

**Innovation Agency Case Study:
Canada's Industrial Research Assistance Program (NRC-IRAP)**

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Overview

Canada's Industrial Research Assistance Program (IRAP) is a longstanding program under the National Research Council; its primary mission is to increase research and development and technology commercialization by Canadian small and medium enterprises (SMEs). Although it has a relatively small number of instruments for intervening in the private sector to improve technological research and development, it has highly effective frontline agents (Industrial Technology Advisors - ITAs) that are able to deploy those instruments quite well. The ITAs discretion allows them to adapt flexibly to changing economic and technological conditions, even if the IRAP more broadly has not been more experimental or evolutionary.

This case study of Canada's IRAP is based on the analytical elements developed in the accompanying methodological document, "Innovation Agencies: The Road Ahead." (Breznitz and Samford 2016). Each of the section is framed around the guiding questions laid out in the Table 1 of that document. The particular variables are indicated with a with number of the guiding question and the numbered indicator as found in Table 1 [#.#].

0. How would one characterize the “national innovation system”? How would one characterize the productive structure of the country?

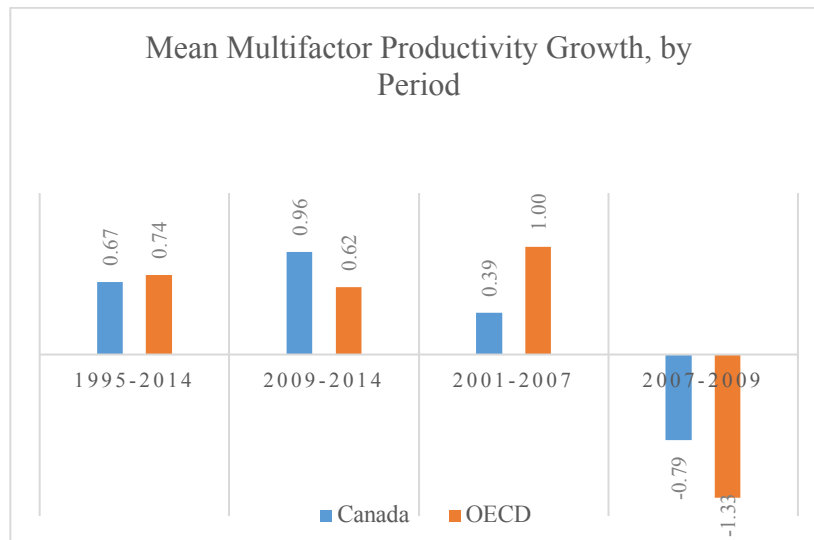
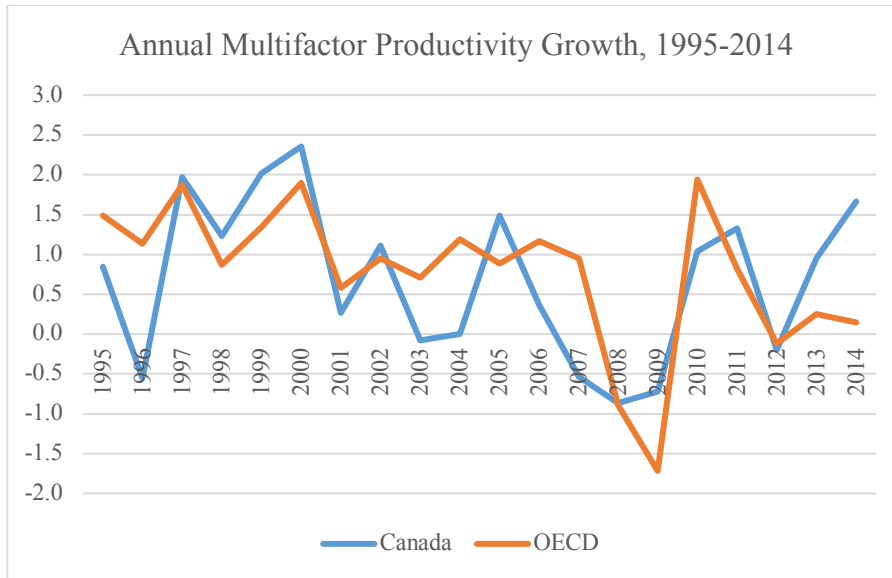
Canada is a wealthy country with a diversified and open economy and strong interests in natural resources and traditional manufacturing as well as a broad variety of services. [0.1a] The economy is dominated by service industries (72 percent of GDP), particularly finance, insurance, real estate, healthcare, and trade. The workforce for this service-based economy is highly trained, with over 50 percent of adults having tertiary (college or university) education, the highest share in the OECD (with a mean of 32 percent). [0.2c] Manufacturing currently represents some 13 percent of GDP, although this number has long been in decline, from roughly 17 percent in 2002. Subject to commodity prices, natural resources account for some 8 percent of the GDP (Stats Can 2012).¹ Given the instability of commodity prices and the slippage of the manufacturing sector, there is much interest in spurring the revitalization of manufacturing with advanced methods and creative services. There is a growing high-tech sector, which currently accounts of 7.1 percent of real economic output nationally (Ryerson report), and the new Liberal government has a very strong interest in developing effective innovation policies. [0.1b]

The Canadian economy is very closely integrated with the United States, which is far and away Canada’s largest trade partner (the source of half of all imports and the destination of about three-quarters of exports). [0.4] The US is also the largest national owner of foreign investment stock in Canada. Roughly half of all direct FDI is controlled by US companies, with aggregated European companies accounting for another 35 percent. [0.5] While the presence of American automotive companies may be some of the highest visibility foreign companies, they are far from the most important foreign investors. The largest investment sector is manufacturing (roughly 30 percent over the last decade), with petroleum products, chemicals, and primary metals being the most important sub-sectors. Another 20 percent of FDI stock is accounted for by investment in mining and oil extraction (Global Affairs Canada).²

This relationship with the US offers clear benefits – a close and voracious consumer of primary goods, a frequent investor. But this relationship also creates challenges for Canada in terms of innovation, with the US being a destination for outmigration of skilled workers, a purchaser of Canadian start-ups, a looser source of private capital, and a competitor that spends billions of dollars on R&D through a “hidden” developmental state (Block 2008). On the whole, multifactor productivity (MFP) has grown more slowly in Canada than in peer countries in the OECD; that said, there are signs that Canada’s MFP grew faster in the wake of the Great Recession (at least prior to the collapse of oil prices). [0.1c]

¹ <http://www.horizons.gc.ca/eng/content/significant-shifts-key-economic-sectors>

² <http://www.international.gc.ca/economist-economiste/statistics-statistiques/investments-investissements.aspx?lang=eng>



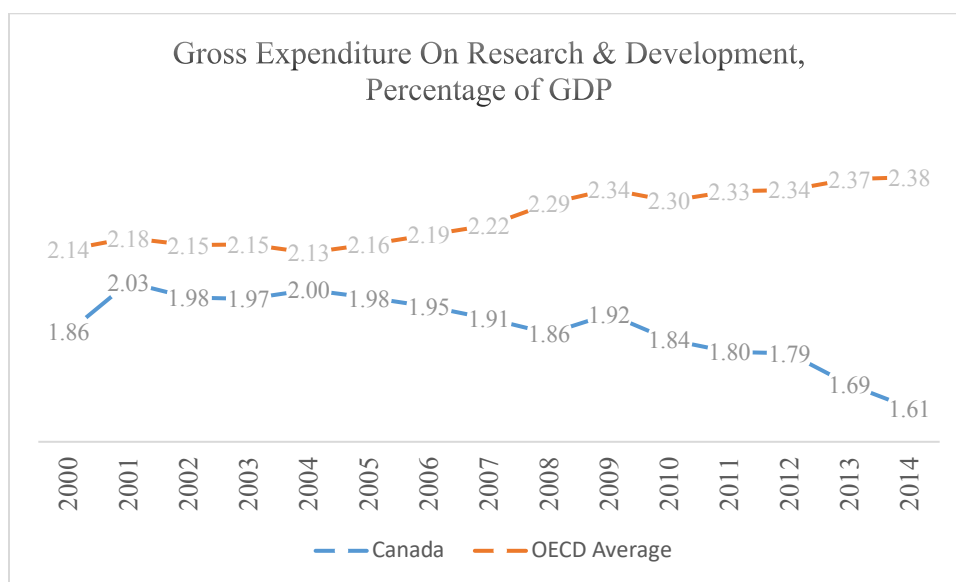
The Canadian government has developed a national innovation system that is multifaceted and is intended to augment some of the primary strengths of the economy. [0.2a] National innovation systems are generally considered to consist of academic institutions, private enterprises, public sector organizations, and the relationship between these organizations. Government organizations that facilitate primary research include the Natural Sciences and Engineering Research Council, Social Sciences and Humanities Research Council, Canada Institute for Health Research, and Canada Research Chairs. In the last decade, increasing interest has been paid to the development and commercialization gap, which a number of more *applied* research and development organizations have addressed: National Research Council, National Centers of Excellence, Centers of Excellence for Commercialization of Research, and Business-Led National Centers of Excellence. Direct supports for business come from Industrial Research Assistance Program (IRAP), Sustainable Development Technology Canada (SDTC), Business Development Bank of Canada, Community Colleges (through NRC's College and Community

Innovation Program)³, and Regional Development Agencies (Atlantic Canada Opportunities Agency (ACOA), Canada Economic Development for Quebec Regions (CED), Federal Economic Development Agency for Southern Ontario (FedDev), Western Economic Diversification Canada (WD)). There are also a variety of province-supported programs and agencies, the most developed system of which is in Ontario.

The interest in developing more direct supports for innovation – which have typically been dwarfed by indirect supports, as shown elsewhere – has also extended to encouragement of venture capital. Canada only has a lower measure of venture capital investment as a percentage of GDP than Israel and the United States, reaching almost 2.4 billion CAD in 2014 (STIC 2014). Roughly two-thirds of fundraising by firms came from government-backed sources (STIC 2014).

In spite of a well-developed national innovation system, there are concerns with Canada’s capacity to be innovative and competitive and to retain its high standard of living. These concerns have perhaps best been articulated in the so-called Jenkins report that assessed the state of innovation in Canada in 2011 and the Science, Technology, and Innovation Council’s 2014 State of the Nation report. But concerns in policymaking, academic, and business circles remain palpable. The Conference Board of Canada recently ranked Canada 13th out of 16 peer countries in innovativeness (CBC 2013).

A number of explanations have been offered for what is perceived as Canada’s lag in innovativeness. [0.2b] First, Canada’s rate of investment in research and development – a precursor to innovation and upgrading – has been falling for the last decade and a half. While peer countries in the OECD have steadily increased their gross expenditure on research and development to 2.4 percent of GDP in 2014, Canada’s has been gradually falling to 1.6 percent. Watters (2015) estimates that Canadian institutions would have to invest an *additional* \$81 billion over the next five years in order to return to the OECD average. Within the GERD, over the same period of time both business expenditures and direct government expenditures have fallen; higher education expenditures, however, have risen modestly.



³ See Samford, Warrian, and Goracinova (2017)

A second, closely related issue is that the government of Canada has relied very heavily on efforts to spur innovation through the tax code, rather than through direct industry support (which is reflected in the GERD). In FY 2010-11, for example, of total expenditures on R&D, 70 percent (\$3.47 billion) were indirect costs incurred through the SR&ED tax credit program; only 30 percent (\$1.49 billion) were direct expenditures (Jenkins 2011). This reliance on tax code has been critiqued for favoring large companies and for being poorly targeted (i.e. providing credits to companies that would perform R&D regardless of whether they received the credit or not). Finally, in the thinking of some critics, retroactive tax credits are ineffective at attenuating the kind of risk that is inherent in innovation.

Third, there is an excessive focus on the production of primary research, without the sufficient support for the transfer and adoption of these technologies into Canadian firms (Watters 2013). As noted above, research expenditure in higher education has been rising for the last 15 years, but that has not translated into parallel increases in productivity. There are significant commercialization gaps: while the NIS in Canada may be good at promoting the production of knowledge or technologies, it is less successful at assisting firms in the adoption and integration of these technologies into innovative goods and services.

Finally, there is a perceived general lack of effective coordination between the levels of government (national and provincial), and between the private sector and its interlocutors in the government and educational institutions (Watters 2013).

1. What is the mission of the IA in its environment?

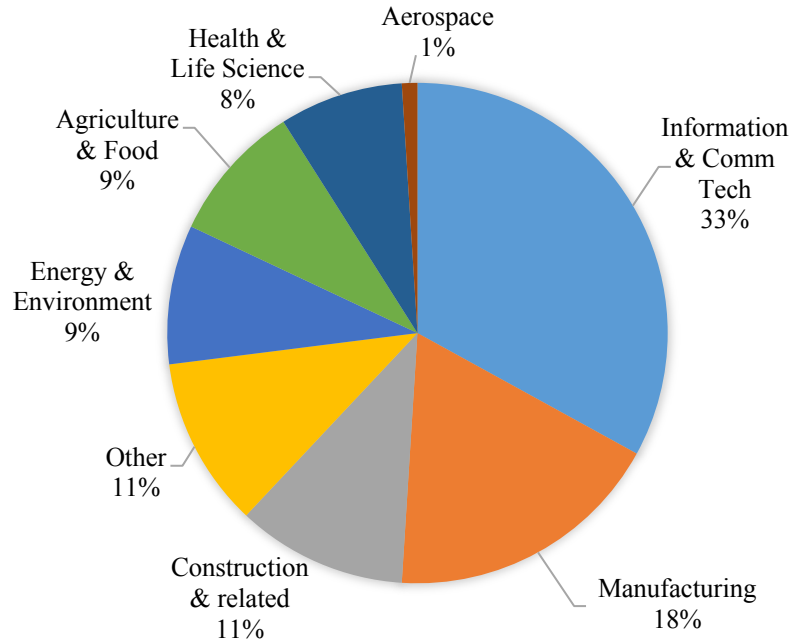
The Industrial Research Assistance Program (IRAP) is a decades old program within the Canadian National Research Council that is broadly geared toward the development of small and medium enterprises (SMEs). The organizational mission of the agency is to “Accelerate the growth of small and medium-sized enterprises by providing them with a comprehensive suite of innovation services and funding.” To this end, NRC-IRAP provides technical information – or connects firms to cooperating research organizations – along with business operations assistance to small firms, regardless of the stage of production or development. In the words of one former executive of IRAP, these interventions are very much aimed at mitigating the risks face by SMEs seeking to innovate: “IRAP was designed to accept and address the intrinsic risk of innovation, not avoid it... These risks are multifaceted. There is a financial risk in investing in new processes and new equipment. There is a risk in introducing new products... There is human resources risk in that the firm has to train its staff in new technologies...”(Coderre 2011, 8) [1.1a]

Drawing in the distinction between transformative and upgrading agencies, IRAP’s mission no doubt places it on the upgrading side of that distinction. [1.1b] That is, it is an agency that is geared toward addressing *existing* technological gaps that small firms themselves identify and request assistance with overcoming. The major instruments that it has available to it are financial and networking instruments that are provided to firms that find themselves without the economic or human resources necessary to make a technological transition, adopt a new technology, verify or commercialize a new product, and so on. These firms are engaged by the agency either because they request assistance from the agency or because a local Industrial Technology Advisor (ITA) becomes aware of them and offers assistance. In this sense, it is almost wholly oriented around the improvement of existing firms and sectors. Similarly, the agency’s support of the employment of young, technically capable graduates by SMEs is a mechanism for promoting training and the introduction of new skills into existing industries. Where the agency might be interpreted as departing slightly from this focus on upgrading is in its short-term support of business accelerators and incubators; while these organizations may help the development of new firms, however, it is unclear that they accomplish the emergence of new industries.⁴ In short, IRAP’s mission and instruments are well-matched in their support of upgrading and incremental innovation in SMEs across the economy, and there is not a sense that the agency is intended to have a broader transformative effect.

IRAP is very much a horizontally-oriented agency that supports innovation in SMEs across the economy, irrespective of their industrial sector. [1.1a] In the years between 2007 and 2012, the grants were dominated by firms developing information and communications technologies (33 percent), followed by general manufacturing (18 percent) and construction (11 percent) (Goss Gilroy 2012). [1.2b] While this may vary somewhat from year to year, the point remains that the agency is explicitly cross-sectoral and understands its role as targeting businesses by size rather than by sector. As discussed below, the Industrial Technology Assistants (ITAs), who deliver the agency’s services, are recruited not only for their technical expertise in a particular sector or technology but also for their experience in business, making them suitable to taking up projects from a range of different sectors.

⁴ Each of these instruments is discussed in much greater detail below. The instruments used by the agency make the upgrading orientation very clear.

Sectoral Distribution Of NRC-IRAP Grants,
2007-2012



In the last few years, there has been a notable shift in direction of IRAP. The agency has begun to place increased importance on business and employment growth, where it had previously had a more explicit focus on technology diffusion (interviews). While growth has always been an aim of IRAP, the agency previously relied much more on the assumption that technology diffusion and development would naturally produce that growth. Recently, there has been increased interest movement of the NRC and IRAP toward a more “industry-driven” model (interview) that considers more carefully the potential for business and employment growth that assistance from the agency will affect. This has obviously affected the manner in which the frontline agents (ITAs) assess and assist firms given that the so-called business case for an intervention has become a more important screening device, and it has resulted in other changes such as recruitment of ITAs with business experience as well as technological expertise.

2. What are the Strategic Objectives of the IA?

NRC-IRAP identifies two strategic objectives that guide its efforts. [2.1] The first objective is to “Provide support to small and medium-sized enterprises in Canada in the development and commercialization of technologies.” This objective identifies the focus of IRAP as being on firms delimited by size rather than by the sector in which they operate, by the level of technological capability the firms have or seek, or by the particular kind of services that they need. Some 98 percent of the firms in Canada qualify as small (<100 employees) with 1.7 percent qualifying as medium (< 500 employees), so the services offered by IRAP are in theory available to the vast majority of firms, excluding only a small fraction of businesses that exceed that size; many large enterprises do not face the same kinds of barriers to the adoption of new technologies that SMEs do.

The second objective is to “Collaborate in initiatives within regional and national organizations that support the development and commercialization of technologies by small and medium-sized enterprises.” This objective explicitly recognizes the IRAP as an organization defined as a collaborating and intermediating agency, rather than as an agency that is free-standing and pursuing goals independently of other research and development organizations. This element of the way the IRAP works is provided through its advisory service, which “helps SMEs identify and understand technology issues and opportunities and provides linkages to the best business and R&D expertise” and is often accompanied by funding to make access to those sources feasible (Goss Gilroy 2012, p. 1). The agency is intended to be an organization that recognizes, learns about, and takes into account the other (sometimes moving) pieces of the national innovation system and seeks to behave in ways that leverage cooperation with those organizations, both national and provincial. This point is developed more below, but this ability for IRAP to intermediate and draw together SMEs and the most relevant research organizations largely inheres in the tacit expertise and flexibility of the Industrial Technology Advisors.

Of note in both of these stated goals is also that the work done by IRAP with SMEs is geared toward *applied* research (i.e., development and commercialization) rather than toward *primary* research (i.e., basic science and invention). This objective seems to be an explicit recognition that most SMEs in Canada do not operate at the leading edge of the technological frontier but instead are competitive adopters. Although the last decade has seen increased government interest in applied research, IRAP has occupied this role for many years.⁵

In sum, the specific objectives of IRAP are to increase the small firm adoption of new technologies by facilitating development and commercialization activities – and hence, competitiveness – within *existing* firms and sectors. With the exception of some funding for incubators, because the agency works with firms who apply directly for assistance, there is little apparent interest in systematically altering existing markets, either by promoting entrepreneurship and start-ups in new sectors or fields, by systematically changing the market for Canadian goods (i.e., increasing exports), or by altering the make-up of business (i.e., promoting diversification).

⁵ One Ontario ITA expressed frustration with the recent emergence of other federal and provincial programs working on applied research consulting for small firms, each of which operate as someone’s “particular empire” and resist coordinating with IRAP (author interview, Ontario ITA).

3. To what extent are the goals and design of the agency “externally suited” to the domestic NIS and to the global conditions?

In light of the conditions outlined above – particularly lagging innovation, over-use of tax credits to encourage R&D, excessive focus on primary rather than applied research, and the preponderance of small firms – IRAP is very well situated to promote innovation in the Canadian economy. IRAP occupies a clear niche in the Canadian NIS: it is focused on small firms, offers well-targeted and pragmatic interventions, cooperates comparatively well with local organizations, and provides mitigation for risk-averse small firms. The Canadian innovation ecosystem is characterized by a gap between the production of innovation through primary research and commercialization. As outlined below, because this gap is so significant and the IRAP so well-suited to filling it, the agency has been very successful (along with being well designed to fit that role and excellently staffed). Because this gap is persistent, the agency’s primary organizational features and instruments have remained mostly the same for several decades. So, it is clear that the IRAP is needed to occupy the role that it does.

The difference between “risk” and “uncertainty” is relevant to government engagement in innovation; “risk” implies calculable probability that adoption of a particular technology will be successful, while “uncertainty” implies enough unknown unknowns that the probability of successful innovation cannot be calculated. While some organizations may help address uncertainty, the role of the IRAP is clearly the mitigation of risk. It is not clear that the agency is able to provide of the same kind of service in the alleviation of uncertainty, as the IAs that have been able to promote rapid innovation based growth have been able to do. To the extent that it is unable to, the question remains whether the agency has failed to address this element of adjusting to higher-tech economy.

What are the operational features of the IA? How does the agency pursue its broad mandate/mission?

4. Organization

Staff

Upper administration in the agency consists of the NRC Vice President for of IRAP and a National IRAP director. Below them in the agency hierarchy is an executive director each region, who is assisted by up to five assistant regional directors, equating to roughly 30 people occupied in upper administration. [4.1] [4.2]

Operating in a horizontal structure below the administrators are the roughly 240 Industrial Technology Advisors (ITAs). These staff members are the core of the agency and constitute the majority of the IRAP staff, roughly 2/3 of all people employed in the agency. These staff members the primary point of contact between the agency and the private sector enterprises the agency seeks to assist.

Around 40 Regional Contribution Agreement Officers (RCAOs), who ensure the smooth functioning of the agreements between firms and the organization. They prepare and administer contribution agreements, process the disbursement of payments according to those agreements, and work with firms and ITAs processing modifications to the agreements. In this sense, they are the bureaucratic facilitators of the legal agreements made between the ITAs and participating firms.

Some 70 staff members are occupied in various roles as administrative support.

The 240 ITAs that are located throughout the country under five regional administrations.

- Pacific Region: 33 ITAs located in in British Columbia and the Yukon. Their expertise reflects the area's industrial strengths, which include natural resource-based sectors (forestry and mining), IT (electronics, software and hardware), advanced manufacturing (advanced materials, aerospace), and other science-intensive industries (biotechnology, fuel cells, electrochemistry).
- Prairies: 47 ITAs are located in the prairie region, where industrial technology needs center around of energy and environmental technologies, agricultural sciences, biotechnology, health-care and pharmaceuticals, and IT (electronics and telecommunications).
- Ontario: 70 ITAs are based in the Province, clustered in 35 teams. Their expertise reflect Ontario's diverse economy: electronics, software, photonics, cleantech, manufacturing, life sciences, medical devices, construction, and aerospace
- Quebec: 50 ITAs including those related to communications, environment, aerospace, and manufacturing
- Atlantic and Nunavut: 30 ITAs operate in 13 communities. Given the nature of industry in the Atlantic region, the expertise of ITAs in the region include agriculture and aquaculture, wood products, nutraceuticals and food products, and to a certain extent advanced manufacturing, telecommunications, and biotechnology.

Regional placement is very important for the ITAs. First, it allows them to develop and maintain expertise in the kinds of firms and sectors that populate the geographic area in which they are based, along with knowledge of the strengths and capacities of the allied research organizations that might assist small firms (more on this in the section on Instruments). Second, decentralization allows the agency to be much more responsive to the firms operating in a particular area. Although electronic communications have lowered some of the delays since his time, former NRC Vice-President for IRAP Keith Glegg noted, “The presence of an IRAP management office in each [region] allowed improvements in the timeliness of whatever the program could deliver. So, a small project that would take a few weeks to execute in the firm wouldn’t have to suffer a four-week approval delay in some regional or Ottawa office” (Glegg in Coderre 2011).

Training/Professionalism of staff

IRAP staff are highly professionalized, with both administrators and most ITAs having extensive experience in the private sector as well as some form of technical training before joining IRAP. [4.3a] Upper administrators are highly professionalized and bear no evidence of being appointed for political reasons. All current administrators had private sector experience with technology or engineering before joining the agency; the importance of private sector experience is a characteristic that has historically highly valued by IRAP and by the NRC more broadly (Coderre 2011). The current NRC Vice-president for IRAP, for example, advanced through regional administration beginning in 1998, and prior to joining IRAP “worked in R&D and consulting with a major research organization, was involved with sales and marketing for a computer numeric control (CNC) company, and was a senior manager for an engine parts manufacturer” (IRAP 2016). His experience, therefore, includes management, business operation, and research and development. [4.3b]

The IRAP ITAs also have high levels of technical training and experience with in their various areas of expertise in private firms. Previously, ITAs could be recruited mostly for technical expertise, but current recruitment filters out young applicants without private sector experience and high levels of technical ability. Experience is seen as critical to the job of the ITAs because their ability to assist SMEs through business consulting, technical advice, and organizational intermediation is based on lessons learned from their own experience. The ITAs have been described as “front line delivery agents... drawn from people with research and development experience and could advise clients on their technological and innovation needs *from personal experience*” (Coderre 2011, p. 7; emphasis added). According to IRAP, of the existing ITAs:

- 34% have been entrepreneurs
- 45% have run their own R&D facility and/or been a leader within an R&D facility
- 41% have worked in a college, polytechnic, university
- 75% have masters or PhD education

Moreover, because of the highly independent nature of their work, ITAs have typically been recruited with some less tangible characteristics in mind. Indeed, ITAs are “street level bureaucrats,” a fact that the recruitment and hiring processes must reflect. Coderre’s (2011, p. 140) description on his experience hiring ITAs reflects as much:

“We sought to identify those individuals who would fit well with the IRAP philosophy. We weeded out those who felt that they needed to work to a fixed set of regulations and directives. We wanted ITAs who would be able to work relatively independently, to think on their feet, and to be flexible, providing the specific help that was needed while adhering to our core principles.” Because of the intangible personal characteristics needed for ITAs, filling of open positions can be a lengthy process with numerous rejected candidates who don’t have the right “fit” (interview). ITAs tend to have a perception of themselves as not being government bureaucrats but as part of the private sector, and they tend to be impatient with the more bureaucratic trappings of government (Interview).

Competitive wages

Competitive wages are an important part of recruiting and retaining personnel; this is particularly true of agencies that seek to recruit agents out of the private sector, where salaries often have greater growth potential than in government. Given the extent of their training and expertise, ITAs may be able to earn more in the private sector; however, at the very upper end of their salary scale, they would fall roughly within the top 3 percent of Canadian earners.⁶ The impression of one regional director and ITAs themselves, however, is that ITAs are more highly motivated by an interesting and fulfilling work environment and a desire to give back to Canada. [4.4]

ITA salaries are determined by a different system from the general government classification system, which relies on the duties that a public employee is expected to perform. By contrast, ITAs are part of the Resource Council Officers (RCO) system, which uses a “person-based classification” scheme in which an employee’s salary is “based on their expertise, skill, outcomes and impacts of their previous work experience” (NRC). This would seem to offer the salary flexibility to attract people from high paying positions in the private sector, recognizing their experience and accomplishments in the private sector. This flexibility implies a range of possible salaries, but recent job advertisements for ITAs show the top of that salary point for the position to be \$140,418 CAD. This places them above the top salary potential for many related public servants (Engineering & Scientific Support: ~ \$100,000; Technical Inspectors: ~ \$100,000; General Technical ~\$110,000; Scientific Regulation Group ~\$120,000), on a par with others (Research Scientist ~\$140,000), but below others with a few others with high outside earning potential (Medical Officers: ~\$200,000).

Aside from relatively high salaries, morale among ITAs is reported to be very high because the nature of the work is challenging but rewarding and they are carefully screened prior to hiring. Although they handle numerous project simultaneously, ITAs report enjoying the pragmatism of their jobs and the concrete and visible benefits of working with small industries in need of assistance, along with the appreciation of the opportunities for learning that it provides. Finally, the esteem in which IRAP as a whole is held by industry seems to confer reputational benefits on them as well. A former IRAP executive, William Coderre, saw these elements – rather than high

⁶ Based on 2013 numbers from Statistics Canada: 677,440 (of 26,172,530 earners) earn \$150,000 CAD or greater per annum (Statistics Canada, CANSIM, table [111-0008](#)).

salary alone – as preventing ITAs from being poached by the firms to whom they offered assistance: “I would make a point to ask the ITAs I met if, in their work of offering helpful and knowledgeable support, their clients did not try to hire them away from IRAP, as employees. Most would smile and say that such offers were frequently made to them, but where else could they have the diversity of technical challenges every day that they found in their work as ITAs?” (Coderre 2011, 149).

Promotion / Tenure

Because of the horizontal structure of the agency, there are relatively few options for moving up within the agency itself. [4.5] Current upper administrators have had a tendency to enter into the organization at the administrative level, while ITAs tend to remain in those positions without much opportunity for advancement in title.

Of current upper administration, including the six executive directors (five regional and one national director) and the NRC vice-president, only one appears to have advanced from being an ITA to administration. Others have advanced from other administrative positions in the NRC / NRC-IRAP or to have come to the agency directly from industry. There is also a lack of possible mobility between the RCAOs and ITAs, given the different requirements for recruitment. As discussed above, ITAs have significant technical expertise as well as experience in the private sector. RCAOs do not acquire this kind of experience in their positions in IRAP (which involve monitoring and facilitating agreements between the agency and firm or other organizational partners). Consequently, there is not a means for incumbent RCAOs or other administrative support staff to advance into positions as ITAs. Among other things, this is likely to ensure the critical ITA positions remain strongly tied to the private sector and are not simply advanced from existing stock of agency employees. In spite of the apparent lack of upward mobility, tenure for ITAs within the agency tends to be long.

Learning/Monitoring

NRC-IRAP has a variety of mechanisms for learning and monitoring the performance of the agency, staff, and participating firms.

IRAP Monitoring:

Because much of the work done by the IRAP is completed by ITAs who are decentralized and work with a high degree of discretion, it is critical for the agency to have strong mechanisms for the evaluation of the overall performance of the agency. At the broadest level, IRAP receives an “internal” audit by NRC officials on an annual basis, which focuses on the issuance of agreements, contributions from the government, and management of agreements with private sector. These audits focus on the routine elements of IRAP’s operations, ensuring that proper procedures are followed in the applications, grants, and agreements with other organizations. [4.6b]

Additionally, the agency receives an external audit and evaluation every five years, as do all federally funded grant and contribution programs under the Federal Accountability Act. These evaluations are thorough reports on the kinds of firms assisted by IRAP, the value and effectiveness of those projects, the overall benefit to the Canadian innovation system. The most

recent evaluation (2012) noted that the IRAP receives extra scrutiny; because of its “high materiality and visibility, the Program was assessed as posing a high evaluation risk and therefore required an in-depth methodological approach, which included primary and secondary data from qualitative and quantitative sources” (Goss Gilroy 2012). IRAP administration appears to be highly responsive to the findings of the external evaluations, as several relevant examples demonstrate. The 2007 external audit report noted the decline in the number of new projects (although the average value of the projects was rising), identified a roughly 10 percent decline in the number of ITAs available to take on projects, and recommended funding changes to reduce the trade-off between high-value projects and project reach. The number of ITAs has since been brought back to its initial level. The 2012 report (Goss Gilroy 2012) describes either steps already taken or planned steps to meet the recommendations of the assessors. Recommendation 1 and Recommendation 3 in the 2012 report suggest giving ITAs greater involvement in choosing which SMEs should be served by IRAP (i.e., giving them greater discretion) and increasing the ability of SMEs to offer feedback about their ITA (i.e., increasing accountability for ITAs). Regarding the selection of firms to assist, in his description of IRAP, Coderre (2011) a past IRAP administrator, identified mixed incentives: if the success of client firms is used as a benchmark for the value of their assistance, managers are more likely to pick the firms that are already more likely to be successful without assistance from the agency. However, the goal of the agency is to help otherwise strong firms that will not undertake innovation on their own. In other words, there is a careful balance between selecting and assisting firms that are risky enough to need help but not so risky that they are likely to fail as firms. In selecting firms, then, they look for “indicators that could infer that a proposed project would lead to a change of corporate behavior beyond the normal R&D activity of the firm”: longer duration, more advanced R&D, hiring new staff for it, etc. (Cooper in Coderre 2011, p.185)

ITA Monitoring:

The ITAs, as noted elsewhere, have a high degree of discretion; while their high levels of experience and expertise and their flexibility have been identified as sources of their efficacy, there are also mechanisms to ensure their accountability. ITAs are responsible for following systemized procedures laid out in a field manual

The agency has developed means by which the firms that have been assisted (i.e., the clients) can respond to their experience with the agency. The agency carries out post-project assessment and continues to track the firms it assists for five years after the completion of the project. This post-project assessment includes evaluations of the ITA performance, including 1) questions that gauge the level of client satisfaction, and 2) an option for firms to address any concerns with NRC-IRAP management (Goss Gilroy 2012). Moreover, the NRC-IRAP provides transparent service standards, which articulate the type and level of performance participating firms can expect from ITAs and IRAP.

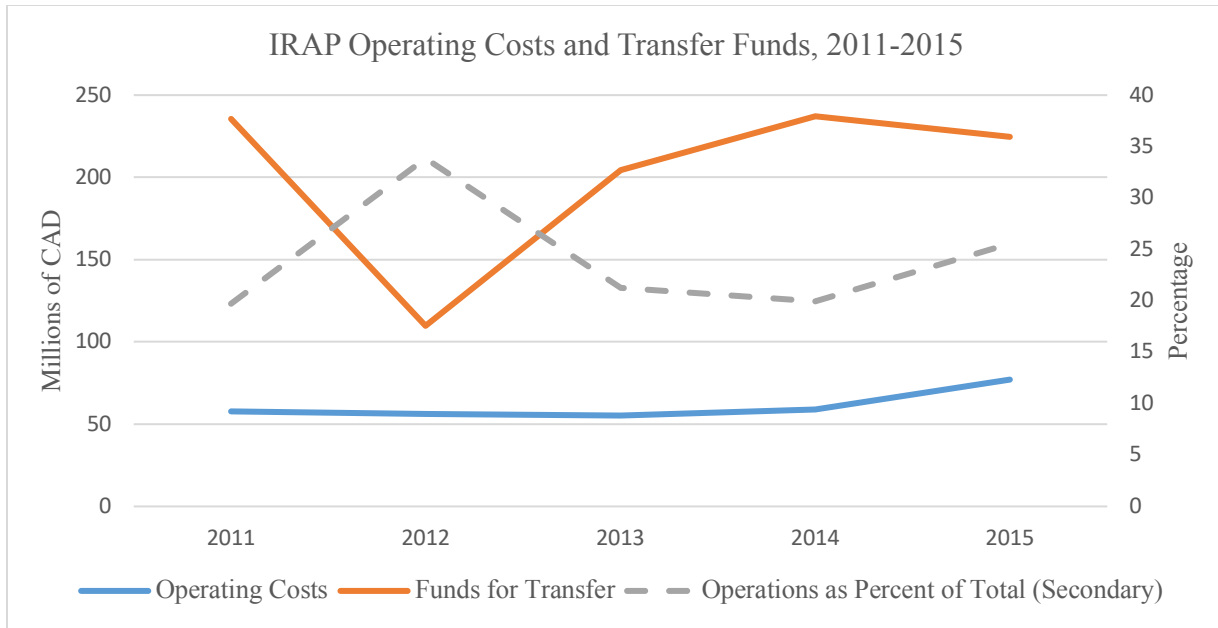
External Perceptions:

By most accounts, IRAP has historically been held in very high regard by the private sector. That said, several private sector interviewees remarked that “it depends on the ITA,” suggesting that as individuals some of the front-line bureaucrats are less effective than others (interviews). There is also a sense among some in the private sector that the shift in IRAP described elsewhere and a general mistrust of bureaucrats by the Conservative administration (2006-2015) has increased the

burdens and pressures on ITAs in ways that reduce their discretion and make them less effective (interviews).

[4.6] IRAP keeps a website with descriptions of successful projects from across sectors and regions and over time. Rather than reproduce several of those here, readers are directed to <http://www.nrc-cnrc.gc.ca/eng/irap/success/2016/index.html>. This is obviously part of the agency's efforts to brand itself, but it is telling that they do continually supply narratives of successful cases.

The primary operating costs for the IRAP are salaries for personnel, with the majority of these being the ITAs. As reported elsewhere, the number of ITAs has remained relatively stable, with some attrition and then rebuilding in recent years; operating costs have also remained relatively stable, in spite of the fluctuating amounts of transfers that are administered by the ITAs.



5. Governance

IRAP is one unit of the National Research Council and is overseen by one of six NRC Vice-Presidents. The NRC itself is overseen by the Minister of Science, Innovation, and Economic Development. The IRAP operates with relative autonomy from the broader National Research Council, with the NRC-Vice President. Within IRAP, governance is directed by a central decision making group, which is called the Senior Leadership Team. This team is comprised of the NRC Vice-President and the six national and regional directors. The role of this group is to provide strategic guidance and oversight for IRAP. [5.1a] A regional director noted that “[IRAP] is remarkably *not controlled* by the NRC. We have our broad KPIs that are at the NRC level that we support. After that, the majority of the decisions are in the hands of the VP” (interview).

[5.1b]

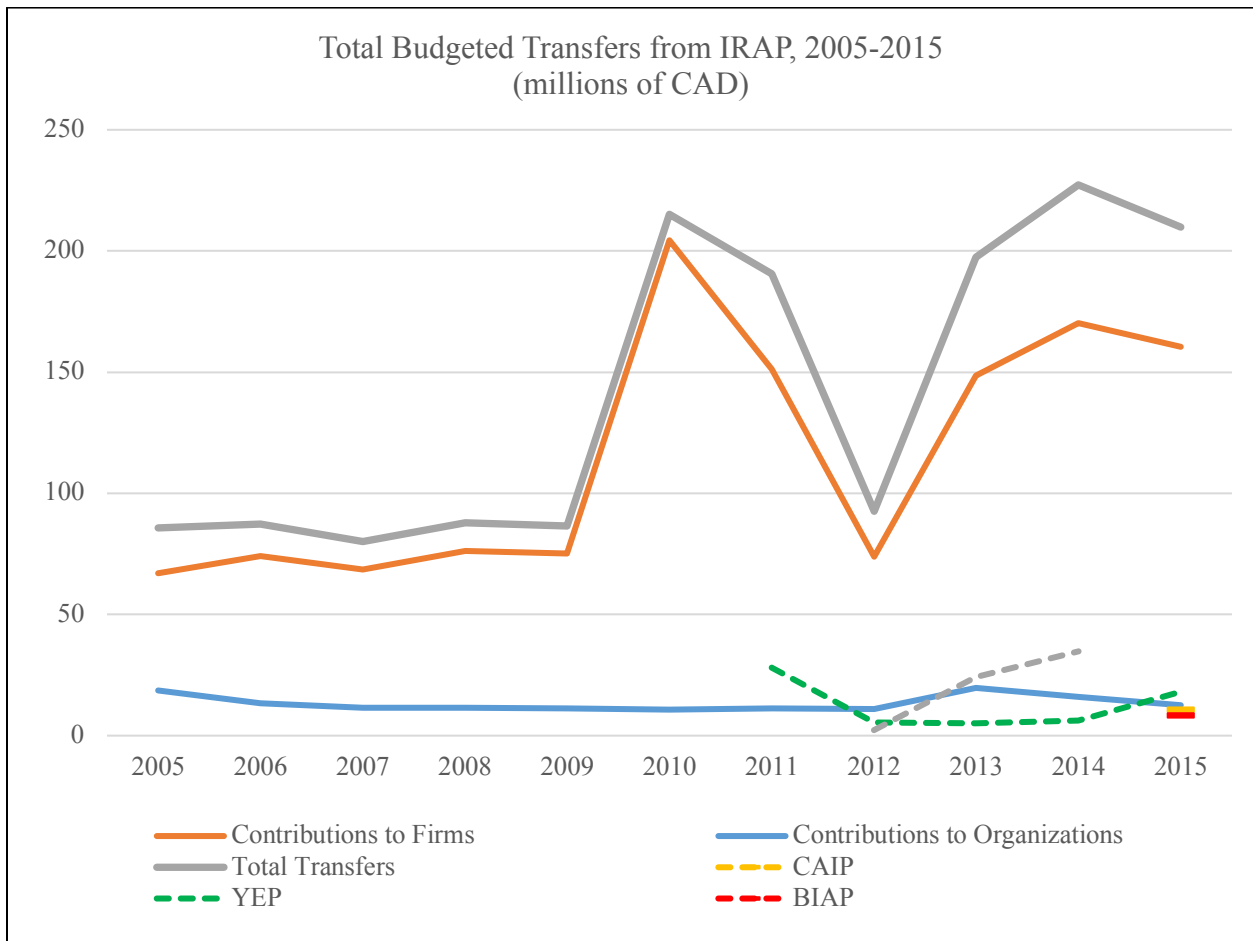
At the subnational level, each of the five regions has an Executive Director. Along with serving on the Senior Leadership Team, the executive director also sits on the Regional Management Committee in her respective region, along with ITA directors and the Manager of Operations and Finance. The Regional Executive Director, then, acts as an important conduit between the region and the national leadership team, facilitating the representation of regional concern at the national level and conducting national information and initiatives down to the regions (NRC (2014 (12-13 audit))).

In addition to government oversight, IRAP also has an Advisory Board that is legally required and which provides general strategic advice about the direction and management of the agency and helps the agency monitor the economic horizon. [7.2a] The Advisory Board has been in place since 1987 and consists of eleven members, most of whom are advisors that come from the private sector. The eight current private sector representatives come from a range of sectors: finance & venture capital, pharmaceuticals, ICT, and business consulting. Most of the current members, who are selected by the NRC Vice-President in charge of IRAP, appear to be available offer “macro” strategic advice about running businesses, business strategy, and finance. This is likely to be a useful compliment to the technical product or process information that IRAP helps SMEs acquire. Among other things, according to IRAP, this private sector advisory council

functions to keep a close relationship between the private sector and the agency such that the agency can remain apprised of developments and general conditions in industry. Although an important link to the private sector and an important source of direction and advice, the Advisory Council does not make binding decisions for the agency. Moreover, in the opinion of a member of the board, there is not a real consultative interaction between IRAP administration and the advisory board. [5.4] [5.5] [5.6]

5. Financing

IRAP receives both “core” funding, which funds the contributions to firms and contributions to organizations, as well as temporary funding from a variety of ancillary programs and larger government initiatives that IRAP administers. Before 2009, funding levels had been quite stable, growing slowly year over year. [6.2] In the ten years between 2002 and 2011, funding level hovered between in the area of \$70-80 million. The complete budget for IRAP was nearly doubled in 2012 as part of the Economic Action Plan, which had the effect of essentially doubling core funding. Salaries and operating costs were roughly 25 million per annum between 2002-2006, rising to around 45 million between 2007-2011.



Short term funding comes from a variety of other initiatives, which IRAP has not necessarily spearheaded but which the agency is charged with administering (in part or full). An example of temporary project funding is the Digital Technology Adoption Pilot Program (DTAPP), which was part government effort to upgrade digital technology use in SMEs, and which NRC-IRAP were selected to deliver between 2011 and 2014. Although similar to the advisory and granting

instruments provided by IRAP, DTAPP was administered as a program with separate requirements.

In years of 2009 and 2010, the complete IRAP budget (including all recurring funds and special funding reached roughly \$280, which is roughly .015 percent of national GDP (Shapira et al 2015). By comparison, the gross expenditure for research and development in 2009 was roughly 1.9 percent of GDP (Watters).⁷ Of that, BERD accounted for roughly 1.0 percent of GDP, higher education investment (HERD) accounted for roughly .72 percent of GDP, and other government expenditure accounted for .19 percent of GDP. At less than 10 percent of the other government expenditures on R&D, IRAPs budget is comparatively small. [6.1]

[6.3] [6.4] While IRAP agents notes that ultimately “decisions are at discretion of the government of the day,” funding for the agency is relatively stable and there is a sense that it is not in danger of political manipulation (interview). Over time, there have been incremental increases year-to-year in the budget, along with occasional large increases (e.g. in the wake of the recession of 2008).

⁷ As noted earlier that percentage is lower than the OECD average (roughly 2.3 percent in 2009), and fell sharply between 2004 and 2014.

7. Coordination

Public Sector

[7.1b] Because of its role as a networking agency, IRAP maintains coordinated relationships with a very large number of other organizations within the NIS. Most of these relationships are maintained with the intention of having a strong network of known and available sources of technological and business assistance for SMEs. It is not clear that there is greater degree of strategic coordination between IRAP and other organizations. [7.1d]

Because of the localized actions of the ITAs, most of these relationships are maintained at the local or regional level. [7.1a] IRAP provides a partial list of the organizations that it has historically or currently coordinates with; this list of organizations changes significantly over time, as new partnerships emerge and old partners (such as OCRE) disappear or are re-purposed. We provide a partial list here to give an idea of the broad scope of coordination that ITAs manage.

In the Pacific region:

- British Columbia Innovation Council (BCIC)
- Accelerate Okanagan Technology Association
- LifeSciences British Columbia (LSBC)
- British Columbia Technology Industry Association (BCTIA)
- Victoria Advanced Technology Council (VIATeC)
- Western Economic Diversification Canada

In the Prairie Region:

- Alberta Innovates
- Arctic Energy Alliance
- BioAccess Commercialization Centre
- Biomedical Commercialization Canada
- Composites Innovation Centre
- Government of the Northwest Territories
- Industrial Technology Centre
- Innovate Calgary
- Innovation Saskatchewan
- Manitoba Innovation, Energy and Mines
- Ministry of the Economy, Saskatchewan
- TEC Edmonton
- Western Economic Diversification Canada
- Local universities, colleges and technical institutes

In Ontario:

Government:

- Ministry of Research & Innovation (MRI)
- Ontario Centres of Excellence (OCE)
- Ministry of Economic Development and Trade

Non-Profits

- ventureLAB, (formerly Innovation Synergy Centre in Markham (ISCM))
- MaRS in Toronto
- Communitel in Waterloo

- Sault Ste. Marie Innovation Centre
- Northern Centre for Advanced Technology Inc. (NORCAT) in Sudbury
- Ottawa Center for Research and Innovation (OCRI)

In Quebec

- Association pour le développement de la recherche et de l'innovation du Québec (ADRIQ)
- Canada Economic Development for Quebec Regions (DEC)
- Centre de recherche industrielle du Québec (CRIQ)
- Centre de recherche informatique de Montréal (CRIM)
- Centre d'entreprises et d'innovation de Montréal (CEIM)
- Centre francophone d'informatisation des organisations (CEFRIO)
- Centres locaux de développement
- Consortium for Research and Innovation in Aerospace in Québec
- École de technologie supérieure
- École Polytechnique de Montréal
- Inno-Centre
- Institut de développement de produits
- Institut national d'optique
- Manufacturiers et exportateurs du Québec
- Ministère du Développement économique, de l'Innovation et de l'Exportation
- MITACS inc.
- Réseau Trans-tech
- Université Laval
- Université du Québec (Trois-Rivières)

In the Atlantic Region:

- Atlantic Canada Opportunities Agency (ACOA)
- Fisheries and Marine Institute of Memorial University
- Dalhousie University
- New Brunswick Community College
- PEI BioAlliance

Not all of the agency's cooperative partners are at the provincial or regional level, however, IRAP maintain cooperative working relationships with federal trade, research, and development organizations as well. These organizations include:

- Federal Economic Development Agency for Southern Ontario (FedDev Ontario)
- Business Development Bank of Canada (BDC)
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Foreign Affairs and International Trade Canada (DFAIT)
- Export Development Canada (EDC)

The notion that coordination with many organizations, programs, and agencies is effective is not shared by all. One interviewed ITA felt that there is resistance to coordinate with IRAP by some relevant business assistance programs, because directors can feel that the program is "my little empire" that they are unwilling to share (interview).

Private Sector

[5.2a] [5.2b] There are two mechanisms by which IRAP coordinates with the private sector. First, the primary mechanism is through the ITAs' contact with private enterprises, which is formalized through the instruments described below, and informally through the ITAs' day-to-day contact with firms in their regions. The informal contacts come from the ITAs' experiences in the private sector along with their attendance at networking activities, working groups, public meetings, and so forth. As one ITA indicated, they also bring connections to the private sector with them to the position: "That's the whole purpose of hiring someone coming from the industry. I build it on the basis of the relationships and the connections that I had from the private sector. Then you actually further build it using all sorts of other vehicles to do that" (interview)

The second form of coordination with the private sector through the formal advisory council, which consists of members from the private sector. These mechanisms are described in detail in other parts of this report (primarily Part 5 (Governance) and Part 7 (Instruments)), so they are not discussed in further length here.

8. What kinds of instruments does the agency employ?

IRAP employs a small number of non-temporary instruments: advisory services, contributions to firms, contributions to organizations. It also has a longer-standing but not permanent instrument - contributions for youth employment – and is currently administering a variety of temporary/pilot instruments. The primary financial instruments are in the form of grants: grants both directly to SMEs and to a network of complementary organizations that assist SMEs with technology development and adoption. However, financial contributions are often paired with networking assistance in order to help locate appropriate partner organizations. Figure 1 lays out the four non-temporary instruments (as well as three one-time or pilot programs in parentheses) with respect to their targeted activity and the means by which the instruments intervene. The effectiveness of these instruments is assessed several ways. First external audits of the program are conducted every 5 years, including cost-benefit analyses of the programs. Additionally, these audits report on the findings of the surveys that firms that participate in IRAP program, which detail the “post-treatment” behavior of the firms with regard to their R&D behavior. Findings reported here draw heavily on external audits (e.g., Goss Gilroy 2012)

Table 1: IRAP Instruments

		Targeted Activity						
		Knowledge creation / transfer	Labor (HK formation)	R&D and innovation for firms	Entrepreneurship	Innovation systems	New sector development	Trade promotion
Means	Grants		4. Youth Employment Program	1. Grants for small/med firms (BIAP) (DTAPP)		2. Grants for Organizations that assist SMEs (CAIP)		
	Credit financing							
	Investment							
	Information			3. Advisory Services				
	Coordination / networking			3. Advisory Services				

1. Advisory Services

[8.1] The most fundamental and most common form of direct assistance to SMEs comes in the form of what IRAP calls “Advisory Services.” These services target R&D activity but do so with information and networking assistance, rather than financial contributions. ITAs who administer the services assist firms by consulting directly with them on “every aspect of the innovation

process, from concept to commercialization, providing technical and business advice, referrals and other innovation services as needed” (i.e. information provision). Or they help match the firms with research labs, business support programs, or other organizations that have necessary expertise in: “technology and business assistance; literature and patent searches; referrals to other programs and services; expertise searches; linkages and networking to appropriate resources; and strategic intelligence” (i.e. networking) (IRAP)

[8.2] There is not an additional line of the IRAP budget that is dedicated to advisory services; instead the costs of the instrument are entailed in the salary costs of the ITAs, and the provision of these services is a key part of their interactions with SMEs. These services are sometimes coupled with and lead to applications for the direct grants to SMEs (described below).

[8.3] 90 percent of firms that engage with IRAP receive some sort of business advice from ITAs (either around project development, business strategy, or financial practices). About half receive technical advice. And roughly 60 percent receive assistance with referrals or linkage development. As discussed elsewhere, roughly 1 in 5 firms that receives advisory services also eventually receives a financial contribution.

[8.4] This instrument is promoted by ITAs, in the same manners described in the below instrument.

[8.5] Advisory services are initiated when firms contact ITAs regarding assistance or when ITAs make contact with the firms through their informal channels. Application and selection are less of a concern, since they strive to assist all companies that approach them, and the services that are provided are less concrete. Advisory services may develop into applications for SME grants, at which time more complete screening process is engaged.

[8.6] Advisory services do not have the same reporting requirements, so there is little formalized assessment of the work of ITAs with firms. Formal monitoring begins when advisory services lead to contributions from IRAP.

[8.7] Advisory services do not have the same reporting requirements, so there is little formalized assessment of the work of ITAs with firms. Formal monitoring begins when advisory services lead to contributions from IRAP.

[8.8] Advisory services are available on a rolling basis as SMEs approach an ITA in their region. There is no prolonged waiting time for services.

[8.9] There has been little change in this instrument for numerous years, although the advisors face a constantly shifting environment of organizations and programs that they use as partners. Again, some private sector participants have noted an increasing bureaucratization of the ITAs and inflexibility that has been detrimental to the functioning of the program (Interviews).

[8.10] It is very difficult to assess the effectiveness of the advisory services, as they are not monitored in the same manner that recipients of the contribution programs are. The services provided are also less formal in nature, relying on relationships developed between firms and the

ITA, which can have nebulous starting and ending points and may last for years. Goss Gilroy (2012) writes, “Recently, NRC-IRAP has been under pressure to demonstrate the value of its advisory services, and will likely be increasingly called upon to do so in the future. Demonstrating the value of advisory services will entail measuring not only the outcomes of the services on the firm, but also the ITA’s delivery of the service, including the intensity with which they are delivered.”

2. Grants to Small and Medium Enterprises

[8.1] The first form of financial support is direct research and development support for SMEs. This support comes in the form of non-repayable contributions to cover between half and 80 percent of the cost of an approved R&D project.⁸ The funding may compensate for associated costs within the firm or the cost of outside subcontracting work. It is intended for the development, adoption, and commercializing technologies that are new to the firm.

[8.2] Level of Aid: This kind of direct support to firms constitutes the majority the IRAP budget for innovation programs. In the years 2007-2008, the budget for these contributions hovered around \$70 million, a number that increased by roughly \$120 million in 2009-2010 due to short term funding increases, and then settled around \$150 to \$160 million for 2012 to 2014. In short, the direct contributions have greatly increased since the Great Recession, which has both allowed IRAP to serve more SMEs and has altered the manner in which firms obtain assistance. This funding direct to firms is roughly 7-8 times the amounts dedicated to direct grants to organizations (see below). \$160.7 million in FY 2014-15, or 71.4% of funds that go to grants and contributions spending.

[8.3] The agency tends to support relatively new firms that fall well below the 500 employee threshold. Between 2002-2012, the approximate median firm size receiving assistance was nine employees and median age was around seven years old (Goss Gilroy 2013).⁹ Standard projects can be funded up to \$350,000; they can be extended up to \$500,000 with the approval of the regional manager and up to \$1 million with approval of the NRC V-P for IRAP. The number of firms that are assisted has varied by external factors and the amount of yearly funding, which, as noted has jumped. At funding levels around the 2006-2009 levels, IRAP core budget generally funded around 800 firms per year, while at the newer funding levels the number of firms is roughly twice that (Goss Gilroy 2012). The median contribution to firms in that period was \$45,000 (with a mean of \$81,000)

[8.4] Grants to SMEs are promoted through two mechanisms: 1) through the ITAs’ day-to-day immersion among firms in the private sector as well as 2) through the many local organizations with whom the IRAP cooperates. First, ITAs are required to be familiar with the firms operating in their regions and within their areas of expertise. The presence of ITAs (although possible not complete knowledge of the instruments they oversee) is well known given the age and

⁸ IRAP officials prefer to use the term “contributions,” rather than “grants” because of the performance conditions associated with the provision of funding. The terms are used interchangeably here.

⁹ Mean firm size was significantly larger (29), the distribution skew suggesting there was assistance afforded to relatively larger firms.

prominence of the agency. Firms approach ITAs when they have a project they would like assistance with; ITAs can likewise reach out to firms to encourage them to develop R&D projects, which the agency can help fund. Clearly, this form of outreach/recruitment depends very highly upon the ITAs being both well-networked and well-informed about the goings on in the private sector in their region. Second, SMEs often seek out assistance from one of the accelerators, incubators, or other cooperating organizations, and ITAs approach the enterprises through these organizations.

[8.5] Selection Process: Estimates from ITAs differ slightly, but up to roughly 20 percent of the firms that receive Advisory Services (as described below) also receive funding contributions. The process of applications and screening for grants is administered through the ITAs. As discussed above, the ITAs are required to maintain a working knowledge of the firms (and research organizations) operating in their regions. Firms have traditionally requested assistance from ITAs, who assist them in detailing the project needs, identifying the resources necessary (e.g. outside research labs), developing the proposal, and making an application for funding. These relationships are often developed over years. At the point that the collaborating ITA determines that there is a reasonable justification for providing funding, ITAs then bring the case to a working group with two other ITAs to assess the viability of the project (i.e. that it is possible, important, and will generate growth).¹⁰ Upon approval, the ITAs recommend projects to managers at the regional level who approves funding for the project. ITAs also have the discretion to approach firms to recruit them to participate if the ITA is aware of a new technology that might benefit them or sees them as a promising firm. This later form of engagement has been increasing in the last few years due to the greater amount of funding available for grants and to the increased focus on growth (interview).

[8.6] Participating Firm Monitoring:

There are several mechanisms that allow the IRAP to monitor the good faith efforts of the SMEs to use funding and assistance wisely and for the benefit of Canada. First, as noted above, NRC auditors monitor the adherence of agreements and contributions to participating SMEs and organizational partners. The most recent audit, ending in FY2015, found that there had been zero failures of compliance with the issuance and monitoring of contribution agreements. NRC describes the monitoring of participating firms as follows: “Management oversight of the IRAP program is based on regular meetings between Directors and their ITAs to assess the status of on-going IRAP projects and determine which IRAP recipients require additional monitoring. Each region prepares its own project tracking sheet based on SAP financial data to verify the committed funds, amounts paid and cash-flow burn rate for projects on a per region and ITA basis (i.e. the Regional Report)” (NRC 2014 (12-13 audit)).

Second, ITAs also report keeping very close track of the progress of the ongoing projects they are responsible for by checking in frequently with the participating firms and organizations. Once an ITA is assigned to a project, the fact the firm’s performance is then linked to them raises the incentive to ensure that the project is completed successfully. One interviewed ITA stated

¹⁰ The more business-oriented ITAs speak about the justification as a “business case,” belying the degree to which they are increasingly immersed in thinking about running businesses, rather than technology development alone.

that after the approval and initiation of the project, “we monitor [the project] on a monthly basis, at most. If they don't deliver, we pull the plug. I can't think of any other organization being funded by any level of government that works with this level of due diligence” (Interview, Ontario-based ITA).

Third, as of the 1990s the agency has contracted out external audits of spending on individual projects. The projects selected for audit are sampled from the population of firms, but historically sampling has not been at random but instead intentionally favored firms “with prior invoicing problems, multiple projects, and larger levels of funding.” (Cooper quoted in Coderre 2011, p 190).

[8.7] IRAP formally keeps track of the business it assists for 5 years after the end of the program. This system monitors “post-treatment” metrics: 1) revenue, 2) income, 3) number of employees, and 4) investment in R&D. This is a means of measuring the longer-term impact of the project on the firm’s behaviors, many of which would not be visible at the immediate end of the program. IRAP also maintains an interest in any intellectual property (IP) that is developed with their assistance. IRAP allows the participating firms to exploit and own this IP, but that it must be done in a manner that benefits Canada. Firms may not transfer the IP to foreign parent companies or to other firms abroad. Similarly, firms may not simply sit upon unused IP, and it must be transferred back to the control of the NRC or licensed to another Canadian organization (Coderre 2011, 181). As a result of these regulations, IRAP continues to monitor private sector partners to ensure appropriate use of government funded IP.

[8.8] The time-frame for funding for SME contributions is highly flexible. In terms of the funded projects, they can last from several days to multiple years, depending entirely upon the nature of the project. Grants are also available on a schedule that is suitable to businesses; that is, applications are assessed quickly and funds made available without delays. Approval is available in 20 business days for projects of \$50,000 or less, 30 business days for projects of up to \$500,000, and 45 business days for greater amounts. This is said to be one of the benefits to having local ITAs acting as both business contacts and as screeners of applications (Coderre 2011). They are aware of the needs of businesses and seek to operate in a time frame that is more aligned with business than it is with government or academia (Interview, ITA). In program evaluations, 78 percent of firms reported being pleased with the amount of time for the funding decision, while 87 percent were pleased with the timeliness of disbursement of the funds.

[8.9] The most notable recent practical change is the increase in funding. As the funding available for grants to SME has roughly doubled, there has been an increase in ITAs seeking out promising businesses to offer assistance and less reactive funding based on SMEs approaching the agency. As noted earlier, some private sector participants have noted an increasing bureaucratization of the ITAs and inflexibility that has been detrimental to the functioning of the program (Interviews).

[8.10]¹¹

¹¹ The figures in this section include contributions to firms along with the contributions made through the YEP program.

Capabilities

The outcomes related to capability growth reported by firms as a consequence of receiving contributions for a project from IRAP are largely positive (Goss Gilroy 2012):

- 70% of recipients reported an increase in their business skills and knowledge;
- 82% reported increased scientific or technical knowledge;
- 90% reported improved technical knowledge or capabilities;
- 62% reported long-term increase in R&D capacity;
- 68% reported improved business capacity;
- 30% reported being able to develop trademarks, copyrights, or other IP.

Employment

In terms of employment, firms also reported that the funding had helped create or maintain jobs (85%), two-thirds of which were in R&D. On average, participating firms expanded their workforce by 16 percent in the years between 2009 and 2011 (Goss Gilroy 2012). Goss Gilroy (2012) estimates that the annual contribution in terms of jobs is 8,564 FTEs on average, of which 6,683 (roughly 75 percent) are research and development jobs.

Productivity & Development

Funding from IRAP has been found to be effective at improving the productivity of recipient firms:

- 70% believed their firms to be more productive
- 80% were able to create a new product or service and 83% new processes
- 69% were able to commercialize a new technology
- Most say increases in their domestic (66 %) and international (59%) market shares.

Matching

The vast of recipient firms reported being able to increase their own contributions to R&D as a consequence of receiving IRAP contributions (84 percent). For every one dollar contributed by IRAP participant firms contributed \$3.75, which may not otherwise have been invested.

Return on Investment

Goss Gilroy (2011) estimates the overall benefits of IRAP as follows: “NRC-IRAP performance data indicate that most projects result in a positive Return on Investment (ROI) with a cost-to-benefit ratio of 11.36. Furthermore, the partial cost-benefit analysis found that estimated annual profits (\$440M) and SME wages, salaries, and overhead (\$1.1B) that subsequently result from NRC-IRAP projects far outweigh the Program’s annual expenditures of approximately \$130 million.” These numbers are roughly the same as the previous 5-year period.

2. Grants to Organizations that Aid SMEs

[8.1] In addition to direct funding to businesses, financial contributions are provided to other organizations that also support technology and development and adoption among SMEs. These grants support over 100 organizations, which vary from year to year. In some cases, these beneficiaries are organizations where the agency’s ITAs are based. As made clear elsewhere, because IRAP does no research on its own, it is important that it help maintain the network of

institutions and organizations that do conduct the kind of research and provide other services that are necessary to assist SMEs. IRAP's function as a networking and intermediary organization is only as good as the other organizations in the network of the local innovation system.

[8.2] The total amount of funding for grants to organizations is dwarfed by the direct grants to SMEs, which has historically been about 7 to 8 times as much. In FY 2014-15, \$20.1 million was spent on organization support, roughly 8.9% of total program spending by IRAP in that year. This percentage has remained roughly the same over the last decade, in spite of notable alterations in the overall budget in recent years. That is, it was closer to \$10 million in years before the large increases in funding outlined previously.

[8.3] The beneficiaries of this program are organizations, rather than firms, but they are organizations that also seek to assist small firms with technology adoption, business advice, infrastructure, working space, and so on. Many of these organizations are also play host to the ITAs. For example, MaRS in downtown Toronto is a business accelerator that is supported by IRAP through this instrument and is the location where a group of ITAs operate. Between 2006 and 2011, an average of 60 organizations per year has received funding through this instrument.

[8.4] This instrument is administered by ITAs, in the same manners described in the above instrument.

[8.5] As in the other instruments, the organizations are in contact with the ITAs and develop funding proposals through iterative discussions with the agent. Screening operates in the same manner, based on the potential private sector beneficiaries and the appropriateness of the organizations goals to the local ecosystem in which they operate.

[8.6] Monitoring of the contributions to organizations is far less systematic than the grants to firms. Goss Gilroy (2012) notes that organizations are required to submit a final report on their activities, but that this report does not have a defined structure or required data for submission.

[8.7] See above.

[8.8] There is not a prolonged waiting time – or defined cycles – for the funding decisions or disbursement of the funds.

[8.9] Funding supports the operation of the participating organizations, rather than a short-term or well-defined projects (as the support to firms does). So the time of the organizational grants is more extensive.

[8.10] The monitoring of the funded organizations is less rigorous than the monitoring of grants to firms; the funded organizations are only asked to report on their activities. This creates, “strong limitations in the program’s ability to collect, analyze and report on the activities, reach and impacts of its financial assistance to funded organizations.” That said, the funded organizations’ assessment of the funding mechanism is high, with approval of the timeliness of the funding decision at 80 percent and approval of the timeliness of the payments at 91 percent of client organizations.

4. Youth Employment Program (not permanent)

[8.1] The Youth Employment Program is a relatively long standing instrument, although it is not funded as a core instrument like advisory services or contributions to firms. The YEP provides funds to SMEs to help offset the costs employing young people with needed technical skills. Youth Employment Program assistance comes in the form of 6-12 months of financial assistance to small firms to hire highly-skilled interns with desirable traits and needed technological skills to work in the firm, and ideally be hired permanently after this period of government support. IRAP states that the sponsored youth employees “who will work on technical opportunities within the firm and on non-technical but technology-related projects such as: research and development, engineering, and multimedia; development of new products and processes; market analysis for a new technology-based product; business development related to science and technology activities; and improvement of customer services, etc.” In short, it is hoped that they young employees introduce new skills to the SME, at the same time that they are incorporated into a labor market that is rapidly changing. YEP does not include training, certification, or research provided or coordinated by the IRAP; in this sense, any skills development is highly decentralized, occurring between the SME and the employee.

[8.2] This program was funded with \$20 million in FY 2014-15, which represented 8.9% of total program spending that year. This amount has risen from roughly \$5 million in 2007, particularly after a steep increase in FY 2012, although the percentage of program spending has remained relatively stable.

[8.3] The number of firms receiving YEP funding is less than half of the number receiving funding for R&D projects. Goss Gilroy (2012) estimates that of the 8,000 individual recipient firms assisted between FY 2006 and 2010, 2,400 firms received YEP funding. The first years of this period had a \$15,000 median contribution (same mean), but this jumped to \$30,000 near the end of the same period (in keeping with the general growth of funding) (Goss Gilroy 2012)

[8.4] This instrument is promoted by ITAs, in the same manners described in the above instrument.

[8.5] Selection process is same as described above, administered by ITAs

[8.6] Monitoring Mechanisms are the same as described under SME Grants.

[8.7] Project monitoring Mechanisms are the same as described under SME Grants.

[8.8] YEP are available on a rolling basis as SMEs complete application. There is no prolonged waiting time.

[8.9] This form of funding is relatively new to IRAP, going back 10 years. It is administered as part of the federal government’s Youth Employment Strategy, which facilitates programs in ten other federal departments and agencies (IRAP). Funding for the program increased at the time that other IRAP grant programs grew.

[8.10] With regard to employment creation, most employees/interns hired with the YEP funding kept their jobs after the funding from IRAP ceased (71 percent between FY 2007 and FY 2010). Very nearly all of those who found employment through the YEP reported being engaged in work activities that were related to their training and expertise (Goss Gilroy 2012).

Additional Program Administration and Development

IRAP's primary role has been the administration of advisory services and business and organization grants for R&D. It has also, however, been the administrator of a variety of other initiatives and pilot programs that are funded by other agencies/organizations. This section outlines several of the recent non-permanent programs that have been administered by IRAP; it is inappropriate to not mention them, but they are not ongoing, recurrent instrument. These programs are typically not generated by IRAP alone, but the agency is part of the collaborative process by which pilot programs are designed and developed, and the agency has a voice in whether it is an appropriate agency to deploy the programs (Interview). The agency also plays a role in assessing the viability or the success of these programs. This section describes several of the most recent programs, which are not included in the "Instruments" sections below because of their short-term nature.

1. Canada Accelerator and Incubator Program (CAIP)

Funded as part of the Government of Canada's Venture Capital Action Plan, this program was initiated in 2013 and consists of non-repayable grants to business accelerators and incubators. It was formatted as a one-time request for proposals which would then be funded over a five-year period. Chosen accelerators and incubators would be required to provide 1:1 matching funding for the project. This program clearly fits with IRAP's ongoing funding of organizations that support the growth and development of small firms; however, this funding is targeted at particular kinds of organizations – business accelerators and incubators – that intervene in the economy in specific manners. Recipients of funding have characterized the application process as highly intrusive and inefficient.

2. Business Innovation Access Program (BIAP)

The BIAP is a three-year pilot program begun in 2014 designed to draw on the existing expertise of ITAs and to offset the costs of businesses using university partners as consultants for the commercialization of new technologies (BIAP Evaluation). This focus on the latter stages of development and commercialization was mandated by the Government of Canada, which saw a commercialization gap as a particular problem for SMEs. IRAP is generally agnostic about the stage of technology development among firms it assists, but the BIAP is intended to specifically target those at the stage of commercializing technologies. Otherwise, the means of administration fit mostly

seamlessly with the role of the ITAs, who provide advisory services to participating SMEs and facilitate grant applications.

The manner in which pilot programs are evaluated is quite clear with the BIAP, which is apparently under consideration for extension. Midterm audit/evaluation found that the BIAP has in actuality overlapped significantly with IRAP by targeting firms at all stages of research and development. This draws into question the program's value as distinct initiative, unless IRAP is unable to make the program more complementary with its traditional advisory services.

3. The Digital Technology Adoption Pilot Program (DTAPP)

DTAPP was an experimental program run between 2011 and 2014, with a total budget of \$80million over 3 years (\$62 million of which was directly granted to firms and organizations). The goals of the program were to spur the adoption of efficiency-raising digital technologies by small firms, which often have difficulty adopting new technologies. As with BIAP, DTAPP was folded into the portfolio of advisory and grant services delivered by the ITAs, but was directed specifically at the adoption of digital technologies. Outside auditors found that the program fit well within the existing structure of IRAP and that because of the existing expertise and mode of operation of the ITAs, it was relatively easy to put in place. In spite of what seems to be a positive external audit – regarding program design, implementation, and short-term outcomes – the DTAPP was not refunded.

[9.1] In general, there is a strong coherence between the mission of the IRAP and its operational features. Its stated mission includes assisting small and medium enterprises (up to 500 employees). Several features make the agency's interactions with the private sector show it to be very well suited to addressing the immediate R&D needs of SMEs. First, the embeddedness of ITAs in local communities serves SMEs well as ITAs come to know local firms and their conditions and are approachable because of their geographic proximity and sectoral expertise. Small firms in particular are likely to need ongoing advisement, which is made possible by this closeness of the ITAs to their local community of private firms. Second, as discussed above, the ITAs have a good deal of latitude and discretion built into their operations, which allows them to deal with the client firms in ways that they believe are most suitable. This discretion allows them to consult with firms and select appropriate interventions and provides the flexibility to scale up their assistance to financial contributions if appropriate. Small firms are often short of resources, so this flexibility allows these gaps to be addressed in an appropriate and tailored – and not one-size-fits-all – manner. Third, the speed with which funding can be approved and disbursed – within several weeks – and the flexibility of funding periods are also critical to small firms, who may have very small projects that need to be funded or may need long term funding for projects that are of greater significance. The point is that with almost all of the firms in the country qualifying for assistance for SMEs, there is a great variety of sectors and technological or business needs, so the flexibility (with accountability) that is built into the operation of the ITAs assistance makes the IRAP effective.

The instruments employed by IRAP also seem to be well designed to assist SMEs. For example, the ongoing nature of Advisory services is beneficial for small firms that may have recurring technology gaps and need regular consulting more than larger firms. Moreover, the provision of grants to firms only when the firms and their business plans are known well enough by an ITA for the agent to support them helps ensure that the grants will be used effectively. That said, one critique of IRAP has been that demand for grants to firms has typically outstripped supply; this may have been alleviated somewhat by the rise in the transfer budget for IRAP. With only a fifth of advisee firms receiving funding, ITAs can be sure to direct funding to those that both need and appear likely to use the funds well. With the expansion of funding, those standards may fall somewhat and may have negative consequences on the cost-to-benefit of IRAP's instruments.

In general, the importance of assisting SMEs seems to be well-recognized by the federal government and funding has nearly doubled since the years before the financial crisis of 2008. Funding levels otherwise appear stable and insulated from political interference or manipulation of which firms receive funding.

There has, however, been a clear shift in the direction of the IRAP in the last decade, from focusing particularly on technological innovation and adoption to business growth and competitiveness vis-s-vis technology adoption. In the words of one ITA, "IRAP was very strictly focused on helping technology firms to develop technologies. Now, we're helping small and medium technology Canadian firms to become globally competitive and increase their market share and grow their businesses" (interview). Not surprisingly, this shift has caused consternation among some of the agencies' stakeholders because it has been accompanied by a change in the manner that the agents operate. For example, currently recruited ITAs must have business experience, with the presumption that it will give them the kinds of skills necessary to judge applicants on their business case rather than on their technological needs alone. While technical expertise is still important, it is not sufficient. This has altered the make-up of ITAs and is seen

as problematic by some of the “old guard” of ITAs. Similarly, some private sector actors also see ITAs as increasingly bureaucratized, more bound by justifying their decisions, and, consequently, less helpful in technological matters. That said, the shift in recruitment profiles of ITAs *is* consistent with the emerging focus on business growth and competitiveness. It remains to be seen this newer orientation affects the effectiveness of the agency.

The second shift has been in the increasing use of ITAs to administer temporary or pilot instruments (which are discussed above). These programs generally come in the form of funding intended to particular purposes (digital technology adoption, or business incubation); they are promoted by agencies outside the IRAP but use the ITAs to administer them, much as they administer the permanent IRAP instruments. This trend is quite recent, so the effects are yet to be seen, although there is some suggestion that it will detract from the effectiveness of ITAs by giving them more reporting requirements (interview).

[10.1] By the broadest measures of success for the agency, the IRAP is extremely successful: “Return on Investment (ROI) with a cost-to-benefit ratio of 11.36. Furthermore, the partial cost-benefit analysis found that estimated annual profits (\$440M) and SME wages, salaries, and overhead (\$1.1B) that subsequently result from NRC-IRAP projects far outweigh the Program’s annual expenditures of approximately \$130 million” (Goss Gilroy 2012). Moreover, as mentioned above, IRAP participant firms contributed \$3.75 dollars to every dollar funded by IRAP for projects. So, the agency clearly has a positive impact, although it is difficult to know how much of this is accounted for by selection effects. Participant firms are, after all, selected in part because of their fitness businesses.

One point that numerous interviewees noted was a significant shortcoming is that the agency is unable to assist firms that grow beyond their eligibility as a SMEs. The agency is not legally able to assist firms as they grow into larger, globally competitive firms that employ more than 500 people. As a consequence, firms that the agency has helped for years can be left without any form of assistance (other than the SR-ED tax credits) as they grow in size. This is an issue because of the propensity for Canada to lose larger firms through acquisitions by American companies, and there is a sense that the Canadian economy would be healthier with more large firms.

[10.2] By all accounts, the IRAP is held in high regard by agencies across the government. This reputation stems from a sense that what IRAPs does is central to the Canadian economy, even if the work ITAs do on a daily basis is much more circumscribed and small-scale. It should be noted that while the IRAP is highly regarded as SME technology assistance program with dynamic agents (ITAs), the agency itself is *not* known as highly experimental or cutting-edge. The ITA model has largely been in place since the beginning of the agency. It is not necessarily looked to as a developer of new programs. In fact, it often administers funds from other programs (e.g., BIAP and CAIP, as described above), and while it does have some say in making sure the programs are structured such that ITAs can administer the funds, they are not experimental programs developed by IRAP. So instead of looking to programs or ideas developed by IRAP to be applied in other venues, other agencies or programs seem to value IRAPs position as being closed ties to the private sector through the ITAs’ networks. As noted elsewhere, this trend is not necessarily unalloyed benefit to the agency; the more beneficial trend for innovation in Canada might be the scaling up of some of the effective parts of IRAP program in other agencies, rather than the layering of other programs over IRAP. Breznitz and Ornston (2012) discuss some of the related dangers of IAs being held in high regard.

[10.3] In general, IRAP is very highly regarded in the private sector. It has a long history of assisting SMEs, and as the numbers cited above indicate, most businesses are very happy with the assistance they receive from the agency and have a sense that it increases their long-term potential and ability to adopt and develop new technologies. This opinion, is of course, not universal. Some interviewees noted that the usefulness of the agency is highly contingent upon the particular ITA and their fit with the firm in question. One firm in the Greater Toronto Area, for example, reported approaching the regional ITA and getting no useful assistance at all one year and then a few years later getting excellent assistance from a different ITA and a referral to a nearby Canadian organization to help with research needs (when they otherwise would have contracted an American organization). Clearly, then, the discretionary and network-based role of

the ITAs helps them operate effectively, but it also leaves the agency's reputation and effectiveness in individual hands.

Conclusions: Strengths and Areas of Concern for IRAP as an Innovation Agency

The Canadian IRAP is a well-known and respected agency, both among policymakers and in the private sector. Its renown stems from the fact that it has been 1) a consistent player in the Canadian innovation ecosystem for decades, 2) has managed at high rate of return for the country's relatively small investment in the agency, and 3) has done so through a network of discretionary but highly capable and committed field agents whose work with the private sector has been the primary driver of the agency's success.

Perhaps the greatest strength of the agency is the capacity of ITAs to locate themselves within ecosystems of private firms in ways that allow them to be both valuable as network builders and suppliers of informational and financial resources for the businesses who they serve. This requires not only technical knowledge and private sector experience that allows the ITAs to understand the kinds of conditions faced by firms, but also the kinds of skills that allow them effectively manage multiple ongoing projects and a large amount of tacit information about the potential partners in their area. Because of the tacit knowledge and networking ability and the importance of recruiting people who are both technically skilled and can manage this discretion well, it is not clear to what extent this model of intervention is replicable in other settings, particularly if agents are inspired to join an agency in part because of its reputation.

IRAP may not look particularly co-evolutionary (i.e., shifting to adapt to changing conditions in the private sector). It has, after all, operated very similarly over the course of its existence, with some variations but no clear programmatic change in spite of the major changes in both technologies and the global and domestic economic settings over the latter half of the 20th Century and the beginning of the 21st. Although it may not be broadly co-evolutionary, it seems that this flexibility is partially built into the manner in which the ITAs operate. The ITAs begin with high levels of technical expertise and actively learn about the changing conditions that the firms in their geographic and technological areas face, emerging new technologies and their implications, and means of overcoming them. As they learn on an individual basis, they are able to provide new information and new strategies and to recommend new research partnerships to their firm clients. So, even though the kinds of instruments available to them have not shifted appreciably over time, the flexibility and discretion of ITAs allows them to evolve and adjust to new economic and technological conditions facing Canadian SMEs.

Areas of Concern

While the IRAP is rightly recognized as a highly effective agency, it is clearly distinct from the kind of innovation agencies that have made their mark by being experimental, such as those in Finland and Israel (Breznitz and Ornston 2012). IRAP, by contrast, has employed a relatively fixed model of providing R&D assistance to small firms through its outreach agents and is relatively limited in its scope of instruments. This has proven to be an effective model for incremental and aggregating technological advances. The agency has not taken to serious steps to move outside this framework or to develop alternate programs or instruments for technological development. In other words, the program has been largely committed to a single method; given that this method clearly addresses the mission of assisting SMEs in technology development, it hard to take issues with it. However, it is worth asking whether the IRAP could take more advantage of its success with a limited set of instruments to experiment with other kinds of

targets or other means of assisting the private sector. Its high status and close contact with the private sector would seem to provide an opportunity for the program to be more open to looking into new manners of promoting technology development.

One of the lessons derived from studies of other IAs is that they tend to work better when they are not scaled up, but remain relatively small and flexible (Beznitz and Ornston 2012). It seems logical to conclude that this kind of layering may represent the overloading of the agency. Moreover, this layering should not be understood as agency experimentation in the most fundamental sense: the agency does not markedly change the manner in which the IA operates or the manner in which it intervenes in the private sector, restructuring only the frameworks through which financial transfers are provided. Moreover, the additional programs tend to come from outside the IRAP and are not internally generated by agency itself in response to needs or opportunities perceived by the agents. In short, this trend – whether a consequence of design or simply of convenience – presents the possibility of detracting from the efficacy of the program.

A second, and related, potentially troublesome issue for IRAP is the apparently recent trend of layering pilot or short term programs over the existing strengths of the ITAs. This is apparent in the figure that shows the budgeted transfers for IRAP (Public Accounts). In recent years, numerous programs with targets more specific than IRAP's broad focus on small firm growth and technology development have been given to the IRAP to administer. ITAs become responsible not only for their permanent instruments (assistance, contributions to organizations, contributions to firms) but for the other temporary instruments as well. This layering may take advantage of the ITAs' capacity to embed themselves within and build networks of research institutions and private firms, as well as their proven capacity to deliver funds effectively. It may also be understood as consistent with the shifting focus from SME technology development and commercialization to business growth, as they aim for factors such as increased use of informational technologies and support of business accelerators that facilitate business growth but not necessarily technology per se.

However convenient this layering may be for other entities seeking the effective administration of their initiatives, it is not immediately clear that it improves IRAP's effectiveness. First, some ITAs have noted the higher reporting requirements that they have been encumbered with in recent years, as well as noting that it has hindered the manner in which they have traditionally operated. There is little increase (at least until 2015) in the operating costs for IRAP, suggesting that greater amounts and more types of funding are distributed through roughly the same number of ITAs.

In sum, the IRAP has proven to be an effective provider of informational assistance, networking, and financial resources, that have raised the R&D capacity and technological competitiveness of Canadian SMEs. It has proven able to remain relevant in the face of technological and economic change. The nature of IRAP and its horizontally organized ITAs has ensured that this progress has been incremental and ongoing, rather than more radical and fast-moving. That said, IRAP's success in these terms seem to have come with several less positive characteristics and trends: 1) In their success, ITAs have become de facto administrators of a growing number of different sources of funding with their accompanying reporting requirements, 2) the tried-and-true

methods prevent real experimentation with alternate instruments, which might also prove effective means of pursuing the agencies core mission.

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