

Assessing the Effectiveness of Federal R&D Programs Supporting Business Innovation

This discussion paper was written by the Secretariat to the Review of Federal Support to Research and Development Expert Panel as an input to the Panel's deliberations.

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Introduction

Summary

The Review of Federal Support to Research and Development Expert Panel was asked to assess the relative effectiveness of federal research and development (R&D) programs in increasing business R&D and facilitating commercially oriented R&D partnerships. This paper examines the challenge of assessing the relative effectiveness of R&D support programs from three perspectives, and closes with an approach for consideration.

- First, the paper reviews current federal practices for assessing program effectiveness, including the role of the Auditor General of Canada and the role of performance evaluation in the Expenditure Management System. Because programs tend not to collect performance information on an ongoing basis, program evaluations are the primary source of available performance information. However, there are limitations to their current usefulness for assessing the relative effectiveness of programs due to lack of results comparability, low coverage, and issues of reliability related to attribution, timing and evaluation methodologies.
- Second, in an effort to explore the possibility of developing a single measure of program effectiveness, the Panel's secretariat applied a benefit-cost approach —initially developed by the Department of Finance (Parsons and Phillips 2007) to estimate the impact of the Scientific Research and Experimental Development Tax Incentive program and informed by work published on the assessment of provincial tax subsidies (Dhalby 2005) — to select programs in the Panel's mandate. The experience with benefit-cost analysis and its potential application more broadly is described in some detail in this paper.
- Lastly, instead of seeking to achieve a single, universal measurement methodology like the benefit-cost approach or, in the alternate, accepting that each program can be evaluated only on its own individual terms, the third section of this paper explores the possibility of grouping similar programs and evaluating them using sets of intermediate outcomes that can be reasonably applied as performance measures for the programs in that grouping. The section concludes with a summary table (Table 2) setting out a classification typology for different forms of support, common intermediate outcomes that could be expected from all programs falling into each of the support categories, and common performance indicators that could be required for all programs within each category.

Continuum of Program Assessment Methodologies

Underpinning the discussion in this paper is the notion of a continuum of approaches for assessing the effectiveness of programs, as depicted in Table 1 below. The first type in the continuum is the “specific” approach, relying on assessments tailored to particular programs, including analysis of program-specific performance indicators. Program evaluations, which were

considered as part of program case studies for the Panel, include program-specific analyses such as surveys of recipients, case studies of funded projects, bibliometric and technometric analyses, and project data collection against performance indicators. Such analyses provide useful information about a program’s evolution over time, but have only limited ability to compare impacts relative to other programs. It should be noted that some evaluations also include international benchmarking, and many include benefit-cost analyses (discussed below), which are further toward the “High comparability” end of the spectrum in Table 1. The latter are not always consistently applied, and limit the usefulness of results for comparison. As is discussed in the Benefit-Cost Approach section of this paper, existing program evaluations were consulted as some of the best available information on program effectiveness, but their usefulness was limited by several issues, including low comparability.

Table 1 Continuum of Approaches to Assessing the Effectiveness of R&D Programs

<i>Low comparability</i>		<i>High comparability</i>	
<i>“Specific”</i>	<i>“Segmented”</i>	<i>“Proxy”</i>	<i>“Net Economic Benefit”</i>
Unique indicator(s) for each program	Unique indicator(s) applied to bundles of like programs	Common indicator(s) applied to all programs	Quantification of net economic benefit
Strengths: performance metrics highly tailored to program objectives	Strengths: common indicators for multiple programs with similar objectives, permitting comparisons of performance between similar programs	Strengths: allows comparison among all programs	Strengths: comparison of all programs according to final economic outcome
Weaknesses: limited comparability across programs; assessment not directly related to final outcomes	Weaknesses: limited comparability across full portfolio of programs; assessment not directly related to final outcomes	Weaknesses: challenge to select only a few meaningful metrics; risk of applying metrics unsuitable to particular programs; assessment not directly related to final outcomes	Weaknesses: relies on extensive assumptions about relationships between inputs and outputs/outcomes; requires extensive data; may underemphasize qualitative aspects of some programs

A second approach is to apply a small number of common performance measures to programs’ performance. This approach might be called the “Proxy” method, since these metrics stand as shorthand for a broader definition of performance. This approach was embedded within the Panel’s mandate, with two performance metrics highlighted: (i) increases in business R&D and (ii) the rate of facilitating commercially relevant R&D partnerships.¹ Such an approach has the merits of simplicity and comparability, but is not necessarily sufficient to capture the diversity of programs being assessed.

¹ The Panel’s terms of reference identified three questions to address through the Review, the first being: “What federal initiatives are most effective in increasing business R&D and facilitating commercially relevant R&D partnerships?”

At the far right side of the continuum is the “Net Economic Benefit” approach. This performance assessment methodology seeks to relate inputs to final outcomes and identifies the relative public benefit of each program. The approach loses some of the nuanced detail on individual programs, and relies on assumptions about how inputs translate into intermediate outputs and then ultimate outcomes. Such an approach is common in the empirical economic literature and has been applied in previous Government of Canada studies. In studies of selected programs undertaken by the secretariat, the methodology yielded interesting results, but proved impractical to apply to the full suite of programs under review. Data availability on program delivery costs was a significant constraint, and the underpinning assumptions about the relationship between inputs and beneficial outcomes were general (derived from empirical literature) rather than program specific. The methodology and insights related to benefit-cost work undertaken by the secretariat are summarized in the Performance Framework section of this paper.

Given the limitations with the first three evaluation approaches, the last section of this paper sets out an additional approach that segments forms of support for business innovation into categories of similar initiatives and then applies common performance metrics to all forms of support within each category. The categories of support are organized into an outcomes map or logic model. The hope is that these categories and their performance indicators could become a subject for further discussion within the federal program evaluation community.²

Current Practices for Assessing Direct Program Expenditures

A starting point for determining the effectiveness of federal R&D programs was to draw on the findings of existing assessment work on direct program expenditures. There are various mechanisms in place for assessing direct federal expenditures, including audits by the Auditor General, strategic reviews and ongoing program evaluations. These mechanisms fit within a framework of accountability to Parliament and supply the government with information to manage expenditures against its priorities and fiscal realities. Each was considered as a potential source of information for the Review of Federal Support to R&D, but further study was undertaken. In brief, existing sources of assessment were either not comparable across the envelope, did not measure all programs within the scope of the Review or tracked indicators disconnected from the impact of federal support to business or commercially oriented R&D.

Reports of the Auditor General of Canada

The role of the Auditor General is to provide an independent and reliable source of fact-based information to support Parliament in holding the federal government accountable for its stewardship of public funds. The Office of the Auditor General (OAG) may comment on policy implementation in an audit, but does not comment on the merits of the policy itself. The OAG does not undertake evaluations of the effectiveness of federal programs, but does comment on the quality of systems in place for measuring effectiveness.

² The secretariat is indebted to the *ad hoc* interdepartmental Federal Evaluators Working Group for their advice and guidance in this regard.

As such, findings from published reports by the Auditor General were not of use for comparing programs or program types. However, past reports provided an important context, which suggested limitations of existing performance information for undertaking a comparative exercise of the nature of the Review of Federal Support to R&D:

- The *2009 Fall Report of the Auditor General of Canada* noted that over the past 40 years, the federal government has made efforts to embed the management practice of evaluating program effectiveness into program evaluations. The Auditor General examined how the evaluation units in six department and agencies identify and respond to the various needs for effectiveness evaluations.³ The report concluded that evaluation coverage is limited and that departments often do not gather the performance information needed to evaluate whether programs are effective.
- The *2005 November Report of the Auditor General of Canada* examined federal policies, government-wide guidance, and the role of central agencies in creating, coordinating and overseeing initiatives that involved a number of organizations.⁴ The report concluded that: (i) much of the federal government's approach to horizontal initiatives is still on a case-by-case basis, (ii) central agencies have not determined the kinds of circumstances requiring a horizontal initiative and the kind of governance needed and (iii) central agencies have not developed enough specialized tools for the governance, accountability and coordination of efforts in such initiatives. In the initiatives examined, the report concluded that there was little planning for measuring and reporting, that most reporting was focussed on individual federal programs and that, as a result, Parliament does not have an overall picture of what the initiatives are achieving. The government response noted that improvements are being made, but cautioned that ministerial accountabilities need to be respected.

As is discussed further in the next subsection, evaluation coverage among initiatives covered in the Review was not extensive, nor was there in place horizontal performance metrics to support the comparison of program effectiveness.

Strategic Reviews

Today, performance assessment has a well-defined role within the government's expenditure management system (EMS), the government's framework for decision making on spending. The EMS encompasses an integrated range of activities, processes and standards that include setting high-level spending priorities in the federal Budget, guidelines and requirements for Cabinet submissions, the approval of funds through Parliamentary supply bills, and the review of government expenditures.

³ The departments and agencies in question are Canadian Heritage, Fisheries and Oceans Canada, Environment Canada, Citizenship and Immigration Canada, Agriculture and Agri-Food Canada, and Human Resources and Skills Development Canada.

⁴ The Canadian biotechnology Strategy, the National Homelessness Initiative, and the Vancouver Agreement (an urban development initiative).

The EMS was introduced in the 1990s to control spending and address the Budget deficit. It included a strong review and challenge function for new funding proposals that looked for reallocations of funding, where possible. In recent years, the EMS has evolved to put greater focus on results. The 2006 *Federal Accountability Act* introduced the requirement for departments and agencies to review the relevance and effectiveness of their grants and contributions every five years. Federal Budget 2007 announced a new EMS that includes a requirement for new spending proposals to clearly define expected results, and a requirement for departments to manage against these results and formally evaluate program performance. The Budget also introduced strategic reviews.

The strategic review process requires organizations to review their direct program spending every four years to assess how and whether programs are aligned with government priorities and core federal roles, whether they provide value for money, whether they are still relevant in meeting the needs of Canadians, and whether they are achieving intended results. Organizations are required to report against each of these areas, based on evidence including evaluations, audits, special studies, organizational assessments, Management Accountability Framework Assessments (see Box 1), Auditor General Reports and follow-ups, and benchmarks based on performance in other jurisdictions or in the private sector. Based on their ratings of programs, organizations recommend reductions for programs not meeting these criteria and propose reallocations of funds toward their most successful and strategically relevant programs.

Strategic reviews were, however, not available for the Review of Federal Support to R&D, because these documents are considered Cabinet confidences. Even had these documents been available, they would likely not have provided sufficient detail to facilitate comparison of programs along the parameters considered in the Review. However, program evaluations, which form part of the evidence base for the assessment of program performance in strategic reviews, were consulted.

Box 1: Management Accountability Framework

The Management Accountability Framework (MAF) sets out the Treasury Board's expectations of senior public service managers for good public service management. The MAF is structured around 10 key elements that collectively define "management" and establish the expectations for good management of a department or agency, including expectations for "results and performance." The MAF is a process that assesses certain aspects of the expenditure management system. As part of its annual assessment of departments and agencies, the Treasury Board of Canada Secretariat rates the quality and use of the departmental evaluation function, based on a review of evaluation reports (e.g., methodology, analysis of limitations, use of performance information) and their use (e.g., in Cabinet submissions and strategic reviews). Due to the general nature of the MAF assessment process, it does not provide information at a program level.

Program Evaluation

In 2009, the Treasury Board of Canada Secretariat updated its evaluation policy with the 2009 *Policy on Evaluation*. The updated policy requires that evaluations cover all direct program spending over a five-year cycle — a requirement that will come into effect for large departments and agencies on April 1, 2013.

Program effectiveness is one of the areas on which departments and agencies are required to report as part of program evaluation, along with other performance requirements (demonstration of efficiency and economy) and an assessment of program relevance (continued need, alignment with government priorities, and alignment with federal roles and responsibilities). In the *Policy on Evaluation*, “effectiveness” is defined by the Treasury Board of Canada Secretariat (2009) as “the extent to which a program is achieving expected outcomes.”

Program evaluations use a variety of methods, including surveys (of recipients, delivery agents, impact communities and oversight agents), case studies, bibliometric and technometric analyses, project data collection against performance indicators and international benchmarking, peer review, and econometric analysis to assess continued relevance and performance against program objectives.

Although the role of performance measurement is well established within the expenditure management system, there are limitations on the use of performance information for comparative assessment of the effectiveness of R&D programs. Under the *Policy on Evaluation*, deputy heads are responsible for ensuring compliance with the policy within their organizations. There is a lack of comparative performance information across the suite of programs and different indicators, and evaluation methodologies are used to reflect program objectives. In practice, each program is evaluated against indicators tailored to approved objectives. As such, there are a great variety of metrics and indicators. In the Review’s envelope, there were no indicators or metrics common to all programs, making relative evaluation difficult. In addition, generally consistent with the November 2005 report of the Auditor General of Canada, there is at present no horizontal performance measurement framework for R&D initiatives supporting business innovation that cuts across departments and agencies.

The availability of performance information for individual programs is also limited, which posed a second challenge for the Review. Consistent with the Fall 2009 report of the Auditor General of Canada, programs infrequently collect performance information required for evaluation purposes as part of ongoing program operations — they tend to do this at the back end as part of program evaluation. Furthermore, evaluation coverage is limited to less than one third of the programs in the scope of the Review of Federal Support to R&D. There are several reasons for low evaluation coverage for the programs being considered here by the Panel. First, as noted above, the Treasury Board *Policy on Evaluation*, which requires that departments and agencies evaluate all direct spending including grant and contribution spending every five years, does not come into

effect until 2013. Second, the policy does not require evaluation of NRC institutes⁵ (which represent 17 of 60 “programs” selected for Review of Federal Support to R&D by the Panel). Third, the policy does not require performance-based evaluations of the Scientific Research and Experimental Development (SR&ED) tax incentive program. Fourth, many programs in the review are too new to have been evaluated.

There are also limitations regarding the reliability of performance information for exercises such as the Review of Federal Support to R&D. Evaluation methodologies rely heavily on surveys of recipients, which can bias findings related to the incrementality of program impacts. In addition, attribution of results to a particular program is a challenge, particularly concerning long-term impacts of importance to the Review (net economic benefit, increased productivity and economic growth). Finally, there is limited follow-up in the timeframe that R&D has an impact on innovation (less than five years), mainly as a result of limited budgets for this type of monitoring.

Notwithstanding these limitations, program evaluations were consulted extensively for case studies undertaken for the Panel as one of the best available sources of information on program effectiveness. This included a review of evaluation findings on program impacts on incremental R&D expenditures and commercially relevant R&D partnerships, where available. Although studies of incremental impacts have been undertaken for selected programs, they were not systematically available across the portfolio.

Conclusion

The Panel is the first body to consider the set of 60 programs selected, which are delivered across 17 departments and agencies as a portfolio. From the foregoing discussion, the well-established methodologies used in government to review individual programs do not, in relation to the mandate of the Panel, provide:

- a useful definition of “effectiveness” for business R&D programs
- an extant body of information the Panel could use for its work
- an analytical framework to compare programs, or even categories of programs, for their relative effectiveness.

The absence of this definition, information and comparative framework motivated the Panel’s examination of alternative approaches to evaluation (in the next section) and extensions on the current evaluation framework (in the final “Performance Framework” section).

⁵ It should be noted that, as part of the NRC’s performance management, the agency has undertaken a number of evaluations extending beyond the scope of the requirements of the Treasury Board *Policy on Evaluation*.

Benefit-Cost Approach to Measuring Program Effectiveness

This section reviews the extent to which it is possible to compare the effectiveness of programs based on their net public benefit by measuring the benefit of each program against its costs, providing a single, cross-cutting effectiveness measure for use across the portfolio of federal R&D programs.

Benefit-Cost Approach to Program Assessment

A benefit-cost approach to program assessment conceptually holds the potential to overcome the challenge of evaluating effectiveness across programs by providing a measure that can, in principle, apply to all programs — the net economic benefit to society. The benefit-cost approach provides a framework for examining the contribution of R&D support programs to their final outcome — improved economic performance leading to a higher standard of living for Canadians. Relative program effectiveness therefore becomes the extent to which the net economic benefit per dollar of program expenditure is higher or lower than that for other programs.

The benefit-cost approach takes into account both the benefits of the additional R&D induced by a program as well as the costs of delivering the assistance. The key benefit of government supporting R&D arises from “spillovers” — despite their best efforts and the use of legal protection, firms cannot prevent the knowledge gained through their R&D from leaking out to other firms. These spillovers result in lower costs or higher productivity for other firms, leading to an improvement in overall economic performance.

The costs of programs include the cost of subsidy, program delivery costs, the cost to recipients of applying for and complying with the program, and the reduction in economic efficiency caused by using taxes to change the market allocation of resources. The largest cost from providing assistance to firms undertaking R&D arises from the need to raise taxes to finance the assistance provided to firms. Higher taxes reduce economic efficiency through adverse effects on incentives to work, save and invest. When expressed per dollar of program funding, this cost is roughly constant for all programs, so it has no impact on the relative effectiveness of programs. Administering and applying for the subsidies absorb resources that could be used elsewhere, which adds to the cost of providing the assistance. Finally, government support for a specific activity reduces economic efficiency by shifting labour and capital from their best uses or, more intuitively, government assistance allows R&D projects to go ahead that have below-market rates of return, which represents a loss in efficiency and economic output.

In the context of the Review, this approach to assessing program effectiveness extended a benefit-cost assessment of the SR&ED program previously undertaken by the Department of Finance (Parsons and Phillips 2007). A modified version of the Finance Canada framework was applied to a range of programs within the scope of the Review of Federal Support to R&D.

Discussion

While the benefit-cost approach provides a sound conceptual framework for evaluating individual programs and comparing their relative effectiveness, there are substantial practical limitations to applying it. Not all of the economic benefits and costs can be easily quantified and, for those that can be, the estimates are not always as precise as would be desirable. For programs with multiple functions, it is difficult to isolate component costs and benefits. Second, the methodology relies on significant assumptions in calculation: given that data are not available on the actual spillovers for individual programs, estimates from the empirical literature have to be used. Finally, it is challenging to apply the framework to the full range of government support including internships, the provision of advice, repayable contributions, risk capital and procurement programs.

Conclusion

The benefit-cost approach to assessing programs in theory offers the possibility of comparing the effectiveness of programs in achieving net economic benefits for society. Such an approach could in principle and with further refinement provide evaluations of multiple programs with comparable but stylized results and, in so doing, contribute to a broader relative assessment of impact. As it currently stands, however, the method is difficult to apply due to several factors: (i) inconsistent availability of data, (ii) reliance on general estimates rather than specific observations for key parameters and (iii) the acceptability of applying the method to a range of activities. These limitations suggest further work would be required to advance benefit-cost analysis to a point where it would be useful to the evaluation community for cross-program comparisons of relative effectiveness.

Toward an Outcomes-Based Performance Framework

Rationale

The assessment of groups of similar programs using common intermediate outcomes-based performance indicators has the potential to offer insight into comparative effectiveness of programs supporting business innovation.

The work presented in this section is based on discussions held by an *ad hoc* group of federal evaluators convened by the Panel's secretariat who emphasized the importance of establishing an outcomes-based performance framework to compare the effectiveness of programs, cautioning that the use of proxy metrics across all program would offer limited insight, given the diversity of programs and the variety of their intended outcomes (e.g., programs target business innovation along different timelines) in the portfolio.

This work is also consistent with approaches being developed elsewhere. During the course of its international consultations, the Panel met with public service officials in the United Kingdom, Germany, the United States, Australia, Singapore, Finland and at the Organization for Economic Cooperation and Development (OECD). The Panel heard that, although all jurisdictions recognize

the importance of performance measurement, approaches for systematic assessment of the relative impact of R&D programs are under development or are not undertaken. Similar to the situation in Canada, program assessment tends to be aligned with accountabilities, resulting in evaluations of individual programs, but less systematic assessment of programs with common objectives. Where they are undertaken, horizontal assessments are most commonly at an overall systems level — looking at the broad performance of innovation systems policies and programs. Nonetheless, jurisdictions are developing approaches for comparative assessment of programs. For example, the United Kingdom’s Department of Business, Innovation and Skills regularly reviews its programs using a monitoring survey of program recipients with a consistent set of questions on the impact and outcomes of R&D programs. Questions touch on impacts with regard to new/improved products and processes, performance (e.g., increased sales, reduced costs and improved efficiency) and innovation capacity.

Forms of Federal Support for Business Innovation

To explore the “segmented” approach to assessing the effectiveness of R&D programs, a categorization of the types of federal support programs has been developed below, with associated possible intermediate outcomes. For the sake of discussion, the categorization of programs used to group similar programs starts from four “inputs” to business innovation similar to those set out in the “firm-centric” model of business innovation in the Council of Canadian Academies (CCA 2009) report *Innovation and Business Strategy: Why Canada Falls Short*, and featured in the Panel’s discussion paper — ideas and knowledge; talented, educated and entrepreneurial people; networks, collaboration and linkages; and capital and financing. This model links the environmental factors that motivate a firm to select business innovation as a competitive strategy to the firm’s demand for the four kinds of inputs for their innovation activity, then to the firm’s outputs, which in turn link up to the overall economy (see Figure 1).

Figure 1 Modified Logic Map of the Business Innovation Process



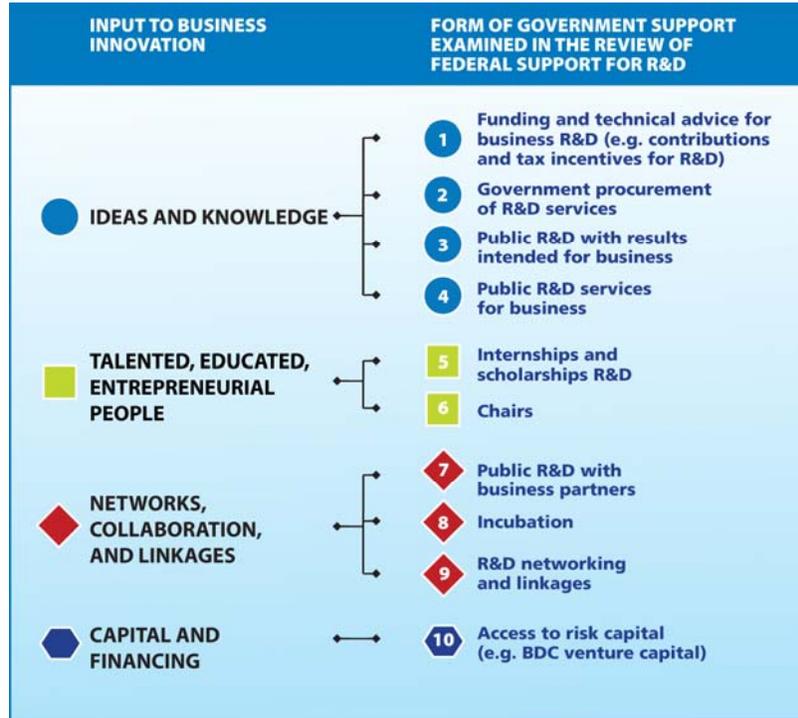
Source: The Panel, modified from the “Logic map of the business innovation process” published by the Council of Canadian Academies (CCA 2009).

As set out below and illustrated in Figure 2, the 60 programs within the Panel’s review can be grouped within these four categories of inputs to innovation activity:

- Federal support for the “Ideas and Knowledge ” input to business innovation:
 1. **Funding and technical advice for business R&D** — consists of government financial or technical advisory support for innovative R&D performed by the recipient firm. The Industrial Research Assistance Program (IRAP) performs both of these functions and, within the portfolio, funding for business R&D is provided through programs including the SR&ED tax incentive program, regional development agency programs such as the Atlantic Innovation Fund, and sector business R&D programs like the Strategic Aerospace and Defence Initiative.

2. **Government procurement of business R&D services** — means that the government pays the private sector to perform R&D in support of departmental objectives, sometimes with the dual purpose of developing private sector capabilities in a sector. Examples include the Canadian Space Agency's (CSA) Space Technology Development Program and Defence Research and Development Canada's (DRDC) Technology Demonstration Program.
 3. **Public R&D with results intended for business** — consists of direct federal support for R&D that is performed in the non-profit, post-secondary and government sectors, is commercially oriented (intended for eventual application in the private sector, for example, through commercialization and licensing), may involve the private sector as a co-funder of the research, and is intended to build Canadian capacity or expertise in a commercially relevant knowledge area. Examples include commercially relevant research performed by the National Research Council (NRC), the portion of proof-of-concept programs such as the Canadian Institutes of Health Research's (CIHR) Proof-of-Principle program, which supports academics in advancing their ideas without the involvement of industrial partners, and the Natural Science and Engineering Research Council's (NSERC) Strategic Project Grants program.
 4. **Public R&D services for business** — means that federal laboratories perform R&D on a fee-for-service basis for the private sector. Many NRC institutes perform this function.
- Federal support associated with the "Talented, Educated, Entrepreneurial People" input to business innovation:
 5. **Internships and scholarships R&D** — involves federal support for R&D internships in business and R&D scholarships that provide student exposure to business, as well as subsidies for undergraduate and post-graduate training in industry to develop highly qualified personnel with an interest in R&D work in the private sector. Programs in the suite performing this function include the NSERC's Industrial Undergraduate Student Research Awards program, the Industrial Postgraduate Scholarships program, the Industrial Research and Development Fellowships program, and the Industrial Research and Development Internships program.
 6. **Chairs** — can be established with federal funding to attract talented researchers who are performing research with a long-term commercial orientation that provides training opportunities for students. There is one program in the portfolio that uses this model, namely NSERC's Industrial Research Chairs program.

Figure 2 Forms of Federal Support for Business Innovation



- Federal support associated with the “Networks, Collaboration and Linkages” input to business innovation:
 7. **Public R&D with business partners** — involves support for R&D performed by non-profit, post-secondary or federal researchers on a project that receives funding from the private sector and whose results are intended for transfer to the private sector partner in the short term. An example is NSERC’s Collaborative Research and Development program.
 8. **Incubation** — denotes collocation and business development services for start-up firms, including access to technology. Several NRC institutes offer incubation services through their Industry Partnership Facilities.
 9. **R&D networking and linkages** — involves support for the development of R&D relationships between the public and private sectors on issues of importance to business. Examples include NSERC’s Interaction Grants, Engage Grants, and Strategic Workshops programs, the Business-Led Networks of Centres of Excellence program, some Centres of Excellence for Commercialization and Research, and some Networks of Centres of Excellence.

- Federal support associated with the “Capital and Financing” input to business innovation:

10. **Access to risk capital** — denotes risk capital support for business or programs that link R&D performers to investors. Examples include the Business Development Bank of Canada’s (BDC) Venture Capital, the Federal Economic Development Agency for Southern Ontario’s Investing in Business Innovation program, and referrals to venture capitalists by IRAP industrial technology advisers and/or NRC Industry Partnership Facility staff. (Note that this program type refers to the “financing” component of “capital and financing” in Figure 1.)

In all typologies, some oversimplification can result. In this case, several programs in the portfolio cut across two or more of the forms of government support outlined above. For example, many NRC institutes perform public R&D with results intended for business (#3 above), R&D services for business (#4) and collaborative R&D with businesses (#5), and provide incubation services (#8) through their Industry Partnership Facilities.

Bundles of Federal Support with Common Intermediate Outcomes

In this subsection, the forms of support detailed above are categorized into bundles of support with common outcomes. Although the forms of support vary within these bundles, their basic purpose is the same. The framework presented in this subsection is based on the discussions of an *ad hoc* working group of federal evaluators (see Box 2), who emphasized that a comparative assessment of programs is best undertaken with consideration of program outcomes, which vary across the portfolio of support.

The resultant “outcomes map” presented in Figure 3 has three key features. First, it preserves the logic of the CCA model presented in Figure 1 above. Support for the activities of various actors at various stages is shown to contribute to firm growth and ultimately aim to increase labour productivity, and lead to an enhanced standard of living and a more innovative economy. Second, it groups forms of support into functional bundles and positions them according to the immediacy of their impact on business innovation. Programs supporting business innovation through transfer of knowledge, technology and talent have a more remote impact on labour productivity. Programs that are closer to market (those that support business R&D and commercialization activities in a more immediate fashion) more directly contribute to economic growth. As a result, programs falling in bundles furthest upstream of business tend to track performance against intermediate outcomes related to the use of business innovation

Box 2 Federal Evaluators Working Group

During the course of the Review, the secretariat to the Panel convened a working group of federal evaluators with expertise in the evaluation of R&D programs to discuss approaches to performance assessment. The group emphasized that a one-size-fits-all approach (e.g., assessment of programs based on impact of business expenditure on R&D) would be impractical, given that programs have different objectives and support business innovation through different means. The group’s discussion resulted in the construction of an outcomes map, which would facilitate comparative evaluation of like programs. During the course of the Review, representative case studies of the various program types were presented to the Panel for consideration.

inputs by business, whereas programs supporting business activities more directly track performance against intermediate outcomes related to program impacts on business. Third, the outcomes map shows that the forms of federal support can be simplified into four bundles with like outcomes. These bundles are described below.

Bundles of Support for Business Innovation

A: Firm R&D and Commercialization

The first bundle consists of those forms of support or program elements that most immediately subsidize business innovation by providing support for R&D and commercialization activities. The bundle includes funding and technical advice for business R&D, government procurement of R&D services, the provision of incubation services (including business development advice), and initiatives providing access to or facilitating access to risk capital financing for R&D and commercialization activities. Examples of programs featuring elements in this bundle include IRAP contributions and advice to firms, the SR&ED tax incentive program, procurement through the CSA's Space Technology Development Program, NRC Industry Partnership facilities, and Business Development Bank of Canada venture capital investments.

As set out in Figure 3, intended outcomes for programs in this bundle include:

- increased business investment in innovation, including R&D, which could be measured by indicators such as increased firm expenditures on R&D and increased firm expenditures on intangibles (e.g., intellectual property)
- increased ability to perform and manage R&D, which could be measured by indicators such as increased number of R&D managers
- improved firm performance, which could be measured by indicators such as increased profits from cost savings from productivity improvements, increased profits from increased sales/revenues from new products and services, or the percentage increase in total revenues resulting from new and/or improved products and services.

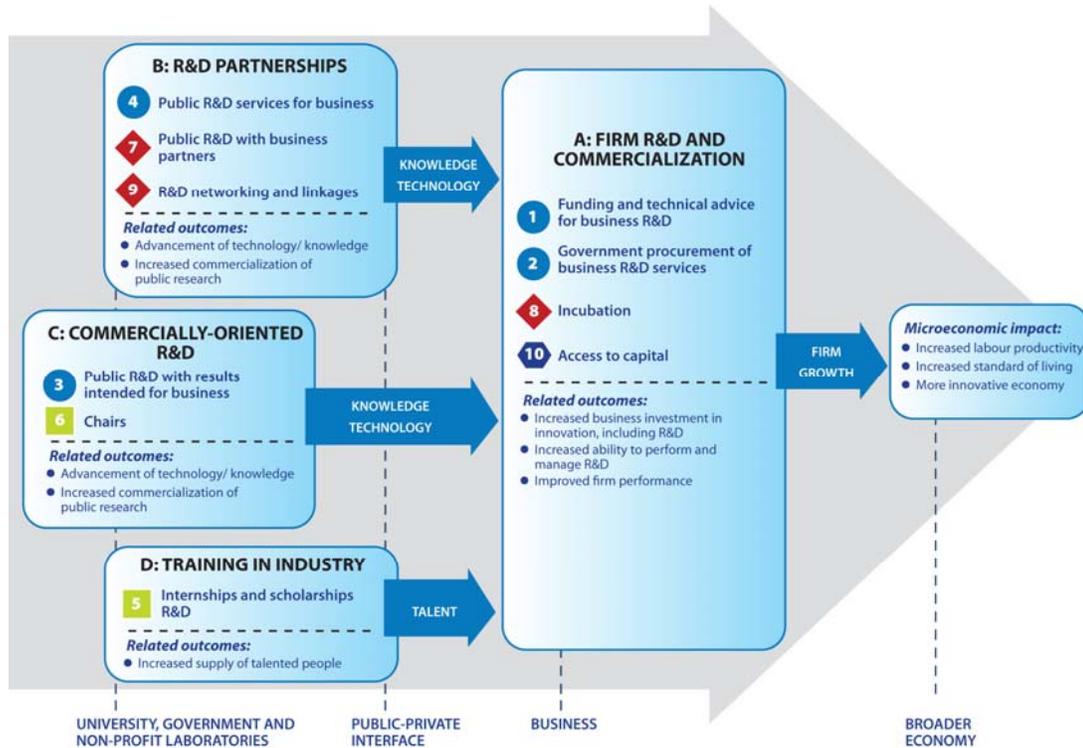
These represent possible criteria for comparative assessment of similar programs that support business R&D.

The majority of the programs in this bundle (and across the portfolio) are “push” oriented in that they fund inputs to business innovation. The “pull” side — programs that pay for the outputs of business R&D activities and so create demand for innovative goods, services and technologies — consists of the federal procurement programs, namely the CSA's Space Technology Development Program and DRDC's Technology Demonstration Program.

The next three bundles of government support consist of other forms of supply-push support that also include R&D and commercialization activities; their use by firms requires transfer of knowledge, technology or personnel across the public–private interface. The impact of these

forms of support on business innovation is therefore less immediate than the forms of support included in the “Firm R&D and Commercialization” bundle.

Figure 3 Outcomes Map by Major Program Bundle, Grouping the Various Forms of Support for Business Innovation Reviewed by the Panel



B: R&D Partnerships

The “R&D Partnerships” bundle groups program elements that offer an extension to private sector innovation capabilities by subsidizing R&D performed for business by federal laboratories, higher education institutions and non-profit organizations on specific R&D projects or business-defined areas of interest. The bundle includes fee-for-service R&D, where business pays in full for R&D services (e.g., NRC institute fee-for-service R&D). It includes collaborative R&D where federal funding and leveraged private sector funding is provided to public R&D performers for R&D related to specific business problems and/or areas of interest (e.g., NSERC’s Collaborative R&D program). It also includes collaborative R&D jointly performed by private and public researchers (e.g., the Business-Led Networks of Centres of Excellence program). Lastly, it includes support for R&D relationship building between private sector and outside researchers (e.g., NSERC’s Interaction Grants program).

The primary aims of support in this bundle are to strengthen the intensity of R&D linkages between the private and public sector researchers, to increase private sector investment in innovation by leveraging the R&D capabilities of non-business R&D performers, and to increase the rate of knowledge and technology transfer from the public sector to the private sector.

Although programs providing support in this bundle can be viewed as subsidizing outsourced firm R&D, their impact on business innovation is somewhat more remote than support for business R&D, given the additional layer of knowledge and technology transfer required for the business partner to benefit from the results of the R&D performed.

As set out in Figure 3, intended outcomes for programs in this bundle include:

- increased adoption of knowledge and technology by firms, which could be measured by indicators such as the percentage of projects resulting in technology transfer and the number of new firms entering R&D activity or number of repeat firms entering R&D activity
- strengthened networks and linkages, which could be measured by indicators such as the increase in small and medium-sized enterprise clients served by post-secondary education service providers, the increase in copublications or the increase in the intensity of collaboration (as measured by the value of private sector R&D expenditures on contracts with the public sector).

These represent possible criteria for comparative assessment of similar programs that support R&D partnerships.

C: Commercially Oriented R&D

The third bundle is federal support for commercially oriented R&D — public R&D of interest to business in the medium to long term that is primarily funded by the federal government and in which the private sector is involved in general direction setting. The primary purpose of programs providing support in this area is to advance knowledge and technology in areas of interest to business for eventual adoption by a variety of business partners. The bundle also includes program elements aiming to achieve the commercialization of university research. Programs providing support in this area tend to have a more remote impact on business innovation than the above two bundles. Key examples include the Strategic Project Grants program, proof-of-concept support programs and NSERC's Industrial Research Chairs program.

As set out in Figure 3, intended outcomes for programs in this bundle include:

- advancement of technology/knowledge, which could be measured by indicators such as increased number of prototypes, increased number of patents, licenses and disclosures, and increased number of publications
- increased commercialization of public research, which could be measured by indicators such as number of spinoff companies, and spinoff company revenues and R&D expenditures.

These represent possible criteria for comparative assessment of similar programs that support commercially oriented R&D.

D: Training in Industry

The last bundle includes program elements that support R&D training opportunities for student and graduate researchers in an industrial setting. Programs providing support in this area subsidize business costs of training highly qualified R&D personnel. Their primary purpose is to increase the supply of talented people for the private sector by stimulating interest in R&D in industry. Programs providing support in this bundle have a long-term impact on business innovation — internships support early-stage integration of researchers in Canadian industry with the intent that they will bring advanced knowledge and expertise to bear on business R&D problems as permanent employees at some stage following the completion of their internships. Examples of programs providing support in this area are NSERC's suite of industrial internships and scholarships programs, and the Industrial Research and Development Internship program.

As set out in Figure 3, intended outcomes for programs in this bundle include:

- increased supply of talented people, which could be measured by indicators such as increase in the number of students/researchers with experience in industry prior to graduation, and retention rates of graduating, highly qualified, highly skilled personnel in Canadian enterprise.

These represent possible criteria for comparative assessment of similar programs that support training in industry.

Summary

Using the outcomes map developed above, a summary of possible performance indicators that could be considered for comparative assessment within each bundle of support for business is summarized in Table 2.

Table 2 Performance Indicators for Comparison of Bundles of Like Forms of R&D Support

Bundle of support	Outcome	Possible indicator(s)
A. Firm R&D and commercialization	Increased business investment in innovation, including R&D	<ul style="list-style-type: none"> • Increased firm expenditures on R&D • Increased firm expenditures on intangibles (e.g., intellectual property)
	Increased ability to perform and manage R&D	<ul style="list-style-type: none"> • Increased number of R&D managers
	Improved firm performance	<ul style="list-style-type: none"> • Increased profits from cost savings resulting from productivity improvements • Increased profits from sales/revenues of new products and services
B. R&D partnerships	Increased adoption of knowledge and technology by firms	<ul style="list-style-type: none"> • Percentage of projects resulting in technology transfer • Number of new firms entering R&D activity/number of repeat firms
	Strengthened networks and linkages	<ul style="list-style-type: none"> • Increase in small and medium-sized enterprise clients served by post-secondary education providers • Increase in copublications • Increase in the intensity of collaboration (value of private sector R&D expenditures on contracts with the public sector)
C. Commercially oriented R&D	Advancement of technology/knowledge	<ul style="list-style-type: none"> • Increased number of prototypes • Increased number of patents, licences and disclosures • Increased number of publications
	Increased commercialization of public research	<ul style="list-style-type: none"> • Number of spinoff companies • Spinoff company revenues and R&D expenditures
D. Training in industry	Increased supply of talented people	<ul style="list-style-type: none"> • Increase in number of students/researchers with industry experience prior to graduation • Increased retention rates of highly qualified and skilled personnel in Canadian enterprise

Discussion

The outcome indicators presented in Table 2 are intended as a starting point for discussing means of assessing the relative impact of programs supporting business innovation. It is worth noting that, as for any logic model, even those forms of support furthest removed from final outcomes seek to achieve these long-term impacts — in this case increased productivity, an improved standard of living and a more innovative economy. For instance, programs in the

“Segmented,” “Proxy” and “Net Economic Benefit” categories mentioned in Table 1 also seek to enhance business performance and, ultimately, increase productivity leading to an improved standard of living and a more innovative economy. However, attributing program activities to these closer-to-market outcomes is difficult, given that such outcomes are necessarily the result of decisions taken by businesses — and the consumers of their products and services — outside the influence of the program.

It is also worth noting that many of the initiatives in the scope of the Review of Federal Support to R&D support activities toward a range of performance objectives. In other words, several of the programs cut across performance bundles. To illustrate with one example, among other activities, NRC institutes support firm R&D and commercialization directly through industrial partnership facilities while performing commercially oriented research that is at the forefront of a commercially relevant domain and subsidizing collaborative R&D. Each of these activities is associated with different outcomes and would require different intermediate outcome indicators to assess.

Conclusion

At the program level, understanding the impact of individual programs on the innovation system as a whole is and will continue to be a challenge. It is hoped that the outcomes map developed will contribute to the discussion of approaches for assessing the relative effectiveness of programs supporting business innovation.

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