked a box on tax returns to indicate income eligible for the lower tax rate. More recently, authors⁴ have used the term "innovation box" or "intellectual property box" to draw attention to the broader availability of the tax preference.

The context for implementing income-based incentives has changed substantially as a result of the G20/OECD Base Erosion and Profit Shifting (BEPS) project. The final report on Action 5 proposed that income-based tax incentives be allowed only if the income taxed at a preferential rate results from expenditures undertaken in the jurisdiction providing the tax incentive (OECD 2015b). The motivation for recommending this nexus requirement is

² The analysis presented in Lester and Warda (2014) suggests subsidy rates in excess of 25 per cent could raise issues of excessive subsidization.

³ The source for the information in this paragraph is Appelt et al. (2016).

⁴ See for example Chen et al. (2016).

to eliminate the use of income-based tax incentives to encourage shifting the profits arising from the commercialization of R&D among tax jurisdictions. A subsequent document (OECD 2015a) provided additional detail on the proposal and set out timelines for compliance. Income-based tax incentives introduced after mid-2016 would have to respect the nexus requirement and existing regimes would have to be modified to be consistent with it by mid-2021. This approach was endorsed by the European Union in 2014 and by G20 leaders in November 2015, along with a large number of other countries participating in the BEPS initiative. In total, 85 countries had approved the “nexus” approach by 2016, including all countries that now have income-based tax incentives in place (OECD 2016).⁵

Comparison of expenditure- and income-based incentives

How do income-based incentives with a nexus to domestically performed R&D⁶ compare to expenditure-based measures? For risk-neutral firms operating in a single country, a revenue-neutral shift from expenditure to income-based incentives would not affect either the amount of R&D undertaken or the amount of R&D that is commercialized, provided that the time value of money is recognized. Rational firms would calculate the expected net present value of the subsidy based on expectations about the values of the expenditure-based tax benefits and the taxes to be paid on the income it generates. In contrast, risk-averse firms would respond negatively to the same revenue-neutral shift in support because the delay in receiving the subsidy has a larger impact on its expected value than for risk-neutral firms. Startups and undiversified firms — those that derive most of their revenue from the commercialization of R&D — are more likely to be risk-averse than other firms. The lower spending on R&D would also result in less commercialization activity by risk-averse firms.

Risk-neutral firms operating in more than one country — a category that includes virtually all multi-national enterprises (MNEs) — would have an incentive to increase commercialization activity in response to a shift in support to income-based measures. MNEs have the option of commercializing R&D where it is performed or in locations that are closer to customers or that provide advantages in the form of lower production costs or taxes. Income-based measures make offshoring options less attractive, which would raise real activity in the country making the concession. In a fully employed economy, this would raise real income in the implementing jurisdiction if the additional commercialization activity displaced lower-productivity production or if there are favourable spillover effects from commercialization to other activities, particularly R&D. In addition, reducing the tax rate on income from intellectual property encourages MNEs to retain taxable income in the jurisdiction where the R&D is performed, which would in turn lower the fiscal cost of the tax reduction per dollar of subsidy provided.

The qualitative impacts of a revenue-neutral shift of support for R&D from expenditure to income-based measures are summarized in Table 1, assuming a nexus with R&D is required. There is some empirical support for the assumed response of MNEs. Chen et al. (2016) examine the impact of “innovation boxes” on profit shifting and on real activity using

⁵ OECD, “OECD Secretary-General Report to the G20 Leaders” (OECD Publishing, Paris, France, September 2016), <https://www.oecd.org/tax/oecd-secretary-general-tax-report-g20-leaders-september-2016.pdf>.

⁶ The discussion in this section assumes that income-based measures are set up to allow firms to deduct expenses at the regular, rather than the incentive, corporate income tax rate. See below for a discussion.

data from western European subsidiaries of European and U.S. MNEs. They find some evidence of a reduction in profit shifting when innovation boxes are introduced as well as an increase in employment and wages. Fixed investment is not affected. Alstadsaeter et al. (2015) find imposing a nexus between the tax preference and performing R&D results in more R&D, which is proxied by more researchers with patented inventions in the implementing jurisdiction.⁷ Further, empirical work by Tecu (2013) indicates that co-location raises the productivity of R&D, so the “repatriation” of commercialization activities prompted by income-based incentives has an additional positive effect. Finally, as argued by Ernst, Richter and Riedel (2014), MNEs have an incentive to locate projects with the highest expected return in low-tax jurisdictions; preferential treatment of intellectual-property income could therefore give an additional boost to the quality of projects undertaken in the implementing jurisdiction.

TABLE 1 QUALITATIVE IMPACTS OF A REVENUE-NEUTRAL SHIFT OF R&D SUPPORT FROM EXPENDITURE-TO INCOME-BASED MEASURES

	R&D	Commercialization	Tax-Base Shifting
Domestic firms ¹			
Risk-neutral	0	0	n.a.
Risk-averse ²	-	-.3	n.a.
Multinationals	0	+	+

Impacts assume that income-based measures allow firms to deduct expenses at the regular, rather than the incentive, income tax rate.

1. Firms without foreign affiliates.

2. Most startups and firms highly-dependent on commercialization revenues would be in this category.

3. The negative effect arises from a reduced level of R&D spending.

The empirical literature on the sensitivity of foreign direct investment (FDI) to tax-rate differentials can be used to provide an additional perspective on how the commercialization activities of MNEs could be affected. In a meta-analysis of empirical work on the sensitivity of FDI to tax rates, Feld and Heckemeyer (2011) report a semi-elasticity of -1.7 for FDI relative to the corporate income tax rate. If this elasticity is applicable to the commercialization activities of MNEs, a tax preference of 10 percentage points would increase commercialization activity by 17 per cent. However, Feld and Heckemeyer also report a semi-elasticity for the marginal effective tax rate, which, as discussed in Lester (forthcoming) implies a much lower sensitivity of FDI to statutory-tax-rate changes. An average of the two results suggests that a 10-percentage-point income-based incentive would increase commercialization activity by MNEs by about 10 per cent in the implementing jurisdiction.

Karkinsky and Riedel (2012) examine how tax rates affect the location of patents within European multi-national firms. They report an average semi-elasticity — the percentage change in the number of patents arising from a one-percentage-point change in corporate income tax rates — of -3.5. Griffith, Miller and O’Connell (2014) examine how corporate income tax rates affect the location of patents for 12 European nations. In contrast to Karkinsky and Riedel, they allow tax effects to vary across all locations. Griffith et al. report semi-elasticities ranging from -3.9 in Luxembourg to -0.5 in Germany, which suggests an overall impact that is lower than found by Karkinsky and Riedel.

⁷ The analysis is based on data from the top 2,000 R&D-performing firms worldwide.

In a separate analysis, Griffith et al. simulate the implementation of patent-box regimes in Belgium, Luxembourg, the Netherlands and the U.K. Assuming that revenue changes by the same percentage as patent counts, the authors find substantial revenue losses in all four countries. This result is consistent with the broader literature on profit shifting. In a meta-analysis of existing empirical work on international profit shifting, Heckemeyer and Overesch (2013) develop a “consensus” prediction that a one-percentage-point reduction in the corporate income tax rate increases reported profits of MNEs by 0.8 per cent. The consensus estimate implies that reducing the tax rate on commercialization income from 30 to 20 per cent, for example, would increase taxable income by eight per cent. As a result, instead of falling by a third, tax revenue from commercialization activities by MNEs would decline by 28 per cent.⁸ Using the -3.5 semi-elasticity for patent counts found by Karkinsky and Riedel, the net revenue loss would be 10 per cent of the MNE intellectual property tax revenue. A semi-elasticity of -5 would be required to obtain a zero net revenue loss.

In summary, a revenue-neutral shift in R&D support from expenditure to income-based measures would result in less R&D performed in the implementing jurisdiction. Another negative factor is higher administration and compliance costs, at least in the short run as firms and governments become familiar with income-based measures. On the positive side, a net increase in commercialization activity is likely and international tax-base shifting by MNEs will reduce the net fiscal cost of providing support for R&D, although it is highly unlikely that the measure would be self-financing. Given the sensitivity of investment and profit shifting by MNEs to tax-rate differentials, it would be plausible to conclude that the net economic benefit from all these changes is positive. There is, in the words of Boadway and Tremblay (2017) an “uneasy case” for income-based incentives.

Calculating the subsidy from income-based measures

In this paper, our interest is in determining how income-based measures affect the incentive to perform R&D and constructing a subsidy measure that includes both income- and expenditure-based tax incentives. Our expenditure-based subsidy measures are obtained by calculating the impact of tax incentives on the user cost of R&D, using the framework set out in our 2014 report (Lester and Warda 2014). We decompose the user cost, defined as the annual cost of using a dollar’s worth of R&D, into the following elements:

- The non-tax component consisting of the sum of the economic depreciation rate and the after-tax financial return to investors;
- The tax payable on the net income generated by commercialization of the R&D;
- The reduction in taxes arising from interest deductibility;
- The net change in taxes arising from the difference between economic depreciation and tax allowances for depreciation, including expensing and super-deductions; and
- The reduction in tax arising from investment tax credits.

All countries in our comparison group allow current expenditures on R&D to be deducted as they are incurred. As a result, the sum of the tax components of the user cost of R&D is

⁸ Calculated as $(t_2 - t_1)/t_1 * (1 + t_2 * \epsilon)$, where t_1 is the base tax rate, t_2 is the incentive rate and ϵ is the semi-elasticity of the tax base to the tax rate ($\epsilon < 0$).

negative in all cases — the tax system subsidizes the performance of R&D. We calculate a subsidy rate as the sum of the tax components divided by the non-tax component of the user cost, which is assumed to be the same in all countries.⁹

Including income-based measures in this framework requires making an explicit distinction between the research and commercialization phases.¹⁰ The approach we use to model the two phases of R&D was inspired by work by Jack Mintz. “Tax Holidays and Investment” (J. M. Mintz 1990) sets out a methodology that can be used to calculate marginal effective tax rates and the user cost of capital as tax rates vary over time. “Measuring Effective Tax Rates for Oil and Gas in Canada” (J. Mintz 2010) illustrates how to quantify the benefit arising from the lag between deductible expenditures and taxable revenues using a “time to build” framework.

In the research phase, expenses are incurred before any R&D-related revenue is generated. Based on a U.S. survey by the National Science Foundation and other agencies,¹¹ the average lag between performing R&D and realizing revenue from the investment is assumed to be two years. The advance payment of expenses increases financing costs, which raises the non-tax component of the user cost. If the enterprise is diversified and profitable, these expenses can be deducted from taxable income during the research phase while taxation of revenue is delayed until the commercialization phase. As a result, the effective tax rate, which is already negative due to expensing of current costs, falls further. The subsidy rate could rise or fall since both the numerator and the denominator increase in absolute terms. However, in most cases implementing time-to-build features raises the subsidy. In about a sixth of the countries in our comparison group, the combination of relatively low tax rates and large tax incentives limits the absolute increase in the tax component and the subsidy rate declines. The change in the subsidy rate ranges from -0.7 to 1.4 percentage points, with a median value of 0.5 percentage points.

The essential feature of income-based incentives is a lower tax rate on the income generated from intellectual property. In the context of our user-cost model, this is achieved by applying a lower rate to the net income derived from the R&D, discounted to account for the gestation lag. As discussed by Evers, Miller and Spengel (2015), a key decision to be made when implementing income-based measures is whether to deduct the expenses incurred to earn the eligible income at the preferential or regular tax rate. If the preferential rate is applied to net income, current expenses are effectively deducted at the incentive rate, resulting in symmetric treatment of income and expenses. In a completely symmetric treatment, interest expense and current expenses incurred to manage and improve intellectual property during the commercialization phase are deducted at the incentive rate. In addition, the tax benefit from expensing current costs incurred to perform the R&D is reassessed or “recaptured” at the incentive tax rate. If the preferential rate is applied to the gross income from the intellectual property, current expenses are effectively deducted at the regular income tax rate, resulting in an asymmetric treatment of income and expenses.

⁹ See equation 5 in Annex 1.

¹⁰ By their nature, investment projects involve a lag between expenses incurred and the realization of revenues from the investment. However, since differences across sectors are generally expected to be small, the time-to-build effect is not usually included in estimates of effective tax rates and the user cost of capital.

¹¹ Quoted in Li (2014, 11). The survey covered almost 40,000 firms in 38 industries. Pakes and Schankerman (1984) obtain a similar result for manufacturing industries.

The implications of these two approaches are illustrated in Table 2.¹² A completely symmetric approach to taxing income and expenses during the commercialization phase results in a lower subsidy rate. This outcome reflects the well-known result that if tax depreciation exceeds economic depreciation by a wide enough margin, a tax reduction increases the effective tax rate on capital, which reduces the subsidy measure used in this study.¹³ An asymmetric approach increases the subsidy rate, although the increase is small with the recapture of past R&D deductions. Note that the impact on the subsidy rate rises with the level of the regular and incentive tax rates, keeping the gap constant. The table also shows that a longer gestation lag reduces the impact of income-based incentives on the subsidy rate. As the commercialization phase gets pushed further into the future, the present value of lower taxes on net income from the R&D becomes smaller.

TABLE 2 CHANGE IN THE SUBSIDY RATE ARISING FROM FAVOURABLE TAX TREATMENT OF INCOME FROM INTELLECTUAL PROPERTY

	Corporate Income Tax Rates (regular / preferred)		
	25 / 15	35 / 25	25 / 05
<i>Symmetric application</i> ¹	-0.6	-0.7	-1.2
<i>Asymmetric application</i> ²			
Interest	0.8	1.3	1.5
Interest and past R&D	4.0	5.3	7.2
Four-year gestation lag ³	3.4	4.5	6.1

1. Past R&D costs and current expenses incurred in the commercialization phase are effectively deducted at the incentive tax rate.

2. Expenses incurred in the commercialization phase are effectively deducted at the regular tax rate.

3. A two-year gestation lag is assumed in all other cases.

The estimates in the table are calculated assuming the rate of return on equity is 10 per cent. Taxes paid rise with the rate of return, so the benefit of a tax reduction should increase with the rate of return. However, doubling the rate to 20 per cent has a very small effect in all cases except when interest and past R&D are deducted at the regular tax rate. For example, if the regular tax rate is reduced from 35 to 25 per cent, the subsidy rate rises to 6.7 per cent from 5.3 per cent with a higher rate of return.

A detailed description of how time-to-build and income-based incentives were modelled is given in Annex 1.

Country summaries

Table 3 presents the key features of income-based tax incentives in the international comparison group relevant to assessing how these incentives affect the decision to perform and commercialize R&D in the implementing jurisdiction. The estimated fraction of R&D performed in the implementing jurisdiction that generates the income eligible for the income-based tax incentive reported in the table requires some explanation. The most restrictive regimes (Greece and India) limit eligibility to income realized directly from patents. In Belgium, Ireland,

¹² The analysis abstracts from current expenses incurred to manage and improve intellectual property.

¹³ This can be seen by inspecting equation 3 in Annex 1, which decomposes the user cost of R&D into tax and non-tax components.

the U.K., the Netherlands and China, patents are also the only source of eligible income, but the preference is extended to include “embedded” royalties or production income. Embedded income arises when intellectual property qualifying for the incentive is used internally to produce products or to provide services. Its value is generally determined through application of arm’s-length transfer-pricing principles to calculate the income that would have been received by licensing the intellectual property (Evers, Miller and Spengel 2015).

TABLE 3 INCOME-BASED TAX INCENTIVES FOR R&D IN 2017 - LARGE FIRMS

	Corporate Income Tax Rate (%)			Coverage of Domestic R&D	Tax Rate Applied to Expenses			Implicit Subsidy Rate on R&D	
	Regular	Incentive	Gap		Interest	Other Current	Past R&D	“Eligible” R&D	All R&D
Belgium	33.99	5.1	28.9	Fraction generating royalty income ¹	Regular	Regular	Regular	11.8%	7.4%
Greece	29	0 ³	29.0	Fraction generating royalty income	Regular	Regular	Regular	10.4%	6.5%
India	34.61	11.2	23.4	Fraction generating royalty income	Regular	Regular	Regular	10.3%	6.3%
Portugal	28	14	14.0	Substantially all	Regular	Regular	Regular ⁴	5.8%	4.2%
Italy	27.9	13.95 ²	13.9	Substantially all	Regular	Regular	Regular	5.7%	5.7%
Spain	25	10	15.0	Substantially all	Incentive	Incentive	Regular	5.7%	5.7%
France	34.33	15	19.3	Substantially all	Incentive	Incentive	Regular	5.7%	5.7%
Turkey	20	10	10.0	Substantially all ¹	Regular	Regular	Regular	3.5%	3.5%
Hungary	9	4.5	4.5	Substantially all	Regular	Regular	Regular	1.3%	1.3%
Ireland	12.5	6.25	6.3	Fraction generating royalty income ¹	Incentive	Incentive	Regular	1.2%	0.7%
U.K.	19	10	9.0	Fraction generating royalty income ¹	Regular	Incentive	Incentive	0.3%	0.2%
Netherlands	25	5	20.0	Fraction generating royalty income ¹	Incentive	Incentive	Incentive	-4.0%	-3.1%
China	25	12.5	12.5	Fraction related to technology transfers by technology and software firms.	Regular	Regular	Incentive ⁴	not modelled	

1. Eligible income includes embedded royalties.

2. Minimum rate, which applies for a maximum of five years.

3. Tax exempt for three years only, but can be deferred indefinitely through tax-free reserves.

4. Expensing replaced with amortization.

Sources: Evers et al.; OECD “R&D Tax Incentives: evidence on design, incidence and impacts”; Deloitte 2017 Survey of Global Investment and Innovation Incentives; correspondence with Deloitte representatives in Greece, Hungary, India, Italy and Turkey.

For these seven countries, we assume the share of R&D benefiting from the incentive equals the average share of inventions patented (Box 1). This approach assumes that the propensity to patent is the same in all countries and that all patents have the same value, neither of which is true, but the bias introduced is hard to assess. We do not make any adjustment to the share for the inclusion of embedded income. In the remaining countries, most forms of intellectual property arising from R&D generate eligible income, so we assume that substantially all of the income derived from commercializing domestically performed R&D is eligible for the tax preference.

The countries in Table 3 are ranked by the implicit subsidy provided to all R&D performed by large firms through income-based tax incentives. The subsidy rate on the R&D that generates the eligible income (“eligible” R&D in the table) is also shown. The subsidy rate is defined as

the change in the tax component of the user cost of capital divided by the non-tax component of the user cost. It is calculated assuming that all large firms are risk-neutral.

Box 1 What is the Propensity to Patent?

Estimates of the share of inventions that are patented are not plentiful. We found only four studies using data from the 1990s and later.

At the low end, Fontana et al. (2013) report a 12.6-per-cent patenting rate. This estimate was developed by examining patenting of new products that were recognized as one of the top 100 most technologically important in a competition organized by the magazine *Research and Development*. The estimate is based on data from 1977 to 2004; almost 90 per cent of the observations are from the U.S. There is no information available on the size of firms included in the sample.

Arundel and Kabla (1998) use a 1993 survey of 604 large firms in Europe to calculate patenting propensities, obtaining rates of 35.9 per cent for products and 24.8 per cent for processes.

Cohen, Nelson and Walsh (2000) find that U.S. manufacturing firms *apply for patent protection* for 49.1 per cent of product innovations and for 31.4 per cent of process innovations. These estimates are based on responses by 1,165 large and small firms to a survey covering the 1991–93 period.

At the high end, De Rassenfosse (2010) calculates that just over half (54 per cent) of inventions are patented. This estimate is derived from a survey of firms who have applied for patents conducted for the European Patent Office in 2006. The survey covers large firms in 28 countries, but 71 per cent are located in the EU, with the balance divided almost equally between the U.S. and Japan. Survey participants were asked to give the share of inventions that were patented throughout the world in 2005. The reported propensity to patent is based on responses from 324 firms.

Each of the estimates has strengths and weaknesses. In the absence of any compelling reason to favour or reject any of the four studies, we use the median value of the estimates of the propensity to patent new products (42.5 per cent) in our analysis of income-based incentives.

Almost half of the all-R&D subsidy rates are in a narrow range from 5.7 to 6.2 per cent. Countries in this group either have a large gap between the regular and incentive rates or allow substantially all R&D to generate eligible income. At the low end, relatively small tax-rate gaps in Ireland and the U.K. combined with deduction of some expenses at the incentive rate results in a near-zero subsidy rate. The Netherlands is the only country applying its incentive rate to current expenses and to deductions for past R&D. As discussed above, this approach amounts to a simple reduction in the tax rate applied to R&D, which, in the presence of tax-depreciation allowances that exceed economic depreciation by a large margin, raises the after-tax cost of capital.

Implementing income-based measures — design issues

As discussed earlier, 85 countries, including all OECD members and all countries that currently have income-based incentives, have endorsed the BEPS modified nexus approach. It is therefore reasonable to assume that the nexus approach will be part of virtually all income-based incentives.

A key consideration in setting up income-based incentives is whether the support should be in addition to or a substitute for existing expenditure-based tax incentives for R&D. If governments decide to add to the level of support, they should carefully consider the risk of excessive subsidization, which would prevent maximization of the net social benefit from intervention and could cause the net social benefit to turn negative. If income-based incentives are intended to be a substitute, governments should be prepared to reduce expenditure-based subsidies by four to five percentage points for a 10-percentage-point reduction in the income tax rate applied to income from intellectual property (Table 2).

A second related issue to be resolved is the size of the income tax reduction to offer. The objective is to encourage the retention of commercialization activity and the associated tax base in the implementing jurisdiction. Factors to consider here are the distribution of real activity and tax bases between the implementing and competing jurisdictions and the tax rates in competing jurisdictions. Countries that have retained only a small fraction of the commercialization activity and/or the associated tax base could consider larger reductions than countries that have retained a large share of the activity and taxable income. Countries that are competing with tax havens that have very low tax rates may not be able to “repatriate” much of the intellectual property tax base through tax-rate reductions.

A third consideration is that the income-based incentive should cover all of the income arising from commercializing R&D, including embedded income from intellectual property, but should not provide benefits for other types of income. This is consistent with recommendations in the OECD/G20 BEPS Action 5 report,¹⁴ which restrict benefits to income that can be linked to the performance of R&D. The OECD’s list of eligible assets includes patents, assets that are functionally equivalent to patents, copyrighted software and other assets that can be demonstrated to have patent-like features (protecting ideas that are non-obvious, useful and novel). Marketing-related assets such as trademarks are not considered eligible assets. Restricting coverage to income arising from patents causes distortions in the type of R&D undertaken and in the decision to protect intellectual property with patents or by other means, even if embedded royalties are considered eligible income. On the other hand, extending benefits to intellectual property that is not the result of investing in R&D runs the risk of subsidizing an activity that does not generate any spillover benefits. Despite international tax-base shifting in favour of the implementing jurisdiction, there will be a net revenue loss in most situations, which would result in a negative net social benefit from the initiative.

In addition, favouring patent income highlights the tension between subsidies and the benefits provided by patent protection. As discussed by Boadway and Tremblay (2017), R&D subsidies and patent protection can be viewed as alternative methods of moving toward the socially optimal level of innovation: if patents permit inventors to capture all the returns to innovation, further incentives would not be required. However, as pointed out by Arrow (1962), inventors cannot fully capture the social value of their inventions through patents, so it is common for governments to provide subsidies as well as patent protection in order to encourage the socially optimal level of investment in R&D. Nevertheless, favouring patent income raises concerns since it may push the subsidy rate on R&D receiving patent protection above the value that maximizes its net social benefit.

¹⁴ OECD (2015b) para. 28.

Fourth, a decision has to be made on whether to allow income from existing intellectual property to benefit from the preferential tax rate. Making existing intellectual property eligible has the obvious disadvantage that it does not provide any incentive to undertake more R&D. On the other hand, eligibility of existing assets should encourage additional commercialization activity as well as international tax-base shifting to the advantage of the implementing jurisdiction. Nevertheless, as the discussion on page five demonstrated, a net revenue loss will occur in most jurisdictions; in the absence of spillovers from commercialization activity, a revenue loss means that the net social benefit from this policy option will be negative. A related issue is how to treat acquired intellectual property. If the property is acquired from a firm in the implementing jurisdiction, there would be an element of double counting if the income from the sale of intellectual property is taxed at a preferential rate. If the property is acquired from a non-resident firm, eligibility would encourage additional commercialization activity; but by the same logic applied to existing assets, the net social benefit would be negative.

A fifth set of considerations arises with respect to startups or credit-constrained firms. Such firms perceive a smaller ex ante subsidy from income-based measures than other firms do. A revenue-neutral shift from expenditure-based to income-based incentives would therefore reduce the amount of support received by start-ups and credit-constrained firms. This outcome may not be a cause for concern if such firms receive other advantages, such as refundability or a higher level of support.

Finally, governments have to decide how to treat expenses under income-based tax incentives. Expenses can be deducted at the incentive tax rate or the regular income tax rate. As demonstrated above, a preferential tax rate on commercialization income combined with deduction of current expenses at the incentive tax rate and recapture of past R&D deductions results in a lower subsidy rate on R&D. The lower tax rate on commercialization income will, nevertheless, encourage MNEs to shift taxable income and commercialization activity into the implementing jurisdiction. Allowing some or all expenses associated with commercialization to be deducted at the regular tax rate, which occurs if the incentive tax rate applies to gross income from commercialization, increases the subsidy rate.

Should Canada implement an income-based incentive?

Three Canadian provinces — B.C., Saskatchewan and Quebec — have implemented patent-box regimes (Box 2). Despite advocacy by a number of observers, the federal government has not implemented any income-based incentives for R&D. As indicated earlier, Boadway and Tremblay (2017) give a qualified endorsement to implementing income-based R&D incentives in Canada. The key benefit would be the retention of intellectual-property-based income in Canada and the associated tax revenue. A more neutral treatment of risky innovation activities is also seen as a benefit. Boadway and Tremblay express the view that there should be a nexus between income eligible for the incentive and R&D performed in Canada and that eligible assets should include a broad range of intellectual property. They conclude that the optimal policy may be to use both types of incentives at relatively low rates. Hausch and De Luca (2017) also provide qualified support for income-based incentives, emphasizing that design features can make the difference between success and failure of the initiative. In contrast, Pantaleo, Poschmann and Wilkie (2013) see a strong case for favourable tax treatment of income from intellectual property and set out a detailed proposal for a revised federal intellectual property tax regime in Canada.

Box 2 Patent Boxes in Canadian Provinces

British Columbia has since 2006 provided a lower corporate income tax rate on certain types of international patent income. A refund of up to 75 per cent of B.C. corporate income tax paid on income received from non-residents from patents in life sciences, clean power generation, waste water treatment and fuel cell technology is available. There is no local development requirement and patents acquired in other jurisdictions are eligible assets. The effective tax rate on eligible income is 2.75 per cent, although the benefit is capped at \$8 million per firm.

Quebec introduced a patent-box regime effective Jan. 1, 2017. Access to the benefit is restricted to manufacturing firms not eligible for the small-business deduction. The preliminary description of the program indicates that patents are the only eligible asset and that embedded royalties will be eligible income. The OECD's nexus requirement is respected by the requirement that the patent be granted as a result of R&D that benefitted from a Quebec tax credit. Subject to a cap, net patent income will be taxed at four per cent instead of 11.8 per cent. With net income as the base, current expenses are effectively deducted at the incentive rate, but there is no recapture of deductions for past R&D. As a result, the implicit subsidy for R&D undertaken by manufacturing firms that generates patent income is 1.5 per cent, which is in addition to the 7.4-per-cent subsidy available from Quebec's expenditure-based tax incentive.

Saskatchewan announced the introduction of a patent regime in its latest budget. The Saskatchewan Commercial Innovation Incentive will reduce the corporate income tax from 12 to six per cent on income arising from a range of intellectual property, including patents, plant-breeder rights, trade secrets and copyrighted software. The low rate applies for 15 years if the intellectual property was developed in Saskatchewan and for 10 years if it was not. There are no sectoral limitations on access to the incentive, but the incentive will only be of interest to larger firms since the tax rate applicable to small-business income is two per cent. Firms will have to demonstrate that the source of the income is an exceptional innovation and will have to meet a number of economic performance criteria. There is not enough information available on the program to determine how expenses will be treated. The Saskatchewan initiative deviates from the OECD recommendations on nexus by not imposing a local-development requirement and on eligible assets by including trade secrets in the list of eligible assets.

We share the Boadway-Tremblay view that there is an “uneasy case” for a federal income-based R&D tax incentive. On the positive side, the analysis of a revenue-neutral shift from expenditure to income-based incentives demonstrates that income-based measures are a more cost-effective way of stimulating R&D by large firms, which are likely to be risk-neutral. In this case, the shift would have no impact on R&D, but the fiscal cost would be lower as a result of profit-shifting in response to a lower tax rate.¹⁵ However, favourable tax-base-shifting effects may be smaller than expected, since feasible reductions in the federal tax rate may not be sufficient to change the behaviour of MNEs. Some tax havens, such as the Cayman Islands and Bermuda, do not impose corporate income taxes. If such jurisdictions are substantial destinations for intellectual-property income earned by Canadian MNEs, reducing the federal rate from 15 per cent to five per cent, which would lower the combined federal-provincial rate from 26.7 per cent to 15.7 per cent, would not have much impact on tax-base shifting.¹⁶ A co-ordinated federal-provincial initiative would be more likely to generate favourable tax-

¹⁵ Note that this comparison only depends on there being some profit shifting; there is no need to make the implausible assumption that income-based measures are self-financing to conclude that they are more cost-effective than expenditure-based measures.

¹⁶ Note that reducing the federal rate to zero would eliminate any gain from profit shifting.

base-shifting effects. More information on how MNEs shift intellectual-property income out of Canada is required before an informed decision on implementing an income-based incentive can be made. In contrast, the case for a revenue-neutral shift in expenditure-based to income-based measures for small firms is weak: there would be less R&D performed, with no offsetting benefit from profit shifting.

If more detailed analysis indicates that tax-base shifting would indeed give income-based measures an advantage over expenditure-based measures, should the income-based measure be in addition to or a substitute for existing expenditure-based measures? The combined federal-provincial subsidy rate on R&D performed by large firms is about 20 per cent, which appears to be below the rate that maximizes the net social benefit from intervention,¹⁷ so Canada likely has some room to increase the overall level of support for R&D performed by large firms.

TAX ASSISTANCE FOR R&D: AN INTERNATIONAL COMPARISON

Overview

In this paper, we present estimates of the subsidy rate arising from expenditure- and income-based tax assistance for 29 of 35 OECD member countries¹⁸ along with four key transition economies: Brazil, Russia, India and China. All but seven of the countries in the comparison group provide expenditure-based tax assistance in the form of investment tax credits or tax-depreciation allowances that exceed the amount invested (“super allowances”). Note, however, that all countries allow current expenditures on R&D to be deducted from taxable income as they are incurred. Since spending on R&D represents an investment that would normally be amortized and deducted over time, immediate deductibility of current expenditures provides a subsidy to R&D. Twelve of the 26 countries providing expenditure-based assistance also provide income-based assistance in the form of a lower tax rate on income from the commercialization of R&D.

Considering only countries that offer explicit incentives, all-inclusive subsidy rates for large firms range from 44.6 per cent in France to 5.3 per cent in Korea (Chart 1). For those countries without explicit incentives, the subsidy rate ranges from 3.8 per cent in Mexico¹⁹ to 2.3 per cent in Finland. The range of estimates reflects differences in corporate income tax rates and in baseline tax-depreciation allowances.

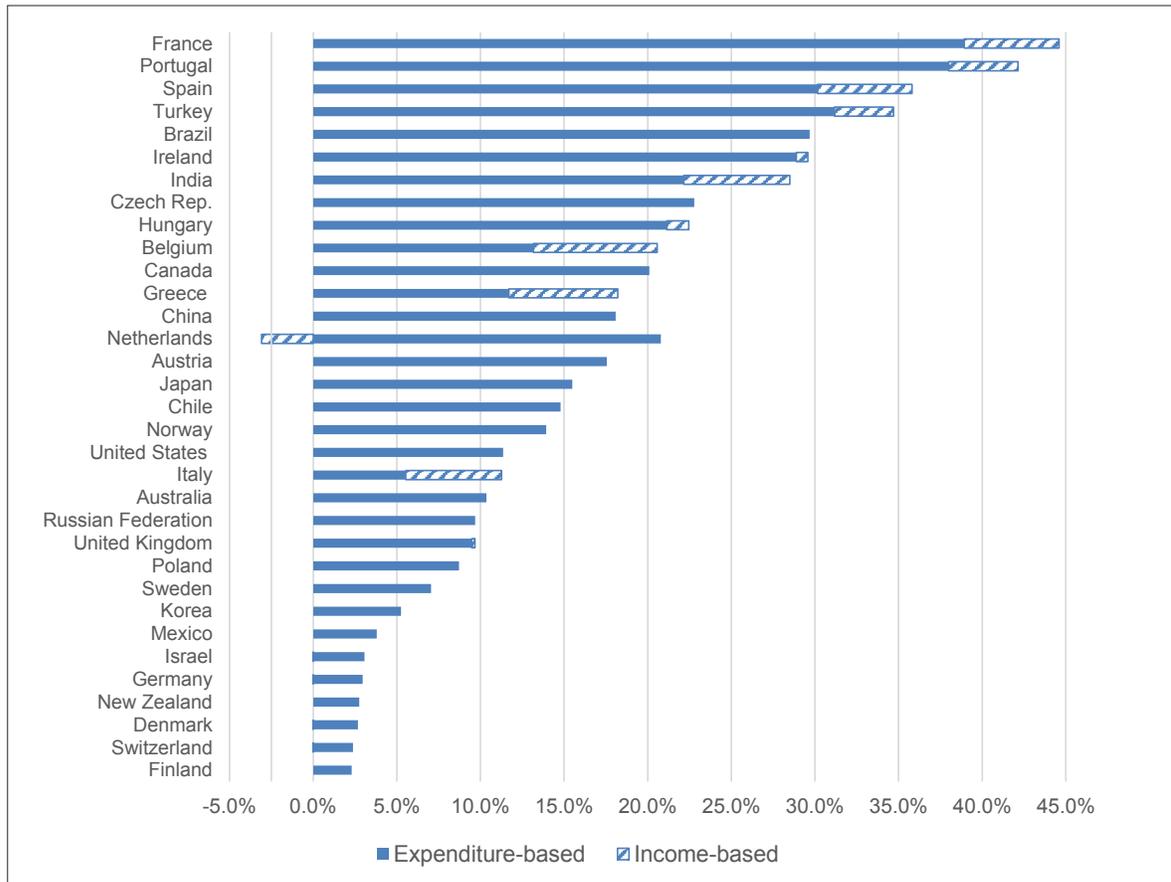
Income-based incentives increase the overall generosity of tax assistance substantially in Italy, where the subsidy rate more than doubles; in Belgium and Greece, where it rises by more than 50 per cent; and in India, where the subsidy rate rises by almost 30 per cent. Inclusion of income-based measures does not have a substantial effect on the composition of the 10 countries offering the most generous subsidies for large firms. Only one country, Belgium, enters the top 10 as a result of income-based incentives, replacing the Netherlands. France and Portugal retain first and second position, respectively.

¹⁷ See Lester (2017).

¹⁸ Estimates have not been prepared for Estonia, Iceland, Latvia, Luxembourg, the Slovak Republic and Slovenia.

¹⁹ Mexico provides what amount to grants through the tax system. This measure is not modelled, in part because the amount of funding available is very small.

CHART 1 R&D SUBSIDY RATES FOR LARGE FIRMS



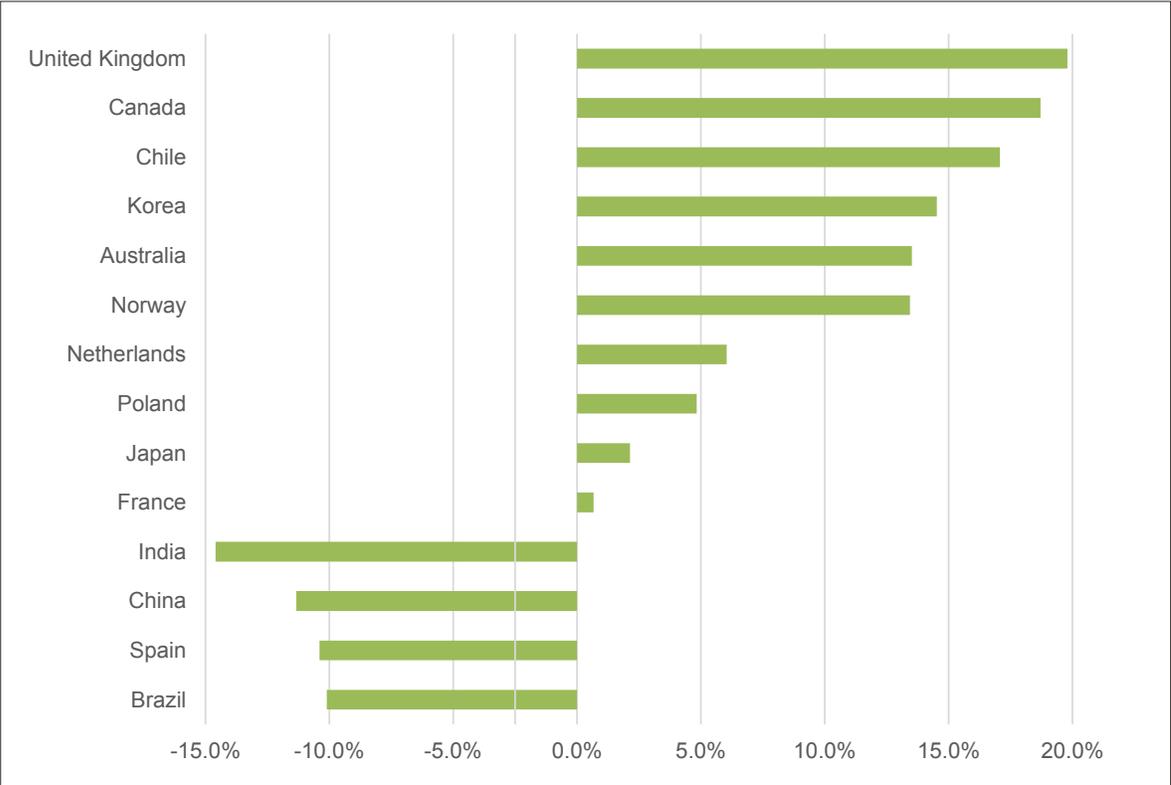
Of the 33 countries examined, only eight provide broad-based preferential tax treatment to small firms.²⁰ These are, in descending order of the gap between small and large firms, the United Kingdom, Canada, Korea, Australia, Norway, Poland, the Netherlands and Japan (Chart 2). In addition, support for small firms is more generous in Chile, despite a uniform statutory credit rate, because of a cap that affects large firms more substantially than small firms. The cap in Spain is expressed in terms of tax liabilities; as discussed in Lester and Warda,²¹ the cap is more likely to be binding for small firms because they are less diversified. France has a two-level credit rate, 30 per cent for spending under 100 million and five per cent over that threshold. Data from the French government²² suggest that little spending is subject to the five-per-cent rate, resulting in an average effective credit rate of 27.3 per cent for large firms. This modest advantage for small firms is eroded by the impact of a lower corporate income tax rate on the value of tax-depreciation allowances. Brazil, China and India also offer lower income tax rates to small firms that translate into lower after-tax savings on their R&D super allowances that are available to small and large firms at the same rate. Conversion of super allowances into tax credits would eliminate the impact of changes in the corporate income tax rate and would keep the incentive neutral.

²⁰ Five countries — Belgium, France, the Netherlands, Portugal and Spain — provide incentives to startups or “innovative” small firms. See Annex 2.

²¹ Lester and Warda (2014) p. 30-31.

²² Le crédit d’impôt recherche en 2013, (Édition avril 2016), (https://cache.media.enseignementsup-recherche.gouv.fr/file/guide_CIR/37/7/Le_credit_d_impot_recherche_en_2013_558377.pdf).

CHART 2 R&D EXPENDITURE-BASED SUBSIDY RATES -- ESTIMATES FOR SMALL FIRMS LESS ESTIMATES FOR LARGE FIRMS



Box 3 Changes in Tax Assistance for R&D Spending Since 2014

Austria increased its expenditure-tax-credit rate to 12 per cent from 10 per cent.

Australia cut its R&D tax credit by 1.5 percentage points, to 38.5 per cent for large firms and 43.5 per cent for small firms. Australia also imposed a ceiling of \$100 million (Australian dollars) on the maximum R&D expenditure claim that is eligible for the tax credit.

Belgium introduced an additional tax credit on capital expenditure undertaken to perform R&D.

Finland did not proceed with the implementation of R&D super allowance beyond its pilot stage.

Greece reduced its super allowance to 130 per cent from 150 per cent.

India reduced its R&D super allowance to 150 per cent from 200 per cent.

Ireland removed incrementality from its R&D tax credit of 25 per cent. The base was spending in 2003, which limited benefits for few firms.

Italy implemented an incremental R&D tax credit of 50 per cent on R&D spending that exceeds the average level over the previous three years.

Korea reduced tax-credit rates on capital spending from three per cent to one per cent for large corporations and from 10 per cent to six per cent for SMEs.

The Netherlands consolidated its research and development allowance (RDA) with the R&D-wages withholding tax credit against payroll taxes (WBSO). They are now being offered as single credit at the rate of 32 per cent (down from 35 per cent) for eligible R&D costs up to a threshold of 350,000 euros (up from 250,000 euros), and 16 per cent (up from 14 per cent) above 350,000 euros.

Norway increased the cap on intramural R&D spending from 5.5 million to 20 million kroner.

Poland implemented an R&D super allowance applicable to R&D wages at a rate of 150 per cent. Other current R&D expenses and depreciation of machinery and equipment are also eligible at 150 per cent for small firms and 130 per cent for large firms.

Sweden introduced a partial exemption from the company's social security contributions of researchers. The exemption is offered at a rate of 10 per cent of the net salary of R&D personnel and is subject to a ceiling.

Turkey implemented a 100-per-cent super allowance for current expenditures and investment in machinery and equipment for firms with at least 15 full-time-equivalent employees engaged in R&D.

United Kingdom increased the small-firm R&D super allowance to 230 per cent from 225 per cent. This change provides an offset to a decrease in the corporate income tax rate, from 20 to 19 per cent.

Sources: OECD R&D tax incentive compendium (2016 edition); Deloitte, 2017 Survey of Global Investment and Innovation Incentives, March 2017.

Comparison with 2014

Since 2014, when our previous international comparison was published, three countries — Italy, Poland and Sweden — have implemented expenditure-based R&D subsidies while one country — Finland — has discontinued its incentive. As a result, 29 of the 35 OECD member countries now provide tax assistance for R&D spending. In addition, 10 other countries have made substantial modifications to their tax-assistance regimes (Box 3). Measures in Austria, Belgium, the Netherlands, Norway and the U.K. were made slightly more generous, while Turkey implemented a new super allowance. On the other hand, Australia, Greece, India, Korea and the two largest Canadian provinces reduced the generosity of their tax incentives. Finally, corporate income tax rates were increased in two countries and reduced in 10, which reduced subsidy rates by lowering the value of tax-depreciation allowances.

Measuring the impact of these changes on overall support levels is complicated by modifications to our methodology. The key changes are adopting a time-to-build modelling framework (for patent-box incentives) and including risk premiums for equity financing and for small-business debt financing. We also used new information to determine the impact of eligibility criteria and caps on effective subsidy rates and updated the baseline tax-depreciation allowances for spending on R&D. We recalculated estimates for 2014 to include the risk premiums and the new information on the impact of caps and eligibility criteria. The net impact of changes since 2014 has been a small reduction in the generosity of tax assistance for R&D spending as measured by the average subsidy rate and a somewhat larger decline in the median subsidy rate (Table 4). Similar results are obtained when the countries that have introduced tax incentives since 2014 are excluded from the calculation.

TABLE 4 MEDIAN AND AVERAGE VALUES OF USER-COST SUBSIDY RATES 2014-2017 (%)¹

Year/Statistic	Large Firms		Small Firms
	Income and Expenditure	Expenditure-Based	Expenditure-Based
2017 with time-to-build			
Median	14.8	13.2	17.6
Average	16.4	15.0	17.6
2017 without time-to-build			
Median	14.4	12.1	17.4
Average	16.1	14.6	17.3
2014 without time-to-build			
Median	-	14.9	18.9
Average	-	15.1	18.3
2017/2014 change without time-to-build			
Median		-2.7	-1.5
Average		-0.5	-1.0

1. Estimates for 2014 have been recalculated using the 2017 methodology, except for the time-to-build feature. See text for details.

Since 2014, there has been only one change in the countries represented in the top 10 ranking of support for large firms: the Netherlands has replaced Canada in the 10th position (Table 5). France and Portugal continue to provide among the most generous levels of support, but India, which reduced its super-allowance rate, has been replaced in the top three by Turkey, which implemented a new super allowance. Corporate income tax rate reductions lowered the subsidy

rate in Portugal, Spain and Hungary. In France, support levels increased because fewer large firms exceeded the spending threshold for the most generous rate. In 2017, the top 10 subsidy rates range from about 21 to 39 per cent, compared to 20 to 41 per cent in 2014. The average subsidy rate in the 10 most generous countries has fallen almost two percentage points.²³

TABLE 5 TOP TEN EXPENDITURE SUBSIDY RATES FOR LARGE FIRMS (PERCENTAGE)

2014 ¹		2017	
Country	Subsidy rate	Country	Subsidy rate
Portugal	40.7	France	38.9
India	38.6	Portugal	38.0
France	35.6	Turkey	31.2
Spain	32.4	Spain	30.1
Brazil	30.1	Brazil	29.7
Ireland	29.5	Ireland	28.9
Hungary	29.1	Czech Rep.	22.8
Turkey	24.5	India	22.2
Czech Rep.	22.6	Hungary	21.1
Canada	20.3	Netherlands	20.8
Average Top-10 subsidy	30.3	Average Top-10 subsidy	28.4

1. Revised estimates. See text for details.

Comparison with OECD 2016 estimates

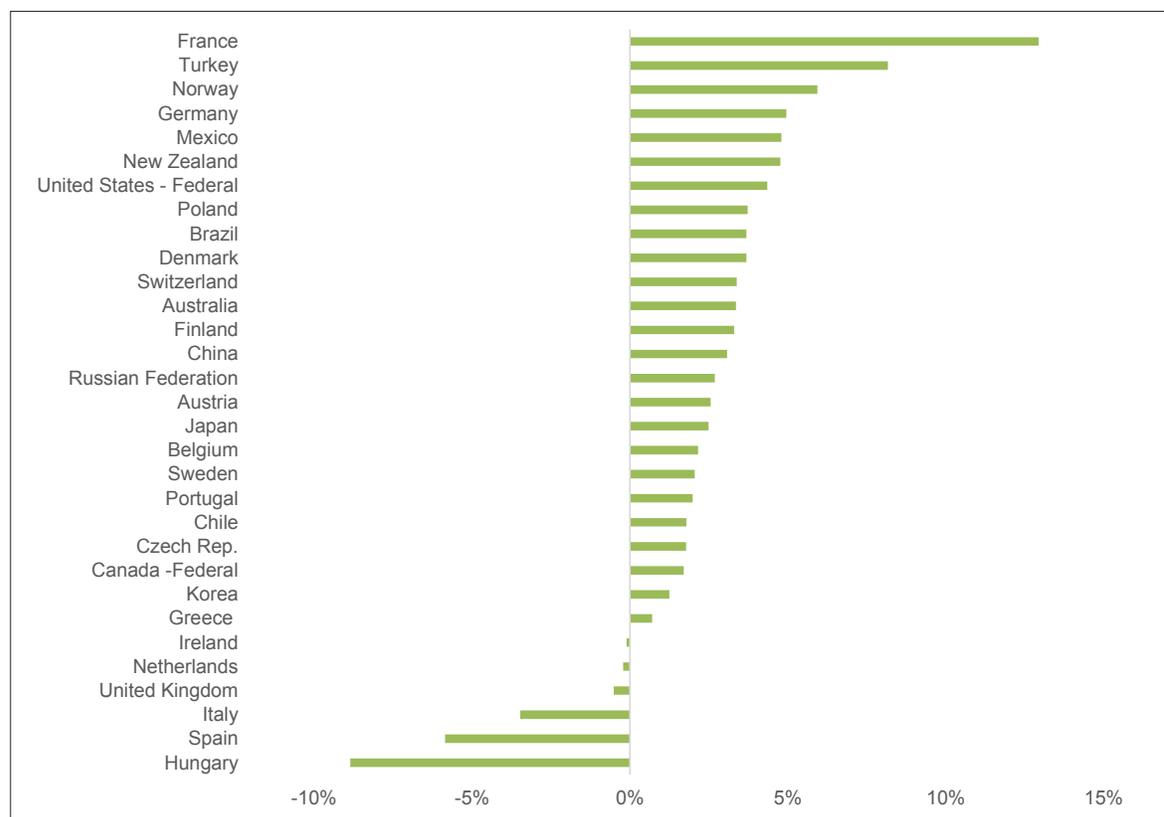
The OECD periodically publishes estimates of subsidy rates arising from tax assistance for R&D in member countries. Charts 3 and 4 compare subsidy rates for the 31 countries included in both the OECD report and this study. The OECD estimates for 2016 (OECD 2017) make use of the B-index formula, which has two key differences with the user-cost methodology. First, the tax on the net return to the investment is explicitly modelled in the user-cost framework but not in the B-Index. This difference reduces the user-cost subsidy relative to the B-Index calculation. Second, the baseline treatment of current R&D expenses is immediate deductibility in the B-Index framework while the user-cost methodology assumes that R&D expenditures should be capitalized and deducted from taxable income over time. Since all countries in the comparison group allow current expenditures to be deducted as they are incurred, this difference raises the subsidy rate obtained from the user-cost approach relative to those calculated using the B-Index formula. In addition, we are using a lower discount rate than the OECD uses, which raises the user-cost subsidy rate by a small amount through its impact on the present value of tax-depreciation allowances. The net impact of these three differences is to raise our subsidy-rate estimates for large firms by about three percentage points relative to the OECD estimates when identical tax parameters are used.

Our 2014 paper (Lester and Warda 2014) transformed statutory investment-tax-credit and super-allowance rates into effective rates by considering the impact of eligibility criteria, caps, thresholds, base effects and other design features of the incentives. These adjustments substantially reduced the subsidy rates for about a dozen countries. As a result, there were large

²³ Corrected for the increase in subsidy rates resulting from implementing time-to-build modelling, the decline would be closer to 2.5 percentage points.

differences for these countries between our subsidy estimates and those prepared by the OECD (2013) that used statutory rates to calculate subsidy rates. The OECD switched to effective rates in 2016, which has reduced the gap in estimates from the two studies. Nevertheless, larger-than-expected discrepancies occur in a few cases, reflecting not only differences in methodologies to estimate the impact of caps but also our use of more recent information on tax parameters and incentive rates.

**CHART 3 EXPENDITURE-BASED SUBSIDY RATES FOR LARGE FIRMS
THIS STUDY LESS OECD**



Examples where our study obtains a substantially higher subsidy rate than the OECD include:

- France, where we calculate a higher effective tax-credit rate for large firms;²⁴
- Turkey, where we include a tax credit on social security contributions; and
- Poland, where we model richer R&D tax incentives for small firms introduced in 2017.

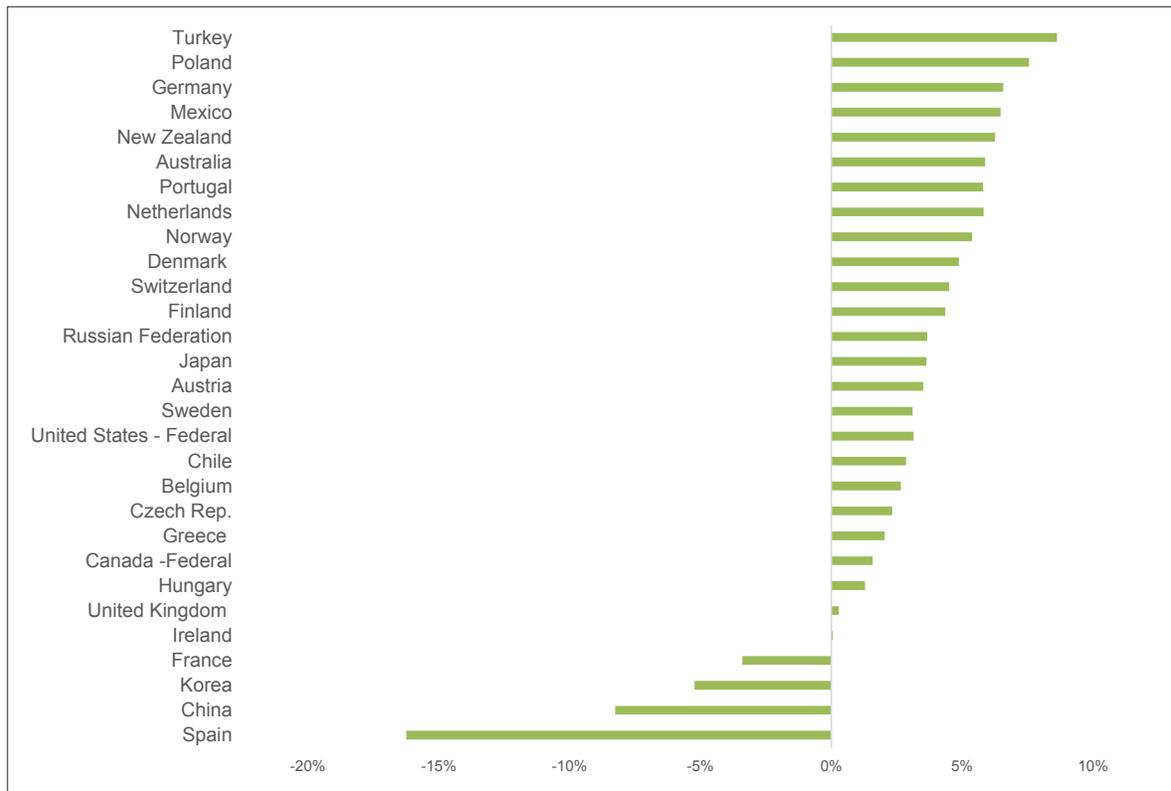
Examples where our study obtains a substantially lower subsidy rate than the OECD include:

- Spain, where we assume that the cap binds more severely than in the OECD estimates, especially for small firms;

²⁴ The French investment-tax-credit rate is 30 per cent for spending up to 100 million euros and five per cent for spending above 100 million. Using data published by the French government (Le credit d'impôt recherche en 2013, Édition avril 2016, https://cache.media.enseignementsup-recherche.gouv.fr/file/guide_CIR/37/7/Le_credit_d_impot_recherche_en_2013_558377.pdf) we calculated a weighted average tax-credit rate of 27.3 per cent for large firms, which is approximately eight percentage points higher than in the OECD report.

- Hungary, where we use the lower large-firm corporate income tax rate implemented in 2017;
- China, where we use a lower corporate income tax rate for small firms;
- Korea, where we assume that overhead costs are excluded from the incentive base for small firms;
- France, where we use the lower statutory income tax rate for small firms; and
- Italy, where we use the lower statutory income tax rate implemented in 2017.

**CHART 4 EXPENDITURE-BASED SUBSIDY RATES FOR SMALL FIRMS
THIS STUDY LESS OECD**



CONCLUSION

This paper has presented comprehensive estimates of R&D subsidies delivered through the tax system for most OECD member countries and four key developing and transition economies. The subsidy rates are calculated in the user-cost framework and include, for the first time, both expenditure- and income-based measures. The subsidy arising from income-based measures is evaluated assuming there is a nexus between the income being taxed at a preferential rate and the expenditures undertaken to generate that income.

If income-based tax incentives for R&D conform to the OECD's nexus requirement, they become an alternative method of subsidizing R&D that will encourage retention of commercialization activity and the associated taxable income in the implementing jurisdiction, without encouraging profit shifting from other jurisdictions. As a result, income-based

measures have the potential to be a more cost-effective way of encouraging R&D than expenditure-based measures. Further, there may be additional social benefits from the retention of commercialization activity, particularly if the quality of jobs created is higher than average.

Nevertheless, countries with income-based incentives or those considering implementing them should carefully consider a number of issues, including:

- *The possibility of excessive subsidization.* In some cases, it will be appropriate to shift support from expenditure-based measures to income-based incentives instead of adding to the overall level of support.
- *The nature of the competition for taxable income from commercialization.* If the competition comes from countries with very low tax rates, it may not be possible to offset the direct revenue loss by a substantial amount through tax-base shifting.
- *The impact on small firms.* Small firms are less likely to be risk-neutral than larger firms, which implies that they will respond less strongly to deferred than to up-front incentives. Differential treatment of small and large firms appears to be required to maintain effective subsidy rates at the same level when income-based incentives are provided.

The subsidy rate for R&D performed by large firms in Canada appears to be below the level that would maximize the net social benefit, so increasing the overall level of support with an income-based incentive would not raise concerns about excessive subsidization. On the other hand, favourable tax-base-shifting effects may be smaller than expected since feasible reductions in the federal tax rate may not be sufficient to change the behaviour of MNEs. A co-ordinated federal-provincial initiative would be more likely to generate favourable tax-base-shifting effects. More information on how MNEs shift intellectual-property income out of Canada is required before an informed decision on implementing an income-based incentive can be made.

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ANNEX 1 – MODEL DESCRIPTION

This annex presents the user-cost model used in this study to calculate tax assistance for R&D. It begins with a short description of the basic user-cost equation and then shows how it was modified to include “time to build” features and income-based tax incentives.

The user cost of capital

The user cost of capital, defined as the annual cost of using a dollar’s worth of capital, is shown in equation 1.

$$(1) \quad UC = (1 - c)(R_f - \pi + \delta)(1 - uz(1 - c'))/(1 - u)$$

Where c is the investment-tax-credit rate;

R_f is the financial cost of capital;

π is the inflation rate, assumed to be two per cent;

δ is the economic-depreciation rate of the knowledge asset created by undertaking R&D, assumed to be 15 per cent;

u is the corporate income tax rate;

z is the present value of tax-depreciation allowances on \$1 of investment;

c' equals c for “non-taxable” credits and zero otherwise. (Tax-depreciation allowances can be claimed on the gross of the investment-tax-credit amount if the credit is non-taxable.)

The financial cost of capital is defined in equation 2.

$$(2) \quad R_f = \beta i(1 - u) + (1 - \beta)\rho = \beta i + (1 - \beta)\rho - \beta iu = R_n - \beta iu$$

Where β is the share of debt in total assets, i is the interest rate, ρ is the rate of return on equity and R_n is the return to capital net of depreciation and corporate income tax.

Using the definition of R_f in equation 2, equation 1 can be rearranged to decompose the user cost into its tax and non-tax components.

$$(3) \quad UC = [R_n - \pi + \delta] + \left[\frac{u}{(1 - u)} (R_n - \pi) \right] - \left[\frac{u}{1 - u} \beta i \right] \\ + \left[\frac{u}{(1 - u)} \left[\delta - (R_f - \pi + \delta) \frac{z}{(1 - c')} \right] \right] - \left[c \left(\frac{(R_f - \pi + \delta)(1 - uz/(1 - c'))}{1 - u} \right) \right]$$

The first term in square brackets in equation 3 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, with interest deductibility shown in the third term; the fourth bracketed term shows how the gap between economic and tax depreciation affects tax revenue; and the fifth bracketed term shows the impact of tax credits on the user cost of R&D capital.

In this study, the benchmark for comparing the impact of tax incentives is the real net-of-tax user cost of capital ($R_n - \pi + \delta$), which is assumed to be the same for all countries. More specifically, the impact of R&D tax incentives is measured by dividing the sum of the four tax components in equation 5 by the non-tax component of the user cost. In the absence of an interest in including income-based incentives in the analysis, an alternative approach would be to consider only the R&D-specific tax measures — the fourth and fifth components of equation 1.

The user cost of capital with time to build

Investment, by its nature, requires making expenditures before revenue is realized. The revenue lag increases financing costs and hence raises the user cost of capital. This increase is partially offset by the delay in paying taxes on the revenue generated by the investment. Further, if the firm making the investment is diversified and profitable, the interest paid on loans and possibly other expenses can be deducted without delay from other sources of revenue. The early use of these deductions reduces the effective tax rate, which puts downward pressure on the tax-inclusive user cost of capital.

Since all capital investment is affected by time-to-build considerations, it is not usually incorporated in estimates of the user cost or marginal effective tax rates.²⁵ There are however two reasons for incorporating time-to-build in estimates of the user cost of R&D investment. First, in contrast to many other industries, almost all R&D expenses can be deducted from (other) income as they are incurred. In most other industries,²⁶ investment expenditures are capitalized and tax-depreciation allowances can be claimed only when the capital good is available for use. As a result, tax benefits provide a larger offset to higher financing costs for R&D investments than for most other investments. Second, modelling income-based R&D incentives requires making an explicit distinction between the research and commercialization phases, because the corporate income tax rate differs in the two phases.

Equation 3 was modified as follows to include time-to-build features:

$$(4) \quad UC = [(R_n - \pi)(1 + R_n - \pi)^{ttb} + \delta] + \left[\frac{u}{(1-u)} (R_n - \pi) / (1 + R_f - \pi)^{ttb} \right] - \left[\frac{u}{1-u} \beta i \right] \\ + \left[\frac{u}{(1-u)} (\delta - (R_f - \pi + \delta) \frac{z}{(1-c')}) \right] - \left[c \left(\frac{(R_f - \pi + \delta)(1 - uz' / (1 - c'))}{1-u} \right) \right]$$

In equation 4, the required net-of-corporate-tax return to investors (first bracketed term) is increased to reflect the gestation lag of R&D, *ttb*, assumed to be two years. Tax on the net return is not payable until the R&D is commercialized, so it is discounted to capture the gestation lag (second bracketed term in equation 4). The other tax components of the user cost are not adjusted because there is no delay in their application.

Including income-based tax incentives in the user cost of R&D capital

Income-based tax incentives involve different corporate income tax rates in the research and commercialization phases. As a result, there are some similarities with modelling tax holidays in a marginal-effective-tax-rate framework,²⁷ which involves a zero corporate income tax rate for some period of the capital asset's life, followed by a non-zero rate for the remainder. Modelling time-variant corporate income tax rates in the user-cost model involves making adjustments to the tax on the net return to interest deductibility and to tax-depreciation allowances claimed during the research phase.

²⁵ Marginal effective tax rates are defined as $(R_g - R_n) / R_g$, where R_g is the gross-of-corporate-tax return to investors and R_n is the net-of-tax return. R_g equals the gross-of-tax user cost of capital less economic depreciation and R_n is the net-of-tax user cost less economic depreciation. R_g and R_n are net of inflation in this formulation.

²⁶ Natural resource extraction also benefits from immediate deduction of some investment-related expenditures.

²⁷ See, for example, J. M. Mintz 1990.

The revised user-cost equation is:

$$\begin{aligned}
 (5) \quad UC = & [(R_n - \pi)(1 + R_n - \pi)^{ttb} + \delta] + \left[\frac{\frac{u'}{(1-u')}(R_n - \pi)}{(1 + R_f - \pi)^{ttb}} \right] \\
 & - \left[\frac{\frac{u}{1-u}\beta i - \left(\frac{u}{1-u} - \frac{u'}{1-u'}\right)\beta i}{(1 + R_f - \pi)^{ttb}} \right] \\
 & + \left[\frac{u}{(1-u)}(\delta - (R_f - \pi + \delta))\frac{z}{(1-c')} \right. \\
 & \left. + \frac{\left(\frac{u'}{1-u'} - \frac{u}{1-u}\right)(\delta - (R_f - \pi + \delta))\frac{z}{(1-c')}}{(1 + R_f - \pi)^{ttb}} \right] \\
 & - \left[c \left(\frac{(R_f - \pi + \delta)(1 - uz'/(1-c'))}{1-u} \right) \right]
 \end{aligned}$$

In equation 5, the tax on the net return has been modified to apply the incentive tax rate instead of the regular tax rate. The tax rate during the research phase is zero with time-to-build modelling, so no other adjustment is required. With a lower corporate income tax rate in the commercialization phase, interest deductibility at a constant tax rate (the first expression in the third bracketed term of equation 5) is adjusted to remove the present value of interest deductions that would have been taken at the regular tax rate during the commercialization phase and adding the present value of interest deductions evaluated using the incentive tax rate. A similar adjustment is made to tax-depreciation allowances, with the result that deductions made during the research phase at the regular corporate income tax rate are reversed (without adjustment for the time value of money) and deducted at the lower incentive rate.²⁸

The above modelling assumes that net income and deductions are treated symmetrically in the commercialization phase — income is taxed at the lower incentive rate and expenses are deducted at the same rate. This is not the typical case: only one country, the Netherlands, adopts a completely symmetric approach.

²⁸ The “recapture” of depreciation allowances is only completely accurate for expenses that are deducted as they are incurred. Explicitly modelling the recapture of amortized expenses, which account for less than 10 per cent of total spending on R&D, would be considerably more complicated.

ANNEX 2: INTERNATIONAL SUMMARY OF EXPENDITURE-BASED TAX INCENTIVES

TABLE A2-1 SUMMARY OF EXPENDITURE-BASED TAX INCENTIVES

Corporate income tax		Payroll/Social security withholdings	
Tax Credits		Super Deductions	Tax Credits
Level	Incremental/Hybrid		
Taxable: Australia, Canada, United Kingdom Non-Taxable: Austria, Belgium (M&E only), Chile, France, Ireland, Korea, Norway	Taxable: United States Non-Taxable: Japan, Korea, Mexico, Portugal, Spain	Belgium (M&E), Brazil, China, Czech Republic, Greece, Hungary, India, Netherlands, Poland, Russian Federation, Turkey, United Kingdom	Taxable: Belgium, Hungary, Netherlands, Turkey
Refundability			
Australia (small), Austria, Belgium (M&E after 5 years), Canada (small), Denmark (tax loss on R&D), France (small), Italy (offset withholding and VA taxes), Norway, United Kingdom	Hungary	United Kingdom	Belgium, Hungary, Netherlands, Sweden, Turkey
Preferential tax-incentive rates for small companies or young firms			
Australia, Canada, Norway	Japan, Korea, Portugal (startups)	Poland, the United Kingdom	Belgium (young innovative firms) France (young innovative firms) Netherlands (small firms and startups), Spain (Innovative SMEs)
Two-level incentive rates			
France			Netherlands, Russian Federation
Caps on benefits			
Australia (small), Canada (small), Chile, Hungary, Japan, Norway	Italy, Japan, Korea, Portugal, Spain, United States	United Kingdom	Belgium, Hungary, Netherlands, Russian Federation, Spain, Sweden, Turkey

ANNEX 3: DETAILS OF EXPENDITURE-BASED TAX INCENTIVES

TABLE A3-1 R&D TAX INCENTIVES FOR LARGE FIRMS 2017¹

Country	Statutory Corporate Income Tax Rate (%)	Investment Tax Credit (%)			Tax Allowances		Cap ³
		Statutory Rate		Taxable ² / Refundable	Super Deduction (Statutory Rate)	Baseline Rates (Current / Equipment / Buildings)	
		Volume	Incremental				
Group of Seven							
Canada	26.8	19.4		YES / YES (some provinces)		100 / 55 DB / 10 DB	
Federal only	15	15		YES / NO			
France	34.4	30/5 ⁴		NO / YES ⁵		100 / 40 DB / 5 SL	
Germany	30.2					100 / 12.5 SL / 3 SL	
Italy	27.9		50	NO / YES		100 / 10 SL / 3 SL	20 million euros
Japan	30.0	8-10	5-30	NO / NO		100 / 50 DB / 2 SL	10% of corporate income tax
United Kingdom	19.0	11		YES / YES		100 / 100 / 100	
United States ⁶	38.9			YES / NO			
Federal Only	32.9		20/14	YES / NO		100 / 20 SL / 2.56 SL	Base for incremental credit <50% of current year R&D
Smaller Developed Economies							
Australia ⁷	30	38.5/0		YES / NO		100 / 20 SL / 2.5 SL	Credit is zero on spending over AUD 100 m.
Austria	25	12		NO / YES		100 / 20 SL / 4 SL	
Belgium	33.99	4.6/80 ⁸		NO / YES ⁹		100/ 33.3 SL / 5 SL	
Denmark	22	-				100 / 100 / 4 SL	
Finland	20	-				100 / 25 DB / 20 DB	
Greece	29	-			30	100 / 33 SL / 8 SL	
Ireland	12.5	25		NO / YES		100 / 100 / 100	
Israel	25					100 / 33 SL / 20 DB	
Netherlands	25	32/16 ¹⁰		NO / YES ⁹		100 / 20 SL / 4 SL	Refunds cannot exceed PWT liabilities
New Zealand	28	-				100 / 22 DB / 4 DB	
Norway	25	18		NO / YES		100 / 20 DB / 4 DB	25 million Kroner of intramural spending
Spain ¹¹	25	25/8	42	NO / YES partial		100 / 100 / 3 SL	25-50% of corporate income tax
Sweden	22	10 (on R&D wages)				100 / 30 DB / 4 SL	
Switzerland	21.1	-				100 / 40 DB / 4 SL	
Emerging Economies							
Brazil	34	-			60	100 / 10 SL / 10 SL	
Chile	24	35				100 / 100 / 20 SL	US\$ 1.0 million

	Statutory Corporate Income Tax Rate (%)	Investment Tax Credit (%)			Tax Allowances		Cap ³
		Statutory Rate		Taxable ² / Refundable	Super Deduction (Statutory Rate)	Baseline Rates (Current / Equipment / Buildings)	
		Volume	Incremental				
China	25	-			50	100 / 100 / 20 SL	
Czech Rep.	19	-			100	100 / 20 SL / 3.33 SL	
Hungary	9	28.5 ¹²		NO / YES ⁹	100	100 / 33 SL / 2 SL	
India	34.6	-			100	100 / 100 / 10 DB	
South Korea ¹³	24.2	3	40	NO / NO		100 / 20 SL / 20 SL	
Mexico	30	-	30	NO/YES		100 / 89 / 74	Budget limit of 1,500 million pesos ¹⁴
Poland	19	-			30	100 / 100 / 100	
Portugal	22.5	32.5	50	NO / NO		100 / 25 SL / 5 SL	1.5 million euros ¹⁵
Russian Federation ¹⁶	20				50	100 / 50 SL / 10 SL	
Turkey	20	85 ¹⁷		NO / YES ⁹	100	100 / 40 DB / 4 SL	

- 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 A3-2.
- An ITC is described as taxable if firms are required to reduce the base for tax deductions by the amount of the credit received.
- The cap is on eligible spending unless otherwise noted.
- Firms are eligible for the 30-per-cent ITC on the first 100 million euros of eligible expenditures and five per cent on the expenditures exceeding that amount.
- Credits not utilized after three years are refundable.
- At the federal level, 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. At the state level, formulas for research tax credit vary depending on the state, with most conforming to federal rules. The combined federal-state marginal effective tax credit rate calculated for this study is 8.7 per cent, whereas federal-only rate is 5.8 per cent.
- Expenses for which a credit has been received cannot be deducted from taxable income. This treatment reduces the effective tax credit by about 22 percentage points
- Two credits are applicable: (1) a credit of 4.6 per cent for capital expenditures and (2) a credit of 80 per cent for income taxes withheld on salaries paid to researchers with advanced degrees. Belgian government sources suggest the wage tax credit reduces salary costs by 16-21 per cent.
- Payroll-withholding tax (PWT) incentive is credited against personal income or payroll tax withholdings or social security contributions, making it effectively refundable.
- WBSO payroll tax credit is 32 per cent for eligible R&D costs (labour and other current expenses) up to a threshold of EUR 350,000 and 16 per cent above EUR 350,000.
- 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.
- 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.)
- For regular companies, current R&D spending is eligible for a volume credit capped at 3 per cent (or a 40 per cent incremental), while equipment is eligible for a 1 per cent volume credit. High Potential and Growth Enterprises may receive preferential tax credit treatment.
- The limit is so small that the incentive has not been modelled: the maximum amount of R&D tax credit that can be applied by the taxpayer in a given fiscal year is MXN 50 million. That finances 30 potential beneficiaries which are selected by the Inter-agency Committee.
- The cap applies to the incremental credit.
- 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.
- There is an 85 per cent exemption of income tax withholdings on wages. The tax rate on wages at 167 per cent of the average wage is multiplied by 85 per cent yielding a wage credit of 13.2 per cent.

Note: SL - straight-line depreciation method, DB - declining-balance depreciation method, PWT - payroll-based withholding taxes

Sources: OECD R&D tax incentive compendium - (new 2016 edition) and OECD review of national R&D tax incentives and estimates of R&D tax subsidy rates - (new 2016 edition), Annex 6, in particular, located at <http://oe.cd/rdtax>;

Deloitte, 2017 Survey of Global Investment and Innovation Incentives (2017), <https://www2.deloitte.com/us/en/pages/tax/articles/global-survey-of-investment-and-innovation-incentives.html>; and calculations by the authors.

TABLE A3-2 R&D TAX INCENTIVES FOR SMALL FIRMS¹

Statutory Corporate Income Tax Rate (%)	Investment Tax Credit (%)			Tax Allowances		Cap ³
	Statutory Rate		Taxable ² / Refundable	Super-Deduction (Statutory Rate)	Baseline Depreciation Rates (Current / Equipment / Buildings)	
	Volume	Incremental				
Group of Seven						
Canada	14.7	42.2		YES / YES		100 / 55 DB / 10 DB
Federal only	11	35		YES / YES		C\$3 million ⁴
Japan	21.4	12		NO / NO		100 / 50 DB / 2 SL
United Kingdom	19				130	100 / 100 / 100
Smaller Developed Economies						
Australia ⁶	28.5	43.5		YES / YES		100 / 20 SL / 2.5 SL
Norway	25	20		NO / YES		100 / 20 DB / 4 DB
Emerging Economies						
Poland	15				50	100 / 100 / 100
South Korea ⁷	11	25	50	NO / NO		100 / 20 SL / 20 SL

1. Generally defined as firms with fewer than 50 employees; exceptions comprise Canada, South Korea and the U.K.. Special incentives for large firms are shown in Table A3-1.
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. This is a maximum cap. The cap falls as taxable income and assets rise.
5. Cap is on the value of the tax deduction.
6. Expenses for which a credit has been received cannot be deducted from taxable income. This treatment reduces the effective credit rate by about 23 percentage points.
7. 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: SL - straight-line depreciation method, DB - declining-balance depreciation method

Sources: OECD R&D tax incentive compendium - (new 2016 edition) and OECD review of national R&D tax incentives and estimates of R&D tax subsidy rates - (new 2016 edition), Annex 6 in particular, located at <http://oe.cd/rdtax>; Deloitte, 2017 Survey of Global Investment and Innovation Incentives (2017), <https://www2.deloitte.com/us/en/pages/tax/articles/global-survey-of-investment-and-innovation-incentives.html>; and calculations by the authors.

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John Lester is a former federal government economist who writes on public policy issues. Mr. Lester's last public service assignment was as Director of Research for the Expert Panel Review of Federal Support to Research and Development. Prior to that, he managed the Tax Evaluations and Research Group at Finance Canada. Since leaving the public service, Mr. Lester has published papers with The School of Public Policy, the *Canadian Tax Journal*, *Canadian Public Policy* and the C.D. Howe Institute. His research and current interests include federal government's expenditure management system (including evaluation policy), cost-benefit analysis of government programs, particularly those related to R&D and innovation, as well as market failures in the financing of innovative projects and entrepreneurship policy.

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Philip Bazel, Jack Mintz and Austin Thompson | February 2018

RECENT CHANGES TO PROVINCIAL GOVERNMENT BUDGET REPORTING IN ALBERTA

<https://www.policyschool.ca/wp-content/uploads/2018/02/AB-Budget-Reporting-Kneebone-Wilkins.pdf>
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