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Giving with One Hand, Taking Away with the Other:

Canada's Tax System and Research and Development

Kenneth J. McKenzie

In this issue...

Canada's generous subsidies for R&D, combined with relatively high taxes on the fruits of innovative activity, might not be serving the country well. If the goal is to generate more R&D activity and the innovative investment that surrounds it, an improved tax environment for business investment, rather than larger R&D subsidies, would be the correct policy prescription.

The Study in Brief

Recent research suggests that Canada's tax system acts as a drag on innovative activity. This study argues that the federal and provincial governments' preoccupation with tax credits targeted at research and development, and relative inattention to the competitiveness of the overall tax regime, is misguided. In effect, the Canadian approach has been to give with one hand, by providing generous tax credits targeted at R&D, and to take with the other, by imposing high taxes on the fruits of innovative activity and entrepreneurship.

Canada's tax treatment of business spending on R&D does appear to be internationally competitive. The cornerstone is a 20 percent federal tax credit — for small businesses it is 35 percent — which most provinces top up with a further R&D credit of 10 or 15 percent.

The result is "one of the most generous scientific research and experimental development tax incentive regimes in the world," according to the federal Department of Finance. And among industrialized countries, in terms of direct tax subsidies per dollar US$1 of R&D expenditures, Canada is indeed near the top.

Despite this support, Canada ranks low in aggregate R&D intensity — that is, R&D as a percentage of gross domestic product. On this measure, business R&D in Canada in 2004 was 1.07 percent — below the average of 1.53 percent for OECD member countries and well below that of the other Group of Seven major industrialized economies except Italy. Canada also compares poorly with Sweden, for example, which provides few direct subsidies for R&D (but has a very competitive production tax regime): business R&D as a percentage of GDP in Sweden is about double that in Canada.

What to do? Federal and provincial governments should work toward increasing the competitiveness of Canada's overall production tax regime. Such a policy could involve reductions in statutory tax rates and structural changes in the tax system. One possibility would be to move toward a business value tax at the provincial level, perhaps coupled with the introduction of tax prepaid savings plans for individuals.

Other changes would be to reconfigure the tax depreciation system to make it more in line with economic depreciation; introducing last-in, first-out inventory accounting for tax purposes would also reduce effective tax rates on investment. Taken together, these initiatives would lower the tax rate on production and free up domestic savings for investment in innovative activities, spurring investment, innovation, and entrepreneurship.

The Author of This Issue

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The competitiveness of Canada's tax regime has been the topic of some scrutiny of late, though perhaps not as much as it should be. The C.D. Howe Institute has played a leading role in this discussion, in particular through its Tax Competitiveness Program.

The inaugural *Tax Competitiveness Report* (Mintz et al. 2005) argued that there is scope for considerable improvement in Canada's tax competitiveness position, particularly with respect to the tax burden imposed on capital. Taking into account corporate income taxes and other capital-related taxes, Canada had the second-highest effective tax rate on capital among 36 industrial and leading developing countries in 2005. The report concluded that governments in Canada (both federal and provincial) "should develop multi-year tax plans to address the many existing problems in the tax system to achieve better economic growth and a higher standard of living for Canadians" (ibid., ii).

One area of tax policy where Canada already appears to be internationally competitive, however, is in the treatment of expenditures related to research and development (R&D). The cornerstone of the system is a 20 percent federal tax credit for R&D (for small businesses, the credit is 35 percent). Most provinces top this up with a further credit of 10 or 15 percent. As a result, the federal Department of Finance boasts that "Canada offers one of the most generous scientific research and experimental development tax incentive regimes in the world."[1] Despite this support, however, Canada ranks relatively low in terms of aggregate R&D intensity — that is, R&D as a percentage of gross domestic product (GDP). On this measure, business R&D in Canada in 2004 was 1.07 percent — below the average of 1.53 percent for member countries of the Organisation for Economic Cooperation and Development (OECD) and well below that of all other Group of Seven major industrialized economies except Italy (OECD 2006).

In a recent C.D. Howe Institute *Commentary*, Rick Harris of Simon Fraser University analyzed Canada's disappointing performance in R&D and suggested several policy responses (Harris 2005). In terms of tax policy, Harris argued that existing federal and provincial resources aimed at supporting business R&D need to be more focused than those provided by the existing R&D tax credit system, and that improving Canada's environment for innovation will require stronger incentives for business investment.

This *Commentary* picks up where Harris leaves off by examining in more detail the role of tax policy in promoting R&D and, indeed, economic activity in general. Recent empirical research supports the view that Canada's tax system, as it applies to the production of goods and services, not just to R&D, acts as a drag on innovative activity and entrepreneurial initiative in this country. I argue that the preoccupation of both the federal and provincial levels of government with tax credits targeted at R&D (and other activities), to the detriment of the competitiveness of the overall tax regime, may be misguided. In effect, the

1 See the department's web site: http://www.fin.gc.ca/toce/2002/cantaxadv_e.html. The reference here is to tax subsidies, although there are several other ways to subsidize R&D, most notably by way of grants. It is also often argued that, in the United States, government-financed expenditures on defence provide an implicit subsidy to R&D, although Mintz (2001) shows that, when direct and indirect grants are taken into account, the difference between Canadian and US subsidies to R&D is quite small.

Canadian approach has been to give with one hand, by providing generous tax credits targeted at R&D, and to take with the other, by imposing high taxes on the fruits of innovative activity and entrepreneurship.

The Tax Treatment of R&D in Canada

At the federal level, R&D tax incentives are offered under the Scientific Research and Experimental Development (SR&ED) program, whereby all eligible current expenditures on R&D are immediately expensed for tax purposes. These include wages and salaries for workers engaged in R&D, as well as expenditures on materials and supplies. Immediate expensing is also extended to expenditures on eligible equipment used in R&D, which would ordinarily be depreciated over time as a part of the capital cost allowance system. Expenditures on buildings and other structures used in the process of conducting R&D do not receive special treatment, but are depreciated under the usual capital cost allowance system.

The most important aspect of the SR&ED program is the tax credit for eligible R&D expenditures, worth $1.7 billion in 2003 (Canada 2004). For small Canadian-controlled private corporations, the credit rate is 35 percent and is refundable; for other businesses, the rate is 20 percent and is non-refundable. Unlike in some other countries, the credit is non-incremental — that is, there is no minimum amount of R&D spending at which the credit kicks in — and it applies to a broad range of eligible R&D expenditures, including all current expenses as well as those on equipment (but not buildings).

In the United States, by way of contrast, the federal tax credit for R&D is much less generous and applies to a narrower range of expenditures than in Canada. The US credit rate is 20 percent of a corporation's qualified R&D expenditures in the current year, and is incremental in the sense that it applies only to R&D above a base amount.[2] The definition of the base amount has varied over time (see Watson 1994; Griffith and Klemm 2001); currently, it is defined for a given year as a "fixed-base" percentage of the average sales over the preceding four years. Qualified expenditures consist of the salaries and wages, intermediate materials expenses, and the rental costs of certain property and equipment incurred in performing research. The incremental design of the US credit is meant to encourage firms to perform additional R&D beyond what they otherwise would be expected to perform, while limiting the cost to government. In practice, however, the credit's incremental nature substantially lowers its benefit: the amount that a firm invests in R&D in one year lowers the amount of R&D that is eligible for the credit in future years, therefore reducing the current value of the tax credit.

A number of provinces offer R&D tax incentives that piggyback on the federal government's SR&ED program: British Columbia offers a tax credit of 10 percent, while Saskatchewan, Manitoba, New Brunswick, Nova Scotia, and Newfoundland and Labrador offer 15 percent. These provincial credits are granted on the same

2 Twenty-eight US states also offer R&D tax credits. They tend to be modeled on the federal credit, and range in value from 2.5 percent to 20 percent (see Wilson 2006).

expenditures as the federal credit under the SR&ED program, increasing the combined credit rate to 35 percent (or 30 percent in the case of businesses in British Columbia).[3] Quebec offers a 20 percent tax credit, but only to the wages and salaries of R&D workers, not to other current expenditures or capital. Quebec also offers a 40 percent tax credit for research contracted out to certified institutions, such as universities and other postsecondary institutions. Ontario provides a 10 percent tax credit to small and medium-sized businesses and a 20 percent tax credit for contract research with eligible research institutions. Two provinces, Alberta and Prince Edward Island, offer no tax incentives for R&D on top of the federal incentives.

Of course, both the federal government and the provinces impose other taxes that affect R&D. Of particular importance are the various taxes levied on labour — including payroll, personal income, and sales taxes — some fraction of which are borne by businesses through higher wage payments. R&D is labour intensive, and R&D workers tend to be skilled and therefore quite mobile, which suggests that businesses bear a higher share of taxes on R&D labour than is the case for other, less mobile types of labour. Moreover, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia all impose special capital taxes on physical capital, as well as property taxes, which also apply to physical capital employed in R&D.

Why Does Canada Do So Little R&D?

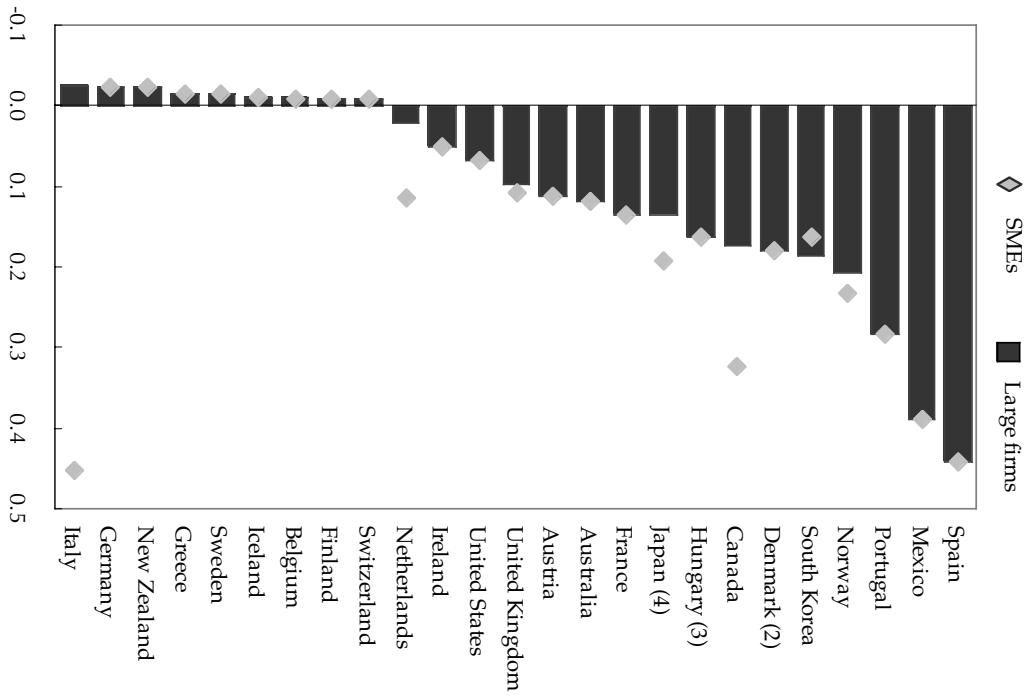
Canada's treatment of R&D is among the most generous in the world, as indicated by Figure 1, which shows OECD calculations of direct tax subsidies offered per US$1 of R&D expenditures for selected countries. Here, a positive number indicates that the tax system lowers the cost of conducting R&D, while a negative number indicates that the tax system increases the cost of undertaking R&D. On this basis, Canada is one of the top R&D subsidizers, while Sweden is near the bottom. Yet, as Figure 2 shows, compared with other industrialized countries, Canada fares poorly in the amount of R&D that is conducted as a percentage of GDP, while Sweden is at the top.

Casual inspection of these two figures forces an obvious question: if Canada offers such generous direct tax subsidies for R&D and Sweden offers so few, why is R&D intensity so much higher in Sweden than in Canada? There are several possible answers.

One possibility is that tax subsidies might not be effective in generating R&D activity because R&D is not sensitive to these subsidies. An extensive empirical literature has examined the impact of tax subsidies on R&D activity, particularly as it relates to the after-tax user cost of R&D expenditures. Studies seem to suggest that a 10 percent decline in after-tax user costs of R&D generates an increase in R&D expenditures of about 1 percent in the short run and 10 percent in the long run. In other words, direct tax subsidies that lower the user costs of R&D are quite

3 The value of these tax credits is lowered, however, by the clawback of credits between levels of government. Some governments, particularly Ottawa, view R&D tax incentives as government assistance and include such credits in taxable income.

Figure 1: *Rate of Tax Subsidy per US$1 of R&D to Small and Medium Enterprises (SMEs) and Large Firms, Selected OECD Countries, 2005*



Source: OECD 2005.

Note: The rate of subsidy is calculated as 1 minus the B-index, where the B-index is the after-tax cost of US$1 of R&D.

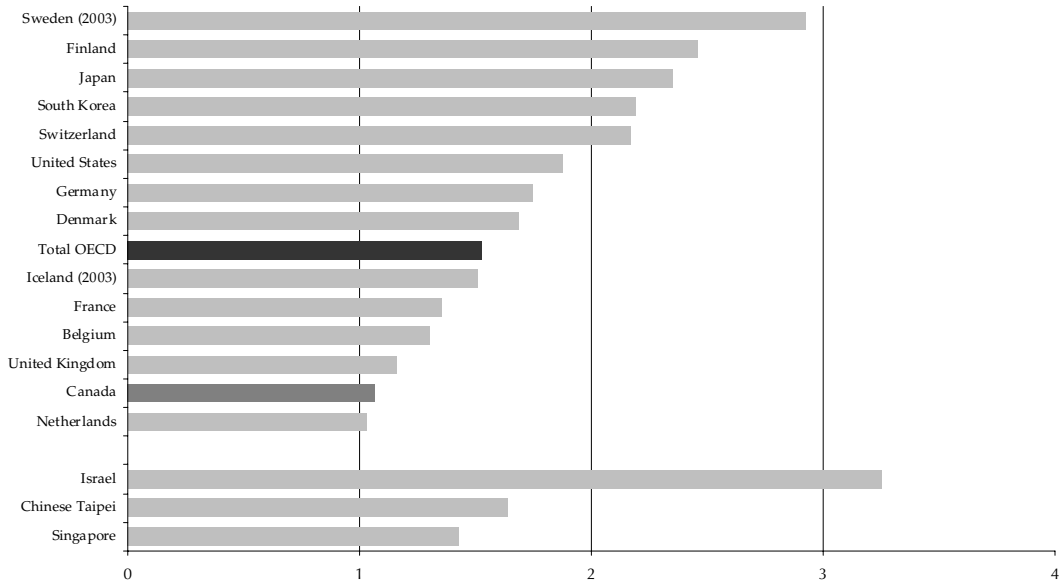
effective in promoting R&D activity, particularly in the long run.[4] For example, in their survey of the literature, Hall and van Reenen (1999) find that the elasticity of R&D with respect to after-tax user costs averages about -0.1 in the short run and -1.0 in the long run. In another study, Bloom, Griffith, and van Reenen (2002), looking at aggregate data from a subset of OECD countries, estimate elasticities of -0.12 in the short run and -0.86 in the long run.

Of course, other explanations are possible that have nothing to do with the tax system. If, for example, foreign-owned firms tend to undertake less R&D than domestic firms, then the large number of foreign (primarily US) firms in Canada could account for this country's low level of R&D. Baldwin and Hanel (2000) show, however, that foreign-owned firms are, in fact, more active in R&D than Canadian-owned firms.

Perhaps the reason for Canada's relatively low level of R&D is that its industrial structure is not conducive to R&D. In testimony before a parliamentary committee in 2001, Statistics Canada's John Baldwin put it this way:

4 This evidence has, however, been criticized on several grounds. One is that R&D tax subsidies may simply inflate the wages of scientists and researchers without increasing the amount of "real" R&D that is undertaken, particularly in the short run, when the supply of innovative personnel is inelastic (see Goolsbee 1998 and Griffith 2000). Another is that public subsidies to R&D may crowd out private spending. As Wallsten (2000) points out, most empirical studies of the effectiveness of R&D tax credits are not able to determine whether the credits stimulate more research or whether firms that do research are just better able to take advantage of subsidies.

Figure 2: *Business Experimental Research and Development Expenditures as Percentage of GDP, Selected OECD and Other Countries, 2004*



Source: OECD 2006.

> [C]omparison of simple R&D to GDP ratios across countries is also misleading if corrections are not made for the different industrial structures of countries. Innovation regimes differ across industries. Studies have shown that there are some industries, like electronic industries and machinery, that are at the core of the innovation system. They do a large amount of R&D and they produce more innovations....Others, such as food products use new materials and machinery from the core sector and tend to expend money not on R&D, but technological and engineering, and production systems. The two sectors work together in a symbiotic relationship….Some countries have more of the former, other countries have more of the latter, and those countries such as Canada that concentrate more on the latter will simply have low R&D ratios because of that, even if they have a highly innovative industrial sector.[5]

Indeed, in a paper for the federal Department of Finance, ab Iorwerth (2005) shows that, although Canada's low level of aggregate R&D intensity hides the quite high level of such activity in some sectors, these sectors are quite small relative to the rest of the economy. Moreover, the auto industry, one of Canada's most important manufacturing sectors, does little R&D. Combined, these facts go a long way toward explaining Canada's low aggregate R&D intensity.

So, research seems to suggest that tax subsidies are quite effective in generating R&D activity and that foreign firms in Canada actually do more R&D

5 See www.parl.gc.ca/infocomdoc/37/1/INST/ studies/reports/indu04/13-ch2-e.htm.

than domestic firms. Canada's industrial structure might provide part of the explanation for its poor overall R&D performance, but the country's low level of R&D remains something of a paradox.

In some recent research, University of Calgary graduate student Nathalia Sershun and I (McKenzie and Sershun 2005) think we have uncovered another part of the explanation: Canada's overall level of taxation on production. Consider Table 1, which shows marginal effective tax rates on production capital in several OECD countries. Here, we see that Canada imposes a very high effective tax rate on production capital, almost three times higher than Sweden. Could this be a factor in explaining Canada's low level of R&D spending relative to Sweden? We think so.

The basic idea is simple. Direct tax subsidies that lower the cost of R&D, as measured by its after-tax user costs, reward effort and exhibit a "push" effect on R&D. High taxes on production — on the "fruits" of R&D (new products and processes) — punish success. Conversely, low taxes on production reward success (or punish it less) and exhibit a "pull" effect on R&D. Both "push" and "pull" effects need to be taken into account when evaluating the overall impact of the tax system on R&D.

Of course, it is possible for R&D to be undertaken in a jurisdiction with a favourable R&D tax regime, while production takes place in a jurisdiction with a favourable production tax regime. If this is the case, then the "pull" effect of a favourable production tax regime on R&D might not be important. Yet, this issue can be addressed on two fronts. First, at the end of the day, the data will tell us the relative importance of the two effects. If the "pull" effect of the production tax regime is an empirically insignificant determinant of R&D, then one possible explanation is the de-linking of production from R&D.

Second, there is reason to expect that there are, in fact, limits to the extent to which production can be jurisdictionally isolated from R&D. It is generally well recognized that, for successful innovating firms, R&D, product development, and production are integrated. That is to say, a good deal of R&D takes place, if not literally "on the factory floor," then at least in close consultation with production engineers and personnel. Gordon (2000), for example, describes Toyota's philosophy of kaizan, which involves continual, incremental product and production improvements that emanate from the plant floor. Similarly, Hildebrand (1995) refers to successful R&D departments that "[beat] the clock through internal integration with line business units." Thus, the need to integrate production units with R&D departments suggests a complementarity that, at least to some extent, precludes the jurisdictional de-linking of production and R&D activities.

To investigate the relative importance of the "push" and "pull" effects of the tax system on R&D, Sershun and I use a panel data set consisting of aggregate R&D as a percentage of output in the manufacturing sectors of Australia, Canada, France, Germany, Italy, Japan, Spain, the United States, and the United Kingdom over the 1979-97 period. We measure the "push" effect of direct R&D tax subsidies by the after-tax user costs of R&D capital. We measure the "pull" effect of the production tax regime using the concept of the effective tax rate on marginal production costs (ETRMC) developed by McKenzie, Mintz, and Scharf (1997). The ETRMC takes into account taxes levied on both labour and capital employed in

Table 1: *Marginal Effective Tax Rates on Production Capital, 2005 (percentages)*

		Effective Tax Rate		
	Corporate Income Tax rate	Manufacturing	Services	Average
China	24.0	45.5	46.5	45.8
Canada	34.3	35.5	41.3	39.0
Brazil	34.0	40.1	37.2	38.5
US	39.2	34.6	40.0	37.7
Germany	38.4	37.7	36.3	36.9
Italy	39.4	33.3	38.1	36.2
Russia	22.0	35.0	34.1	34.5
Japan	41.9	34.4	33.1	33.6
France	35.4	33.3	33.4	33.3
Korea	27.5	31.9	29.6	30.8
New Zealand	33.0	30.1	28.8	29.3
Greece	32.0	33.0	27.8	29.3
Spain	35.0	29.9	25.8	27.3
Norway	28.0	26.1	24.7	25.1
Netherlands	31.5	25.3	24.9	25.0
India	33.0	23.2	24.9	24.3
Australia	30.0	29.4	22.1	24.1
Finland	26.0	23.5	22.4	22.9
Luxembourg	30.4	21.4	22.1	21.9
U.K.	30.0	22.7	21.2	21.7
Belgium	34.0	21.4	21.3	21.4
Poland	19.0	20.6	20.0	20.2
Denmark	30.0	20.6	19.4	19.8
Austria	25.0	20.3	18.8	19.4
Hungary	16.0	18.8	17.7	18.2
Czech Republic	26.0	21.3	14.0	17.7
Switzerland	22.0	16.9	17.1	17.0
Mexico	30.0	17.2	16.4	16.7
Ireland	12.5	14.1	13.2	13.7
Portugal	27.5	11.7	14.6	13.5
Sweden	28.0	12.8	11.6	12.1
Iceland	18.0	13.1	11.6	12.1
Slovak Republic	19.0	9.6	8.7	9.1
Hong Kong S.A.R.	17.5	6.1	8.3	8.1
Turkey	30.0	7.3	5.7	6.4
Singapore	20.0	5.8	6.6	6.2

Source: Mintz et al. 2005, 6.

the production process. It can be thought of as an effective excise tax rate on costs, as it measures the percentage increase in production costs due to the taxes levied on firms' inputs.

After controlling for country- and time-specific factors, our empirical results show that both the "push" and "pull" effects of tax policy are important determinants of aggregate R&D intensity across countries. For the "push" effect of direct tax subsidies, we estimate that the elasticity of aggregate R&D intensity with respect to after-tax user costs is statistically significant: about -0.20 in the short run and about -0.65 in the long run. Thus, a 10 percent reduction in the user costs of R&D due to the imposition of a tax credit is associated with an increase in R&D intensity of about 2.0 percent in the short run and 6.5 percent in the long run. This is in general accordance with previous studies that suggest that direct tax subsidies are indeed quite effective at generating more R&D activity.

Importantly, we find that the "pull" effect of the overall tax system, as measured by the ETRMC on production, is of a similar magnitude: we estimate a statistically significant elasticity of R&D intensity with respect to the ETRMC of about -0.30 in the short run and about -0.90 in the long run. In other words, a 10.0 percent decrease in the ETRMC on production costs is associated with an increase in R&D intensity of about 3.0 percent in the short run and 9.0 percent in the long run.

It is important to emphasize that these effects control for country and year fixed effects. Thus, independently of country-specific characteristics such as industrial make-up and the importance of foreign firms, as well as of effects such as technological change, which influence all the study countries over time, the overall tax regime as it applies to production exerts an important and independent impact on the incentive to undertake R&D.

The obvious implication of this result is that, when considering tax policy in the context of R&D, Canadian governments need to consider the effect not only of direct tax subsidies on R&D but also of the overall production tax regime. More precisely, failing to take account of both effects might result in governments' giving with one hand and taking away with the other: encouraging R&D by offering direct tax subsidies, which lower the cost of undertaking research, but discouraging R&D by imposing high production taxes on the new products and processes that are the fruits of R&D.

As noted earlier, Canada and Sweden provide a study in contrasts in this regard. Canada offers generous direct tax subsidies for R&D but imposes relatively high taxes on production. Sweden, on the other hand, provides few direct subsidies for R&D but has a very competitive production tax regime. Business R&D as a percentage of GDP in Sweden is about double that in Canada. Although much of this difference is no doubt due to the unique structural characteristics of the two countries, our results suggest that some of the difference in R&D intensity is due to differences in their production tax environments. Overall, these results argue in favour of a balanced approach when developing an innovation-friendly tax system. Direct tax subsidies for R&D are indeed effective in encouraging R&D activity, but just as important is the competitiveness of the overall production tax regime.

Table 2: *Marginal Effective Tax Rates (METRs) on R&D, by Province, 2004*

METR on:	Alta	B.C.	Sask	Man.	Ont.	Que.	NB	NS	P.E.I.	Nfld.
						(percent)				
R&D labour	-13.0	-22.5	-28.0	-27.0	-18.8	-30.4	-27.8	-27.5	-10.7	-25.8
R&D materials	-19.2	-29.3	-34.3	-34.3	-26.7	-19.2	-34.3	-34.3	-19.2	-34.3
Contract R&D	-13.0	-22.5	-28.0	-27.0	-41.2	-53.6	-27.8	-27.5	-10.7	-25.8
R&D equipment	-23.7	-33.2	-36.6	-36.6	-29.9	-22.4	-37.3	-37.4	-23.7	-38.0
R&D buildings	37.6	41.0	39.0	48.0	40.4	37.3	42.1	47.3	31.2	27.6
R&D costs	-13.2	-22.5	-27.8	-26.9	-24.3	-30.7	-27.6	-27.2	-11.9	-26.7
Intangible R&D capital	-40.3	-96.6	-153.5	-142.0	-112.7	-202.0	-151.0	-146.2	-35.0	-139.5

Note: The weights on the R&D inputs used to calculate the METR on R&D costs are: labour 45%, contract R&D 20%, materials 25%, equipment 5%, and buildings 5%.

Sources: Canada 1998; McKenzie 2005.

The Role of the Provinces

As noted above, most of Canada's provinces also offer tax subsidies for R&D that are similar to those offered under the federal SR&ED program.

In a recent paper (McKenzie 2005), I present calculations of marginal effective tax rates (METRs) on R&D capital for all 10 provinces. The methodology I use to calculate these effective tax rates is based on the idea that intangible capital such as R&D is produced in-house, not purchased on the market as is tangible, physical capital. Firms use various inputs — labour (scientists), materials (test tubes), equipment (microscopes), and structures (laboratories) — to produce intangible R&D capital (knowledge), which then enters the production or product development process. Table 2 shows the results of several types of METR calculations:

- the METR for each intermediate input used to produce intangible R&D capital in-house (labour, materials, contract R&D, equipment, and buildings);
- the METR on R&D costs, which aggregates the effective tax rates on the intermediate inputs to measure the percentage increase (or decrease, in the case of a subsidy) in the marginal cost of producing intangible R&D in-house; and
- the overall METR on investments in intangible R&D capital.

Note, first, that the effective tax rates on the various intermediate inputs into R&D are, for the most part, negative. This reflects the fact that Canada's tax system subsidizes the purchase of most inputs used in the production of R&D. Particularly important are the negative effective tax rates on R&D labour and contract R&D, which account for about 65 percent of R&D costs.

The second thing to note is that, although the cost of producing R&D is subsidized in all provinces, as indicated by the negative marginal effective tax rates on R&D costs, the size of the subsidy varies substantially across the provinces. In Alberta, for example, the tax system lowers the marginal cost of producing a unit of intangible R&D capital by 13.2 percent, while in Quebec the R&D cost subsidy is more than twice as high, at 30.7 percent.

Finally, in the last row of the table, the calculations of the overall METR on investments in intangible R&D capital are analogous and comparable to the effective tax rate figures for tangible capital reported in Table 1. As would be expected, given the generous tax treatment of expenditures on R&D inputs, all these effective tax rates are negative, indicating the presence of a significant tax subsidy for investment in R&D capital in Canada. This is consistent with the view that Canada's tax system, as it relates to R&D, is, as the Department of Finance claims, "one of the most generous…in the world."

The calculations also indicate, however, a substantial degree of variation in the effective tax/subsidy rates for R&D across the provinces. Despite the fact that neither Alberta nor P.E.I. offers specific incentives over and above those from the federal government, the METR on R&D capital in these two provinces is -40.3 percent and -35.0 percent, respectively, indicating that the federal tax subsidy is nonetheless significant. In the case of Alberta, for example, this means that 40 percent of the required before-tax rate of return on a marginal investment in R&D is accounted for by the tax subsidy. In those provinces that top up the federal system with their own incentives, effective subsidy rates can be described as "substantial," to say the least: with METRs of -202.0 percent in Quebec, -151.0 percent in New Brunswick, and -112.7 percent in Ontario.

To put these figures in context, suppose that, after the payment of corporate taxes, investors require a rate of return of at least 10 percent in order to justify undertaking a new R&D project. In Quebec, the effective subsidy rate of just over 200 percent means that an incremental R&D project could earn a before-tax rate of return as low as 3.3 percent and still earn an after-tax rate of return of 10 percent. In the absence of tax incentives, such an investment would clearly never take place. This is, needless to say, a substantial subsidy for investment in R&D. In Alberta, an incremental R&D project could earn a before-tax rate of return as low as 7.1 percent and still be economical from the firm's point of view.

Of course, subsidies for R&D may well be justified on economic grounds. The positive spillovers that are thought to emanate from R&D suggest that the social rate of return to investing in R&D is greater than the private rate of return to private companies.[6] In investigations of the spillovers from R&D in a Canadian context, Bernstein (1988, 1989, 1996) shows that they are both positive and significant, and that the social rate of return exceeds the private rate of return by a factor of two or more in many cases.

The presence of positive and potentially substantial spillovers means that, if left to its own devices, the private sector would tend to underinvest in R&D. One way for governments to address such underinvestment is through the provision of

6 The social rate of return reflects both the private rate of return to the firm that is conducting the R&D and the benefits to other firms due to spillovers that emanate from the R&D.

tax subsidies. The key question then becomes one of how large such subsidies should be, which is difficult to answer as several factors potentially are in play.

Dahlby (2005) addresses some of these factors by looking at the case for additional provincial tax subsidies for R&D over and above the federal subsidy. His focus is on Alberta, which, as noted, offers no additional tax subsidies, but his analysis can be easily extended to other provinces. He points to three key parameters that are relevant to an assessment of this issue:

- the size of the spillovers that emanate from R&D — the larger the spillovers, the larger the subsidy should be;
- the sensitivity of R&D to tax subsidies — the more sensitive R&D is to tax subsidies, the stronger is the case for those subsidies; and
- the opportunity cost of the funds used to finance R&D tax subsidies — the higher that cost, the weaker is the case for subsidies.

This last point is important. Tax subsidies for R&D must be financed by imposing higher taxes on other activities, such as production. Those higher taxes come at a cost, as measured by the marginal cost of public funds, which incorporates both the revenue cost and the incremental efficiency cost imposed on the economy due to higher taxes. Estimates of the marginal cost of public funds vary widely and depend on the tax under consideration; however, most estimates are in excess of 1.4, so that raising one more dollar in tax revenue to finance a subsidy of $1 for R&D costs the private sector $1.40, consisting of the $1 in tax revenue raised plus $0.40 in incremental efficiency costs.

Dahlby considers the existing range of estimates for these parameters and concludes that, for a broad range of "reasonable" values, the case for an additional provincial tax subsidy for R&D in Alberta is weak. Recalling that Alberta currently offers no additional incentives and has the lowest R&D subsidy in the country, this suggests that subsidy rates in the other provinces are excessive. Although the positive spillovers emanating from R&D might justify some sort of subsidy, effective subsidy rates of the magnitude documented in Table 2 do not appear to be justified on the basis of a spillover argument alone.

There are, of course, several other sources of market failure that Dahlby does not incorporate into his analysis, some of which reinforce the argument against additional while others work in favour of it.[7] The difficulty lies in quantifying these other factors. Given the current state of our knowledge, "first do no harm" might be a dictum worth remembering.

This then raises the question: why has Alberta resisted the temptation to provide additional subsidies for R&D while the other provinces (except P.E.I.) have not? It is not for lack of lobbying. A common refrain from Alberta's high-technology sector is that the oil industry siphons funds away from other sectors. This "Dutch disease" argument — where jurisdictions with generous endowments of natural resources may suffer problems in other sectors through exchange-rate effects, input-cost effects or, as in this case, problems with raising local venture capital — seems to be gaining currency in the province. For example, a recent

7 See Boadway and Tremblay (2005) for a general, non-technical discussion of the various market inefficiencies associated with R&D.

Calgary Herald article (Gignac 2006) claims that more than half of Alberta's high-tech companies are considering leaving the province because of difficulties in raising venture capital. These firms lament the challenge of raising capital in a hot resource economy and, not surprisingly, have called for an R&D tax credit and the introduction of labour market venture capital funds in the province.

This may or may not be a valid argument — Dahlby does not incorporate these considerations into his analysis because they are so difficult to quantify. But perhaps the reason Alberta has refused so far to implement tax credits or other targeted policy initiatives along these lines lies in the nature of the "subsidy competition" for R&D that might be taking place among the provinces, a possibility linked to the idea of the "business-stealing effect" of R&D.

As mentioned above, the presence of spillovers suggests that firms might underinvest in R&D because they do not take account of the spillover benefits of their expenditures. This is the argument typically used to justify government subsidies for R&D that, in principle, can internalize these spillovers. Other factors, however, work in the opposite direction. One such factor is the business-stealing effect, which occurs when the new product or process that emerges when a firm engages in R&D destroys, or at least reduces, the value of existing firms. If the innovating firm does not take account of this business-stealing effect, it might overinvest in R&D.

To offset the business-stealing effect at the local level, it might actually be preferable for a local government to tax R&D or to subsidize it less than a pure spillover argument would suggest. Somewhat ironically, however, the effect might, in fact, encourage governments to steal business from other jurisdictions and to engage in subsidy competition in an attempt to realize two potentially beneficial effects from increased R&D in their jurisdiction. The first benefit is the higher income that local firms might realize by expanding their markets through product innovations or cost reductions due to process innovations. The second benefit is the new entrants from within the jurisdiction and, importantly, from other jurisdictions that might be attracted by the subsidies that are offered.

The extent of this sort of subsidy competition depends on several factors. One is the mobility of R&D resources across jurisdictions — the more mobile, or sensitive, these resources are to subsidies the more intense is the competition. Another factor is the extent to which firms located in different jurisdictions actually compete with each other, which, in turn, affects the degree to which governments of those jurisdictions compete with each other. If the industrial structure of the provinces is such that the products they primarily produce are relatively close substitutes for each other, one might expect the business-stealing effect to be quite high for both firms and governments. If, on the other hand, the industrial structure is such that firms operate in very different markets, the degree of competition — at both the business and policy levels — would be lower.

It is interesting to note, however, that Alberta's industrial structure differs greatly from that of the other provinces due to its heavy and unique reliance on the oil and gas sector. As a result, Alberta has been able to stay out of the R&D "subsidy race," not because of superior policy on the part of the provincial government, but because the province's unique industrial structure means that it has less incentive to engage in subsidy competition with the other provinces.

Pending more evidence on these incentives and effects, how should policymakers react to calls for more (or less) fiscal support for R&D? The high tax subsidies for R&D in most Canadian provinces seem to be due, in part, to subsidy competition among them, and it is possible that this competition has led to high subsidy rates but with little impact on aggregate R&D intensity. Some support for this view comes from a recent study of R&D tax subsidies in US states (Wilson 2006), which finds that, although in-state R&D is indeed very sensitive to tax subsidies, the bulk of this additional R&D is actually "stolen" from other states, with little net increase in aggregate national R&D. In the Canadian context, the concern is that subsidy competition among the provinces is leading to the shift of R&D from one province to another with no significant increase in R&D at the national level. What, then, should policymakers do about it?

One obvious policy response would be for the provinces to engage in a coordinated reduction in R&D subsidies. Though possible and perhaps desirable, such a response is easier said than done. The key word here is "coordinated." Some provinces, however, might find it more rational — because of their industrial structure relative to that of other provinces — to engage in business stealing. Thus, a province that adopted a policy of not actively competing for R&D might, depending on its industrial structure, be worse off if such a policy eroded its competitive position. Accordingly, the difficulty of undertaking a coordinated, cooperative reduction in R&D subsidies at the provincial level represents the essence of the "market failure" associated with the business-stealing effect, at the level of both the firm and government.

A decidedly second-best approach might be for the federal government to take advantage of its position as a policy leader and attempt to undo some of the detrimental aspects of business-stealing incentives by lowering its own subsidies on R&D. In this way, the overall effective subsidy rate on R&D would decline, and the resulting tax savings could be used to lower taxes on production.

Conclusion

Public policies on research and development are thought to be important, particularly in the "new economy," where innovation plays a leading role in economic growth. Boskin and Lau (1994), for example, estimate that R&D accounted for about 10 percent of Canada's economic growth between 1964 and 1990. One key way in which governments can provide incentives for private sector R&D is through the provision of tax incentives.

In this *Commentary*, I have summarized some recent research on the impact of taxes on R&D activity. Although this research confirms earlier suggestions that targeted R&D incentives — the "push" effect of direct tax subsidies — can be quite effective at promoting R&D activity, it also emphasizes the importance of the overall production tax regime — the "pull" effect of the production tax system. In particular, high effective tax rates on capital and labour inputs used in the production of goods and services act as a drag on innovative activity by lowering the rewards to R&D.

The federal government and most provinces offer significant direct tax incentives for R&D; indeed, the federal Department of Finance itself describes

them as "the most generous in the world," with effective subsidy rates as high as 200 percent in some provinces. Despite such incentives, however, Canada's aggregate R&D performance does not compare well with that of other industrialized countries. One explanation for this poor performance might be Canada's uncompetitive production tax regime, particularly as it relates to investment in physical capital.

Moreover, the preoccupation of provincial governments with the provision of targeted incentives for R&D, to the detriment of the overall production tax regime, could be due, in part, to "subsidy competition" for competing R&D resources and markets. Once one takes into account the costs associated with tax subsidies for R&D — in particular, higher taxes on production — it is not clear that Canada's high subsidy rates are justified. Further, provincial policies might simply be shifting R&D from one province to another without generating much aggregate increase in R&D intensity.

Thus, Canada's approach to targeting tax subsidies toward R&D on the one hand, while imposing relatively high taxes on production inputs on the other, might not be serving the country well in terms of either its overall economic competitiveness or its innovative activity and entrepreneurship.

This analysis suggests several policy directions. First, it might be worthwhile to scale back direct tax subsidies for R&D. Although a coordinated reduction of R&D subsidies among the provinces would be desirable, it might be difficult to implement. Accordingly, a second-best approach could entail a reduction in the federal tax subsidy. One possible approach would be to move toward an incremental R&D tax credit, applied only to incremental R&D in excess of some designated moving average, which would reduce the effective subsidy rate. Incremental credits, however, are not without problems. In particular, depending on how they are structured — for example, as a percentage of sales — they might actually discourage production by taxing output (see Watson 1994). Moreover, incremental credits give rise to administrative complexities.

A second policy option would be for the federal and provincial governments to work toward increasing the competitiveness of Canada's overall production tax regime. Such a policy might involve reductions in statutory tax rates — particularly on mobile resources such as capital and skilled labour — but it might also involve some structural changes in the tax system. One possibility would be to move toward a business value tax at the provincial level (see Bird and McKenzie 2004), perhaps coupled with the introduction of tax prepaid savings plans (TPSPs) for individuals (as suggested by Kesselman and Poschmann 2001). A business value tax would lower the tax on capital and shift some of the burden onto labour, while TPSPs would move Canada closer to a consumption tax. Taken together, these initiatives would lower the effective tax rate on production capital and free up domestic savings for investment in innovative activities.

A less radical approach, one that could be taken within the context of the existing system, would be to reconfigure the tax depreciation system and to change the way inventory accounting is undertaken for tax purposes. As suggested in the C.D. Howe Institute's *Tax Competitiveness Report* (Mintz et al. 2005), one reason for Canada's high effective tax rates on production capital is the low tax-writeoff rates that are applied to some types of capital, particularly

investments in new machinery and equipment. Another reason is the requirement that companies use first-in, first-out inventory accounting for tax purposes. Yet, even at relatively low inflation rates, such an accounting method imposes a significant inflation tax on inventory capital, which forms an important part of the capital structure in many sectors. Reconfiguring the tax depreciation system to make it more in line with economic depreciation and introducing last-in, first-out inventory accounting for tax purposes would reduce effective tax rates on production capital and spur investment, innovation, and entrepreneurship in Canada.

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