Final Report
Evaluation of Commercialization of Research

Idea to Innovation Grants

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NSERC CRSNG

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List of Acronyms

CCI	College and Community Innovation program
CU-I2I	College-University Idea to Innovation
FRR	Final research reports
HQP	Highly qualified personnel
I2I	Idea to Innovation
ILO	Industry Liaison Officer
IP	Intellectual property
NAMIS	NSERC's Award Management Information System
NSERC	Natural Sciences and Engineering Research Council of Canada
OECD	Organisation for Economic Co-operation and Development
POP	Proof of Principle programs
R&D	Research and development
SSHRC	Social Sciences and Humanities Research Council

Acknowledgements

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Executive Summary

This report presents the evaluation of NSERC's Commercialization of Research program, which comprises Idea to Innovation (I2I) grants and the Centres of Excellence for Commercialization of Research (presented under separate cover). The evaluation explores a range of activities that are meant to support and accelerate the development of promising technologies and facilitate their transition toward successful commercialization. It covers the I2I grants' first 13 years of operation, from 2003–04 to 2015–16, with a particular focus on the last five years. It is based on a secondary data analysis, two online surveys (one with funded and unfunded researchers and one survey with ILOs), and key informant interviews.

I2I's Contribution to Commercialization

Commercialization is a multidimensional concept that typically unfolds over a period that, in the case of innovations targeted by I2I, may extend over several years. During its first 13 years of operation, I2I provided support to close to 700 projects. The predominant type of funding granted by I2I has been used to support the reduction-to-practice phase, during which researchers work on the development of a prototype. While funding for market assessments was added to I2I in 2010, it represents an option that has been increasingly sought after by ILOs and researchers in recent years.

I2I is expected to provide assistance at targeted stages of the commercialization process (typically the early stages). Projects necessarily require other sources of funding as they move along the commercialization continuum and the technologies reach a higher level of maturity toward commercialization. As such, this evaluation found that I2I funding represents approximately 25% of the total financial support provided. In addition to financial resources, potential or confirmed partners also provide in-kind support that includes market knowledge, access to facilities, tools, equipment, or complementary data.

Projects that receive I2I funding have normally completed a market assessment with funds from either I2I or other sources. In most cases, these assessments are done formally, while other assessments are conducted more informally by ILOs. Findings from these assessments generally lead researchers to either move forward with their innovation or make modifications. Some assessments have convinced researchers to abandon their projects altogether due to the lack of an identifiable market.

Securing appropriate IP protection is an essential component of a successful commercialization project. I2I has been used to promptly secure the appropriate IP protection, which facilitates the process of attracting potential partners.

Once a partner is engaged in the commercialization process, the research results are transferred through various means, including licensing arrangements, patents, publications, reports provided to the partner, or informal discussions. This new knowledge allows partners to not only launch new or improved products, processes, or services, but also acts as a stimulus for new R&D activities or enhances the skill set of the partner. The majority of projects that reach the point of a formal transfer (through licensing or the selling of IP rights) will either enter the market or are

expected to enter the market. I2I contributes to this transfer by providing support at key stages, engaging partners in a more formal setting, and by strengthening the case for investment. I2I is also reported to have a positive impact on broader factors, such as cultures of innovation and technology transfer policies at research institutions, the level of investment made by these institutions, and how researchers collaborate with their ILOs.

This evaluation found that projects that do not secure I2I funding are less likely to proceed to commercialization and those that do tend to be commercialized over a longer period.

Relevance of I2I

In the context of the current political climate, where supporting innovation has been recognized as a government-wide priority, I2I occupies a unique niche as one of the few academic-driven programs that bridges academia and the private sector and supports individual projects. In this environment, the transition process is initially driven by academic leadership (with I2I funding), and proceeds to the point where industry can take over the commercialization of the invention. The fact that no matching funds are required as part of Phase I funding is seen as a key asset, which further distinguishes I2I from other funding sources. It allows researchers to strengthen their ability to attract potential partners and to secure funding from their own research institutions.

Program Delivery

I2I has an efficient delivery structure. Regular intake opportunities, the support provided by program representatives, the prompt decision-making process, and the information required during both the application and the reporting process are all seen as factors that contribute to effective program delivery. In terms of potential areas for improvement, suggestions were provided for the feedback mechanism that is currently used and the requirements and eligibility criteria related to market assessment and Phase I funding. Finally, the ratio of administrative costs to grants provided was found to be fairly in line with that of similar programs.

Recommendations

1. ***The federal government should continue to support the commercialization of Canadian innovations through the three types of funding currently offered by I2I.*** While each type of funding serves its own purpose, and while Phase I funding remains the most relevant form of funding, there is also a strong rationale for supporting market assessments and Phase II funding when applicable.
2. ***Idea to Innovation program management should employ a more systematic approach to document the long-term outcomes of the I2I projects it supports.*** Program management already collects, using a semi-structured process, valuable information on project outcomes, particularly as these outcomes unfold during the post-funding period. Having a more systematic approach for these monitoring activities would provide additional evidence on the rationale for the types of funding provided and on the impacts of the program.

1 Introduction

This report presents the evaluation of NSERC's Commercialization of Research program, which comprises Idea to Innovation (I2I) grants and the Centres of Excellence for Commercialization of Research (presented under separate cover). The evaluation explores a range of activities that are meant to support and accelerate the development of promising technologies and facilitate their transition toward successful commercialization. Since this is the first formal evaluation of the I2I component of Commercialization of Research, the evaluation covers I2I's first 13 years of operation, from 2003–04 to 2015–16, with a particular focus on the last five years. The data collection and reporting activities occurred between April and December 2017.

The purpose of the evaluation is to provide the senior management of the Natural Sciences and Engineering Research Council of Canada (NSERC) with information to support decision-making about I2I. The evaluation will also help ensure that NSERC is meeting the requirements of section 42.1 (1) of the *Financial Administration Act* and the Treasury Board Secretariat's *Policy on Results*.

1.1 Idea to Innovation (I2I) Grants

The fundamental purpose of I2I is to provide financial assistance to researchers from the university and college sector to support the pre-competitive development of technology and to promote its transfer to industry (NSERC, 2017b). The key stakeholders in this process are researchers, industry liaison offices (ILOs) or their equivalent (who provide institutional support for the college or university), and commercial partners, which can be a new (spin-off) or established company, whose role is, ultimately, to secure a market position for the innovative product, process, or service that has emerged from the research.

Types of Funding Offered by I2I

I2I support may be sought at various points during the commercialization process (see subsection 2.1 for a description of this process) to support the achievement of a specific milestone or a combination of milestones. Just as the commercialization process may take various forms, so does the support provided by I2I. As such, the types of funding offered by I2I should not be conceptualized as a linear progression that each innovation will systematically engage in. Rather, the program offers three types of funding and the extent to which each type is relevant to a specific innovation that is transitioning to the market will be shaped by the unique circumstances of the commercialization project, including the type of innovation being pursued.

Table 1: Summary Description of Types of I2I Funding

Name	Summary Description*	Funding
Market Assessment	Following program on-going monitoring, Market Assessment was Introduced in 2010 in order to improve I2I's delivery. This funding supports the preparation of a market study that is expected to provide a meaningful understanding of the potential market for the innovation. The study must describe, among other things: • the problem or opportunity addressed • the proposed solution and who will pay for the solution • the potential market uptake • expected barriers to entry and how they may be addressed • existing alternatives	• Can be submitted on its own, or at the same time as a Phase I application • I2I may support up to 75% of the costs, up to a maximum of $15,000 • Funding is available for one year
Phase I and Ib	**Reduction-to-Practice Stage** The purpose of Phase I funding is to advance promising technologies in order to attract early-stage investment or to build valuable IP in anticipation of transferring the technology to a new or established company. In order to secure Phase I funding, a project should address the following requirements: • The technology must be sufficiently mature (concept explored and sufficient testing done). • There must be a clearly identified and well-described potential market. Applications can include letters of support from potential receptors or end users. • The application should address the set of questions asked in the market assessment portion of the application. • Involvement of experienced business mentors is recommended when the team is planning to spin off a new company. A company may be involved in a Phase I project, but if it is the intended receptor of the technology, the cost of the project should be shared with this partner and the application submitted as a Phase IIb proposal.	Phase I: • Max. of $125,000, for up to 12 months • Non-renewable • May cover 100% of the direct costs of research activities • 10% of the total requested amount co-supports tech transfer activities Phase Ib supplement: • Max. of $60,000, for up to six months • May be granted to help completed Phase I projects secure a partner
Phase IIa and Phase IIb	**Technology Enhancement** Phase II funding aims to determine the technical feasibility of transferring the innovation to the market and define the actual market for the innovation. Depending on the type of partners involved, two types of funding are available: *Phase IIa: Early-stage investment partner* The goal of Phase IIa funding is to support the development of the technology, with the goal of achieving a set milestone that would justify the engagement of a new (start-up) or an established company to further develop the technology. The early-stage investment partner must provide both input into the transfer plan and make a direct financial contribution to the project. When initiating a Phase IIa project, the end product must be easily identifiable, and potential buyers must be identified.	Phase IIa: • Max. of $125,000 per year, for up to 18 months • Covers 66% of the costs, with the early-stage investment partner covering 33% • 10% of the total requested amount co-supports tech transfer activities Phase IIb: • Max of $350,000 over a two-year period

Name	Summary Description*	Funding
	Phase IIb: Partnership with a Canadian company Phase IIb funding allows a new or an established company to further develop the technology. At that point, the prototype must be in existence and the company (new or established) must demonstrate its capacity to manufacture, distribute, or license the technology, as applicable. The company must also be prepared to undertake all required activities to ensure a successful transition to the market.	• Covers 50% of the costs, with the company providing the other 50% through a combination of cash and in-kind (the cash component should equal at least 40% of the amount requested from I2I) • 10% of the total requested amount co-supports tech transfer activities
* A detailed description of each phase of I2I funding is available at http://www.nserc-crsng.gc.ca/Professors-Professeurs/RPP-PP/I2I-INNOV_eng.asp		

Each funded project is expected to include "go/no-go" decision points. A market assessment may conclude that the project should not proceed, or at least not in its present form. Activities relating to the design of an actual prototype (reduction-to-practice) may also reveal limitations that prevent a technology from moving further down the path of commercialization, and the same may occur if commercial scale-up activities fall short of partners' expectations. By its very nature, the commercialization process involves plenty of exploration, testing, and risk management, and does not systematically lead to a successful transition to the market. I2I funding is expected to support a sound and evidence-based process that will allow key stakeholders to make informed decisions on whether an emerging technology should be further advanced toward commercialization.

Eligibility Criteria and Selection Process

University and college[1] researchers who meet NSERC's eligibility criteria can apply for I2I funding (NSERC, 2014). While projects may involve other participants and collaborators that come from academia, government, or the private sectors, only the eligible applicant or co-applicants may apply for and manage funds from I2I.

NSERC provides four opportunities per year to apply for I2I funding (normally in January, April, July, and October). Researchers collaborate with their industry liaison offices (ILOs) to draft the substantive portion of the application, whereas research grant offices ensure that all generic requirements related to NSERC applications have been met, in addition to confirming that the associated research institution supports the application. At any point during the application process, researchers or ILOs may communicate with NSERC program representatives to ask for directions or seek clarification.

[1] To date, very few applications have been submitted by college researchers.

The selection process for I2I is demand-based, which means that all meritorious applications are funded (the I2I grant budget is not capped at a certain level in advance). The Program Selection Committee is responsible for making recommendations related to each funding application. This committee is composed of individuals with broad technical expertise as well as expertise in business, marketing, commercialization, project management, and technology transfer. To support its work, the Program Selection Committee uses the input of external reviewers (typically three reviewers per application), who are scientific or technical experts in the area of the proposal being examined.[2]

The Program Selection Committee aims to put forward a funding recommendation within an average of ten weeks following the application deadline.

During its first 13 years of operation (2003–04 to 2015–16), I2I received a total of 1,422 applications and funded 695 of them, providing a total of $78.5 million in financial support. These figures are further broken down in subsection 2.1 of this report.

1.2 Evaluation Questions

I2I evaluation focuses on six research questions that are presented in Table 2. As a primary goal is to better understand the impact that the program has had to-date, the evaluation begins by documenting and describing the activities undertaken to date and their associated results, as applicable. This analysis is largely based on the series of program outcomes described in the logic model found in Appendix A of this report. In light of these findings, the evaluation turns to the current relevance of the program, and the extent to which it is still fulfilling a meaningful role. The evaluation concludes with an analysis of program efficiency.

The evaluation matrix located in Appendix B identifies the indicators and data sources for each of the evaluation questions addressed by this evaluation.

Table 2: Evaluation Questions

Effectiveness: Achievement of expected outcomes
1. To what extent has I2I contributed to successfully taking innovations to market by a partner (new or established Canadian company)?
2. To what extent has I2I contributed to the transfer and uptake of supported innovations by partners (new or established Canadian companies)?
3. To what extent has I2I contributed to achieving the immediate outcomes associated with each of the I2I funding options?
Relevance: Continued need for the program, alignment with federal government priorities, roles and responsibilities for the federal government
4. What is I2I grants' niche or value add in addressing the need for bridging the gap between academic inventions and commercialization?

[2] External reviewers are used for all types of I2I funding, except for market assessment applications, where the Program Selection Committee proceeds without seeking additional input.

5. To what extent are the objectives of I2I grants aligned with NSERC and government priorities?
Efficiency: Resource utilization in relation to the production of outputs/outcomes and progress toward expected outcomes
6. To what extent are I2I grants being delivered in an effective and cost-efficient manner?

1.3 Overview of the Methodology

The methodology used to evaluate I2I includes a secondary data analysis, two online surveys (one with funded and unfunded researchers and one survey with ILOs), and key informant interviews. These different means for collecting data were purposefully implemented incrementally, allowing for the findings from the secondary data analysis to be considered in the design, execution, and analysis of the two surveys, the results of which, in turn, were considered in the design, execution, and analysis of the interviews. In total, 212 researchers and 67 ILOs participated in the online surveys and 25 individuals were consulted through the interviews (eight funded researchers, ten ILOs, and seven partners).

Appendix C provides further details on each line of evidence used for this evaluation.

1.4 Limitations

Several methodological limitations related to the evaluation of I2I had to be addressed:

- *Range of methods used*: The lines of evidence selected for the evaluation of I2I reflect the scope and nature of the program. Since I2I is a fairly well-contained program with relatively limited resources allocated to it (particularly when compared to other NSERC grant programs), the evaluation opted for a focused methodology based on a document and data review, two online surveys, and selected key informant interviews.
- *Survey respondents*: One challenge that needed to be addressed was the possibility of response bias, which occurs when the population of survey respondents is fundamentally different from the underlying population. This was a particular concern for the survey of researchers, as one may expect researchers that received I2I funding to be more likely to respond than researchers who applied for I2I funding but were unsuccessful. Weighting was used to mitigate the impact of response bias. This method compared the characteristics of respondents to those of the underlying population and weighted the survey responses to account for any differences between respondents and the population.
- *Secondary data analysis:* Only a limited number of Phase II grants have been provided since the inception of the program and not all researchers submitted a final report (75.4%). As a result, while some statistics are presented with the phase variable as the independent (categorical) variable, no inferential statistics were performed in the analysis of FRR data since the sample for the Phase II category (Phase IIa and IIb) was too small.
- *Funded and unfunded projects:* The evaluation includes several findings related to unfunded projects, which are grouped in one subsection. It provides some insights on the experience of unfunded researchers and on the outcomes of these projects. However, the

range of evaluation data and findings collected did not allow for a direct comparison of funded and unfunded projects due to sample size.

These limitations did not prevent the evaluation from adequately covering all evaluation issues and questions.

2 Evaluation Findings

This section of the report describes the evaluation findings. The information is based on the findings that emerged from all lines of evidence. Unless otherwise noted, when opinions are reported, they are the opinions of the stakeholders consulted and not those of the evaluators.

2.1 Effectiveness of I2I Grants

Summary of findings: Commercialization is a multidimensional concept that typically unfolds over a period that may extend over several years. During its first 13 years of operation, I2I supported close to 700 projects. While I2I funding represents a small portion of the total funding required to achieve a successful transition to the market, it provides both targeted support and a broader framework that allow commercialization projects to reach key milestones and help stakeholders make informed decision as to how to pursue actively a commercialization project. The impact of I2I extends beyond the project itself and is reported to have positive impacts on the culture of innovation at research institutions and on the willingness of private partners to engage in a commercialization project.

Commercialization as a Multidimensional Concept

As this section of the report explores the extent to which I2I has successfully supported the transfer of innovative technologies to the market, it would be helpful to further define some of the concepts at play.

The Organisation for Economic Co-operation and Development (OECD) defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" (OEDC, 2005, p. 46). This definition emphasizes the idea of having something *new* to offer that results from research activities undertaken (formally or informally) in various settings, including by businesses, government entities, and research institutions.

Innovation is, by its very nature, a dynamic process, illustrated by the commercialization phase in which it is necessarily engaged. At a fundamental level, commercialization refers to the actual process or steps that allow an innovation to emerge. As noted by Statistics Canada, commercialization refers to "the set of conditions that should be met and the set of activities to perform for a firm to generate revenues from an innovation introduced in the market" (Statistics Canada, 2009).

There are several paths that an emerging innovation may take as part of the commercialization process. Typically, however, innovations that receive I2I support are expected to achieve the key milestones illustrated in **Error! Reference source not found.**, which also includes an overview of how I2I funding aligns with these milestones.

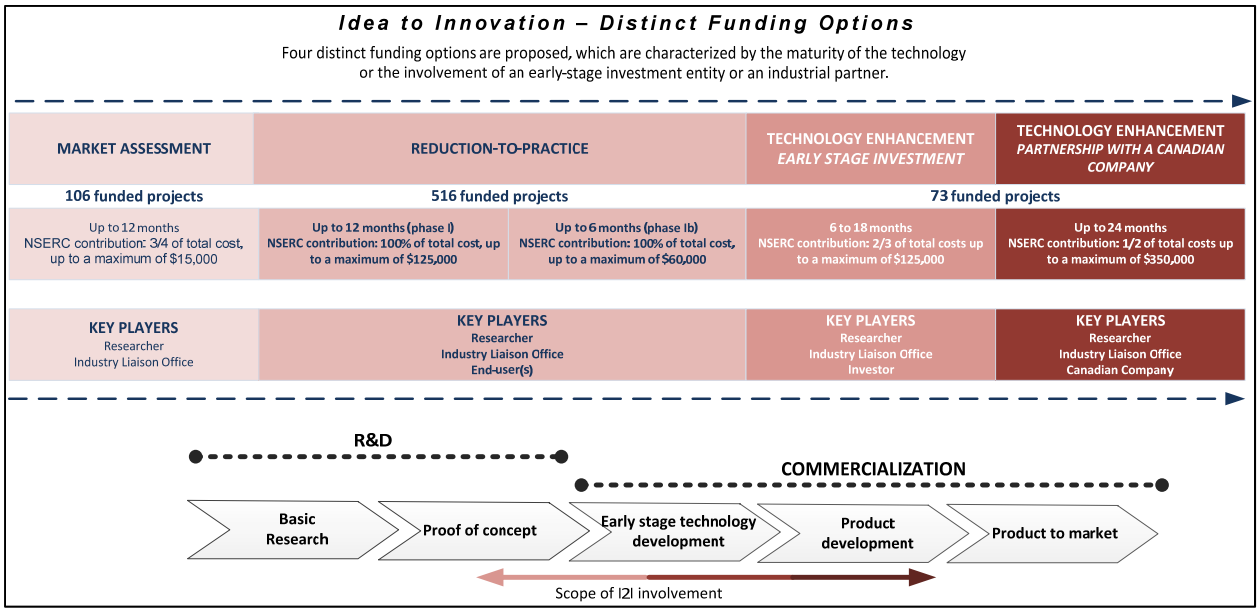


Figure 1: Key Commercialization Milestones

As research and development (R&D) activities progress and reach a certain threshold of maturity (proof of concept), researchers work with their industry liaison officer to complete the applicable disclosure process and explore appropriate intellectual property (IP) protection. An initial assessment of the market is also typically undertaken. If the assessment confirms a potential market, activities then shift to the "reduction-to-practice" phase, when researchers and partners typically collaborate to develop a physical prototype. If expectations and requirements are met, partners normally lead commercial scale-up activities to create a product, service, or process that can successfully be marketed. A full market deployment concludes the commercialization process and any ensuing profits are distributed according to the agreement signed between the project stakeholders. On this last point, it is helpful to emphasize that a successful transition to the market is seen as a defining characteristic of an innovation:

> A common feature of an innovation is that it must have been *implemented*. A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organizational methods are implemented when they are brought into actual use in the firm's operations (OEDC, 2005, p. 47).

The I2I evaluation provided additional opportunities to illustrate the various dimensions of the transfer process. As further described in subsection 2.1, commercialization involves more than a formal licensing agreement, the acquisition of IP rights, or the emergence of a new product or service. Innovations allow for the sharing and growth of expertise among all those involved; it

can stimulate future R&D activities or provide training opportunities for new, highly qualified personnel (HQP), to name but a few examples.

In sum, innovation and the commercialization of innovation are multidimensional and fluid concepts that are context-driven and can lead to a variety of outcomes. It is through this lens that the remainder of the findings presented in this report must be considered.

Financial and Non-Financial Support for Commercialization

This subsection describes the financial and non-financial support that commercialization projects typically receive and explores the relative contribution of I2I to support this process.

Funding Support Provided by I2I

During its first 13 years of operation (2003–04 to 2015–16), I2I provided funding support to close to 700 projects. In terms of success rate, approximately half of the applications received during this period were granted some funding (see Table 3).

Table 3: Success Rate and Distribution of Funded Projects, by Funding Type (2003–04 to 2015–16)

Funding Type	Total # of Applications	Total # of Funded Projects	Success Rate
Market Assessment*	160	106	66%
Phase I and Ib	1,135	516	45%
Phase II (a+b)	127	73	57%
Total	1,422	695	49%

* I2I initiated the funding of market assessments in 2010–11.
Source: NSERC administrative data

Phase I funding has been, by far, the predominant means by which I2I has supported the transfer of innovations to market. Three quarters of the projects funded during the period received this type of funding. As noted in subsection 1.1, Phase I funding is used for prototype development and for when researchers are attempting to secure the participation of a partner to move the commercialization process forward. As such, the program focuses on the transition between researcher-led and company-led commercialization activities.

Not surprisingly, the bulk of the funding provided through I2I went to Phase I projects. As indicated in Figure 2, between $4.1 million and $7.6 million were provided annually for Phase I projects. The average amount awarded per Phase I project (for the entire period covered) was $118,462 and $58,440 for Phase Ib. The average amount awarded when combining Phase I and Phase Ib was $125,337. For market assessment, the average was $12,853 and for Phase II projects, it was $170,368.

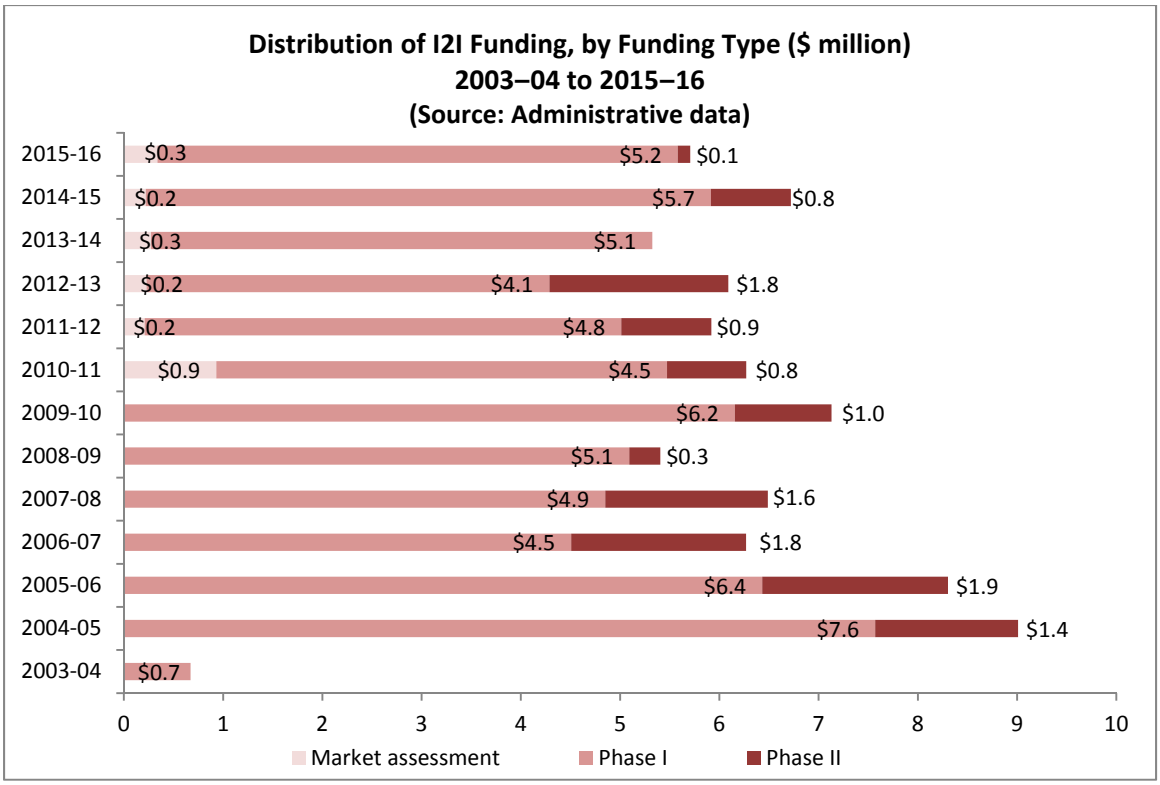


Figure 2

While the number of projects funded to support market assessments was more limited, it is important to recall that this type of funding only became available as of 2010.

There are other trends in I2I funding that are worth noting (all based on administrative data):

- In terms of regional distribution, while funding recipients are found in all provinces, Ontario, Quebec, and British Columbia account for 86% of all projects funded.
- Large universities are the predominant recipients of I2I funding. During the first 13 years of the program, they accounted for 75% of all applications received by I2I and for 78% of all projects for which funding was granted. Large universities also tend to be more successful with their applications. Whereas small and medium-sized universities show an overall success rate of 42% during the first 13 years of I2I funding, large universities achieved a success rate of 51%.

Trends in the number of applications received by I2I provide further insights on the interest shown toward the types of commercialization support that the program offers.

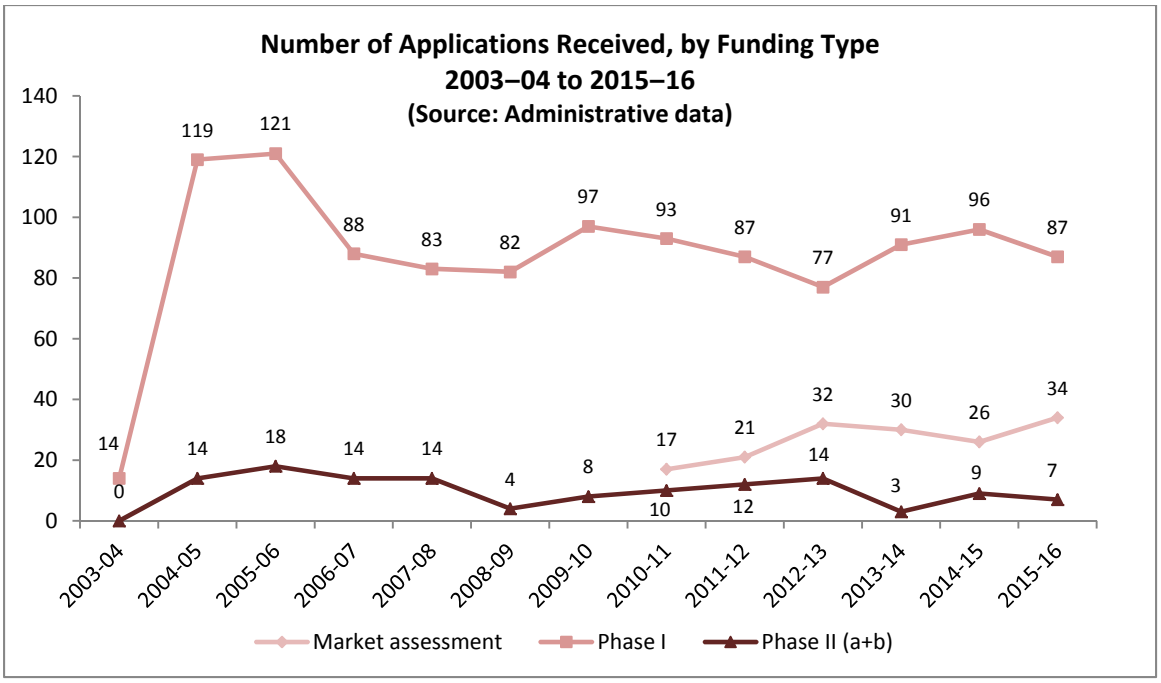


Figure 3

As indicated in Figure 3, the number of applications for Phase I and Phase II funding has fluctuated but remained relatively stable over the 2006 to 2016 period, whereas the number of applications for market assessments has steadily increased (over the applicable six-year period).

Turning to the applicants themselves, the survey data indicate that they tend to be more experienced researchers. As noted in Figure 4, more than half of the survey respondents who apply to I2I have conducted research for more than 20 years in a post-secondary setting. There are, nonetheless, a number of survey respondents who applied to I2I who joined the ranks of post-secondary researchers more recently (four to ten years of experience). It is worth mentioning that, regardless of their level of experience, close to 60% of survey respondents indicated that their application represented their first attempt to secure I2I funding.

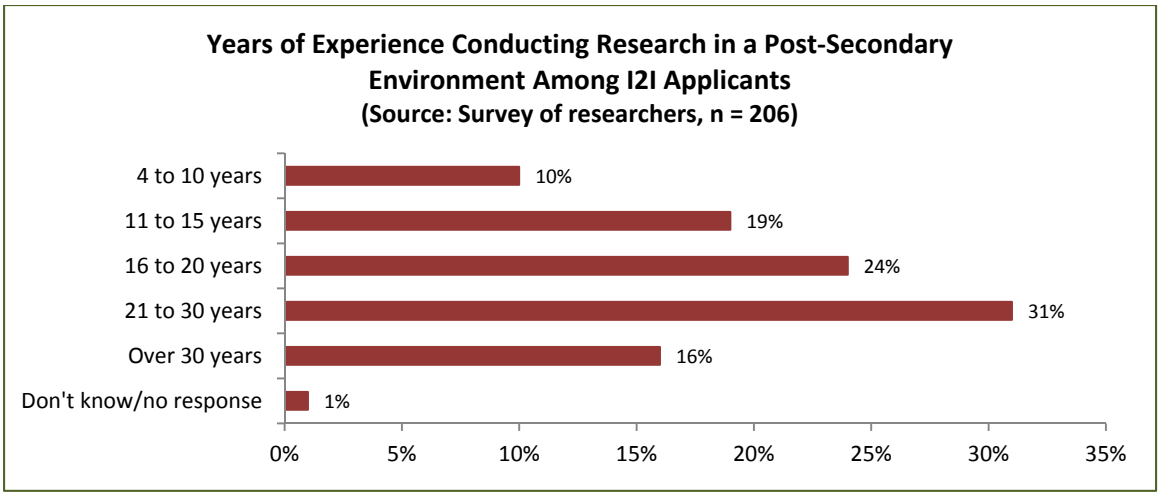


Figure 4

The survey of I2I applicants also provided information on the type of research activities they were conducting at the time of their respective funding applications and the type of industries that were targeted. Among the most common sectors that survey respondents identified were manufacturing processes and products, biomedical engineering, instrumentation technology, medical equipment and instruments, agriculture and primary food production, and information, computer, and communication technologies.

Other Sources of Funding

For an innovation to successfully transition to the market, stakeholders are expected to leverage a number of funding sources that include but are hardly ever limited to I2I grants. This evaluation provided an opportunity to better understand how this complementary funding supports commercialization.

Whenever researchers receive funding from I2I to achieve specific milestones (based on the type of I2I funding received), they may need to seek complementary funding from other sources to undertake these tasks. For instance, if researchers engage in the "reduction-to-practice" stage of commercialization, they may well receive Phase I funding from I2I but may also receive additional funding from other sources to support this specific phase.

In total, 58% of funded researchers surveyed as part of this evaluation indicated that they did receive complementary funding to undertake the activities for which I2I had provided funding. As illustrated in Figure 5, private sector funding, as well as other federal and provincial programs, were the primary sources of complementary funding that researchers were able to secure. In the case of private sector funding, actual or potential project partners typically contributed both cash and in-kind support. In the specific case of other *federal* sources of funding support, researchers primarily turned to other NSERC programs, Mitacs, or the Canadian Foundation for Innovation. For other *provincial* sources of funding, the Ontario Centres of Excellence, Springboard Atlantic, or the programs of *Économie, Science et Innovation* in Quebec were among the examples provided by researchers who were surveyed or interviewed.

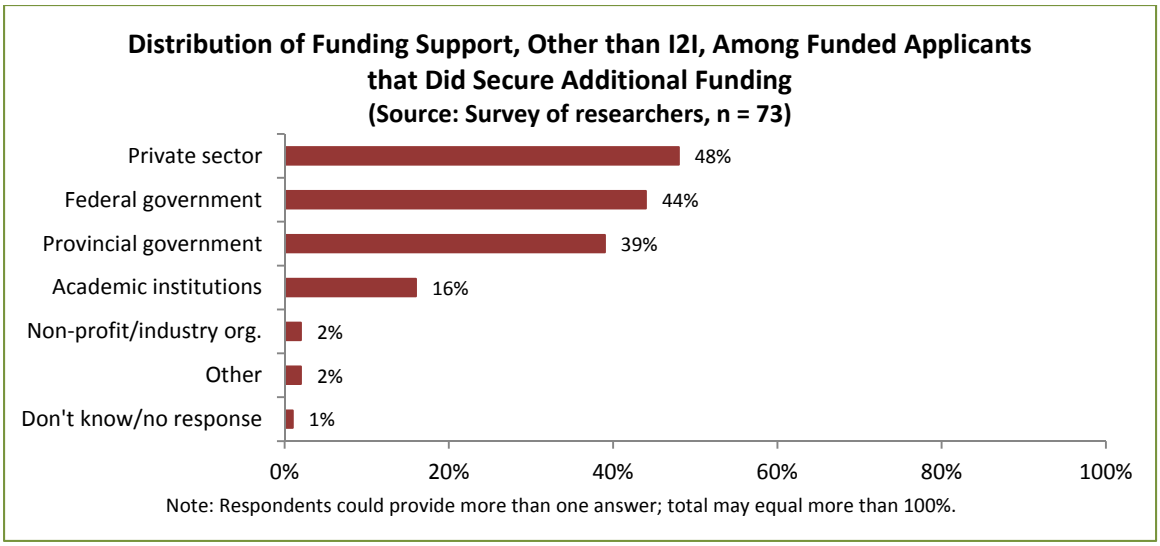


Figure 5

On a broader level, any successful commercialization endeavour requires capital investment that usually extends well beyond any I2I funding. Greater investments are needed to support emerging innovations, particularly as prototypes reach greater levels of maturity, scale-up activities are initiated, and market deployment is under way. The survey of ILOs provided insights into the source and size of investments sought by innovations that also received I2I funding. Funding agencies, commercialization entities, regional development agencies, established companies, and seed funding were the predominant sources mentioned by ILOs. As for the size of the investment, it varied substantially depending on the nature of the innovation. While some projects required less than $10,000 in investment, others garnered close to $25 million. Generally speaking, the majority (52%) of researchers surveyed who succeeded in bringing their innovation to market indicated that I2I funding represented 25% or less of the total money invested.

Non-Funding Support

Just as financial support is a prerequisite for any successful innovation project, so too is non-financial support. As noted earlier in this subsection, confirmed or potential partners who were involved in projects supported through I2I did not limit their participation to financial contributions. They also offered substantial in-kind support, such as market knowledge that affects the commercialization process, including an understanding of potential market value and of the broader competitive market environment, or access to pre-existing relationships. As one partner put it, “our input is helping on the research side to make sure that the technology is developed in such a way that it’s relevant to and viable for customers.” Reports submitted to NSERC by researchers at the end of their projects confirmed that potential or confirmed partners were typically consulted throughout the project life cycle. In some cases, partners provided direct training to the research team, whereas other projects saw partners receiving training from the research team. In-kind contributions also included access to required facilities, tools, instruments, samples, or data that would otherwise not have been available to researchers.

Commercialization Outcomes

This subsection specifically addresses the extent to which a transfer of knowledge is realized and how it is achieved.

Transfer and Uptake of Innovations

This evaluation shed light on how projects supported by I2I evolve through the various key commercialization milestones. It focuses on four critical points of the commercialization process: market definition, the range of IP protection, the transfer process, and the receptors of these transfers.

Market Definition

Defining the potential market for an emerging innovation may be accomplished through formal and informal means and is a fundamental cornerstone of the commercialization process. As noted earlier, without a successful transition to market, an innovation remains essentially unrealized, which highlights the importance of understanding market needs and the relative positioning of the innovative technology within the potential market.

The findings of this evaluation confirm that most commercialization strategies involve a formal assessment of the potential market. As previously noted in Table 3, I2I has financially supported 106 market assessment studies since 2010. In addition, two thirds of the ILOs surveyed indicated that they conducted market research studies that were not supported by I2I. In other cases, however, the assessment was made more informally by the ILOs themselves based on their experience and market knowledge. As one ILO noted during an interview: “Usually, we do the market assessment internally. We try to find market information wherever we can, and nobody pays for that. We are more focused on developing the technology.”

The predominant view among researchers and ILOs is that market assessment studies play a valuable role in the commercialization process. In the vast majority of reported cases (according to both the surveys and interviews), market assessment studies confirmed that the project could proceed as is or with modifications. In some cases, the market assessment study concluded that there was no viable market for the proposed innovation, which typically ended the project. Researchers who received I2I market assessment funding indicated during interviews that it allowed them to proceed with a more thorough analysis of market needs than what would have been possible without I2I funding.

The main concern regarding market assessment that emerged from this evaluation was the potential delay caused by conducting such a study, particularly if I2I funding was requested. Finding the third party to conduct the assessment (which may be challenging in highly specialized sectors, as noted during interviews), securing the funding for the market assessment, and conducting the actual study can take several months.

IP Protection

It is widely recognized and understood among program participants that adequate IP protection is essential to the commercialization process, particularly for attracting potential partners. As noted

during interviews, partners not only expect adequate measures to be taken to protect IP (such as filing a patent), some will only engage in partnership discussions once the IP has actually been granted the appropriate protection.

Considering the wide range of innovative technologies that may be targeted for commercialization, there are a variety of protection strategies that may be considered. The data on Phase I and Phase II project funding leave no doubt, however, that filing a patent remains the predominant protection strategy used for projects receiving I2I funding. Administrative data indicate that 90% of researchers that receive Phase I or Phase II funding have filed for or secured patent protection for their emerging innovation. The data also indicate that 42% of these participants have executed a nondisclosure or confidentiality agreement. Only a small portion (less than 10%) of participants opted for other forms of IP protection, such as trademarks, copyrights, or industrial design registration.

I2I funding can be used to secure appropriate IP protection, and interviews confirmed that this is seen as a unique advantage of this program. Individuals interviewed noted that other funding programs for commercializing innovations do not systematically allow for covering such expenses.

Transfer Process

The transfer of the innovative knowledge and technology being commercialized from the researchers to the partners is expected to take place over a certain period of time and include both formal and informal dimensions. For instance, this evaluation has already noted that potential or confirmed partners typically provide in-kind support throughout the research phase. This type of relationship provides an opportunity to share the findings emerging from the research and, as such, constitutes a form of knowledge transfer. As illustrated in Figure 6, informal discussions occurring throughout the project life cycle remain the most predominant form of knowledge transfer. More structured activities, such as co-publications, reports provided by the research team to the partner, and patents and licensing agreements are all forms of knowledge transfer that I2I participants engage in.

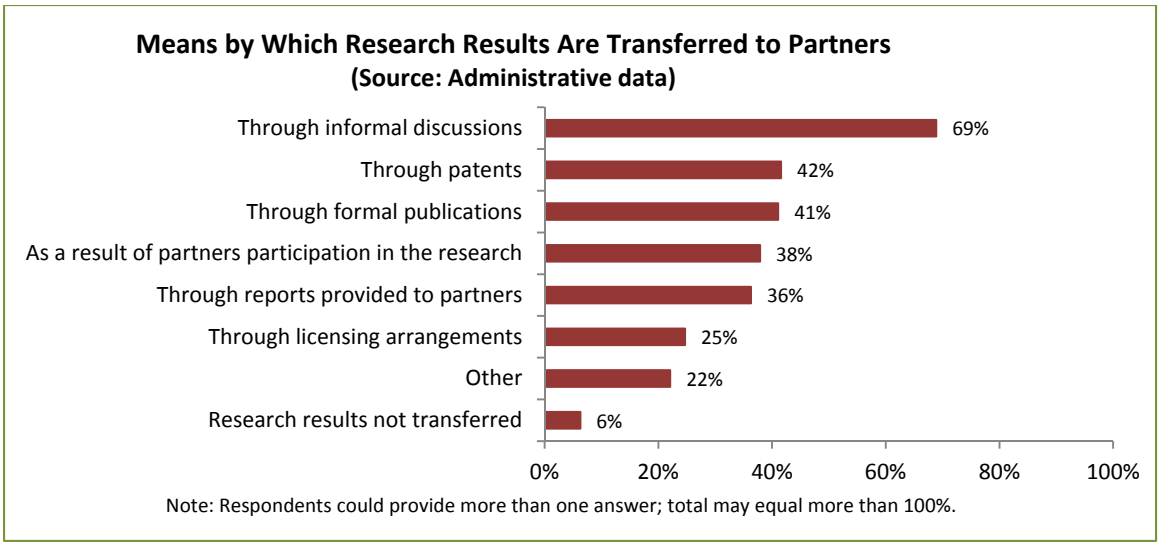


Figure 6

Once transferred, partners may use this new knowledge for a number of purposes. Not surprisingly, as illustrated in Figure 7, researchers indicated that their partners often turned this knowledge into new or improved products, processes, or services. It may also serve as a stimulus for new R&D activities or further enhance the skills and knowledge of the partners' personnel.

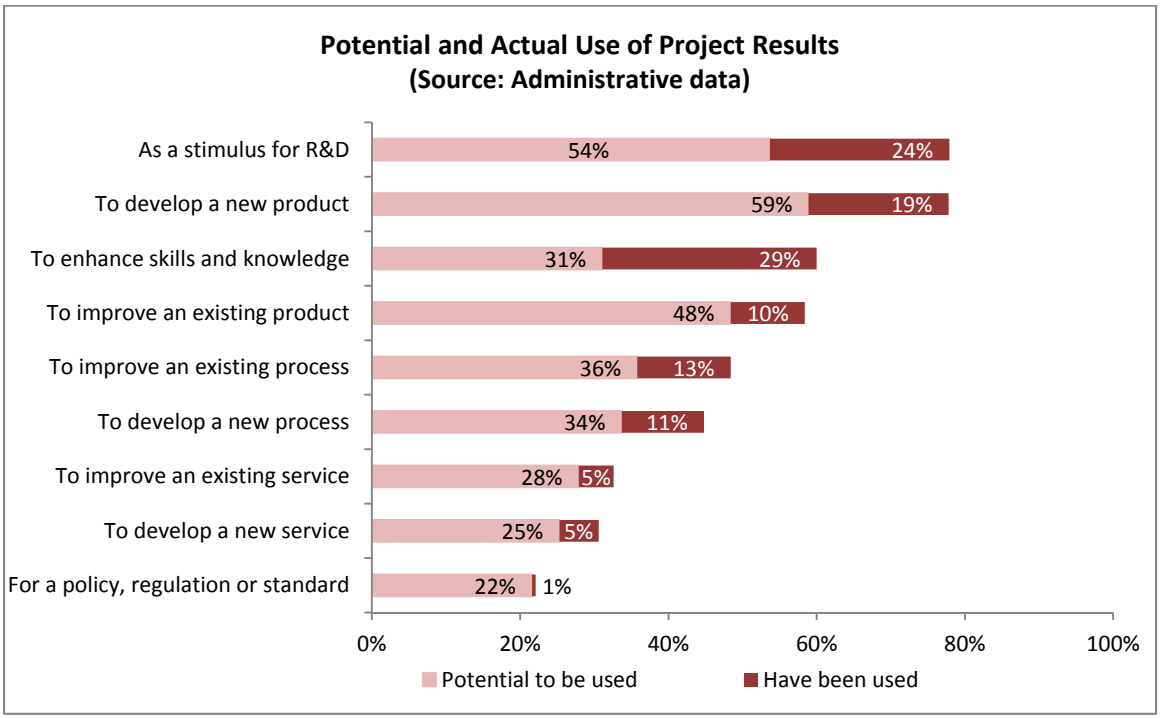


Figure 7

Since an actual market deployment is required for an innovation to be fully realized, the evaluation explored the extent to which projects funded by I2I have, in fact, reached that stage. Two things must first be emphasized when addressing this question. First, there is no expectation

that all I2I funded projects will end up on the market. By their very nature, innovation projects explore new concepts that will unfold in ways that may not have been predicted, involving a significant level of risk management. The goal of I2I is to support a sound decision-making process, including the decision to end projects when sufficient evidence demonstrates that they are not suitable for a transfer to the market. Second, measuring the extent to which an innovation has successfully entered the market requires the ability to follow and track the transferred technology well beyond the reporting period of I2I funding. Funded researchers submit their project reports three months after their funding ends and ILOs are surveyed on various dimensions of funded projects (including market entry) 18 months after the end of the funding period. In practical terms, a successful commercialization process may require more than 18 months. For instance, surveys conducted as part of this evaluation indicated that, of those I2I-funded projects that were successfully transitioned to the market, 52% were transitioned over a period of up to three years and an additional 22% were transitioned over a period of up to seven years. As a result, data gathered by NSERC can tell part of the commercialization story, but not all of it. Surveys conducted as part of this evaluation add some relevant insights, but again, cannot tell the whole story.

Keeping these considerations in mind, the evaluation findings indicate that, once technologies reached the point of being formally transferred to a partner, they had a fairly good chance of actually entering the market. At the time that they were surveyed, 54% of respondents who were funded by I2I indicated that their technology had been officially transferred to a partner (through licensing, selling of IP rights, etc.). Of that subgroup, and as indicated in Figure 8, 41% indicated that the transferred technology had, in fact, reached the market. An additional 38% indicated that the transferred technology had not yet entered the market but was expected to achieve this milestone.

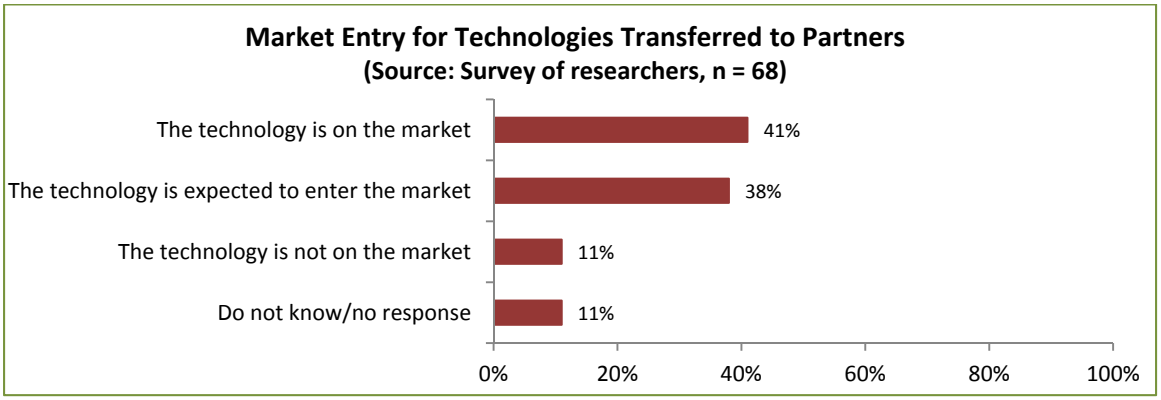


Figure 8

Internal monitoring data collected and used by I2I program management provides additional insights. Based on a sample of 445 funded projects that program representatives have been monitoring through semi-structured follow-up activities, the monitoring data indicate that, in 18% of cases, the technology has been licensed to an established company or spin-off company and has entered the market. More specifically, 16% of Phase I projects, 26% of Phase IIa projects, and 30% of Phase IIb projects succeeded in transitioning an innovation to the market.

An additional 40% of the projects being monitored involved technologies that, at the time of this report, were still under development.

Regardless of the milestones that commercialization projects achieve, this evaluation found that receiving an I2I grant offers a number of benefits that support the technology transfer process.

During their interviews, researchers noted that, by not requiring a cash investment from a partner during the reduction-to-practice phase, I2I allowed them to increase the maturity of their technology to a point where they could engage in a meaningful discussion with potential partners, which in turn ultimately may have improved the terms of an eventual licensing or purchasing agreement. Partners interviewed echoed that sentiment, noting that I2I funding provided support at key stages of the commercialization process and demonstrated a broad commitment toward the project, from both the university or college and the NSERC. Some partners noted that being supported by an I2I grant also strengthened the business case at the partner's organization for providing financial support.

When asked what would have happened without I2I funding, interviewees indicated that projects may have been able to proceed, but most probably at a slower pace. For instance, I2I funding has helped some researchers hire additional staff, such as project managers, who helped move the project forward more quickly, developed a prototype faster, and therefore attracted a partner sooner. Some of the individuals interviewed were also of the opinion that some projects would have not been able to proceed. They emphasized that there were few funding options available to support the early development of prototypes and that I2I helped fill that gap. Government programs and private investors supporting the commercialization of new technologies typically expect to see a fairly advanced prototype in order to minimize their risks, which is something I2I has helped to achieve. In other words, the evaluation findings indicate that without I2I funding (and depending on the nature of the project), a gap may remain between the initial concept and a sufficiently developed prototype that would impede the ability of researchers to engage other funding partners.

Receptors of the Transfer

When it comes to the receptors of the transferred technology, the evaluation findings indicate that they largely consist of either established Canadian companies or spin-off companies in which researchers may or may not be a primary investor. This is in line with the goal of I2I, which is to ensure that the emerging innovations it supports provide benefits to Canadians.

In some circumstances, I2I does allow for technologies to be transferred to a foreign company, as long as there is evidence that the Canadian economy will benefit from the projects being funded. Administrative and survey data confirm that, in a small number of cases, technologies have been transferred to a foreign entity.

According to the ILOs surveyed as part of this evaluation, receiving an I2I grant makes it more likely that the technology resulting from a project will be commercialized by an established Canadian company or a spin-off company in which the project's primary investigator is involved. More details are provided in Figure 9 below.

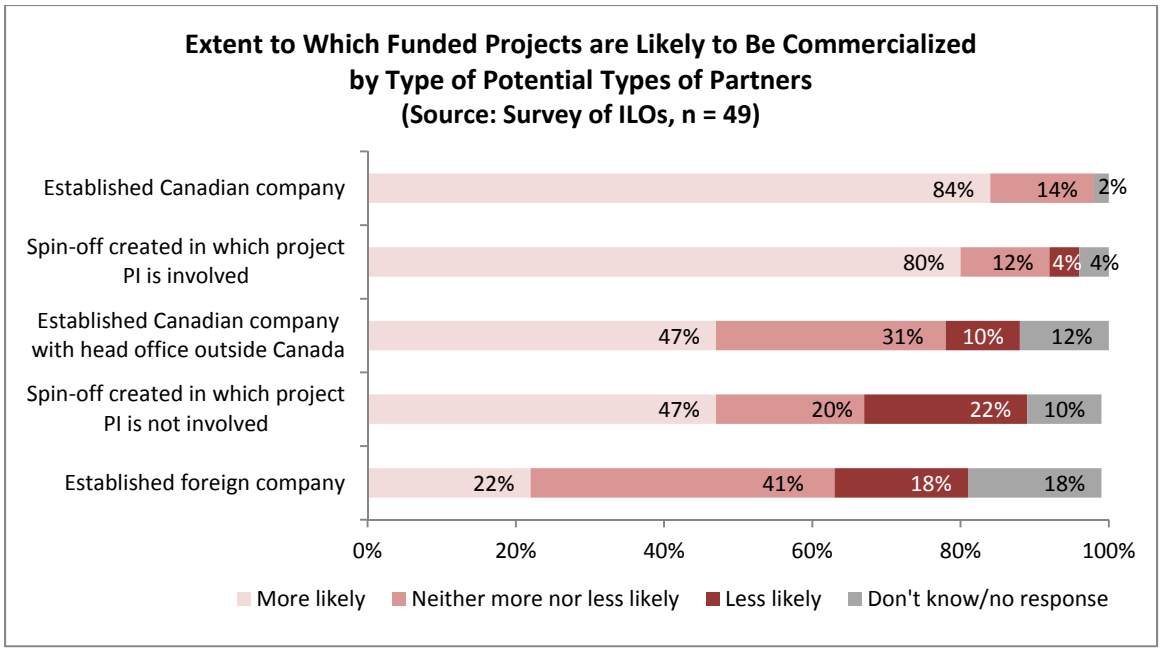


Figure 9

Other Drivers of Commercialization

Beyond the activities that are directly undertaken as part of I2I-funded projects, there are a number of additional factors and considerations that ultimately influence the commercialization process.

When surveyed on this question, researchers and ILOs provided slightly different views. As indicated in Figure 10, while both researchers and ILOs agreed as to the extent to which the availability of highly qualified personnel and high-quality research facilities at the research institution facilitated the commercialization process, they assigned different weights to the contribution made by a range of other factors, including the funding available from research institutions, the academic institution's IP policies, the expertise of the ILOs, and previous relationships with industrial partners. To be clear, both researchers and ILOs agreed that these various factors facilitated the commercialization process, but they did hold different views about the extent to which each of these factors had a positive impact.

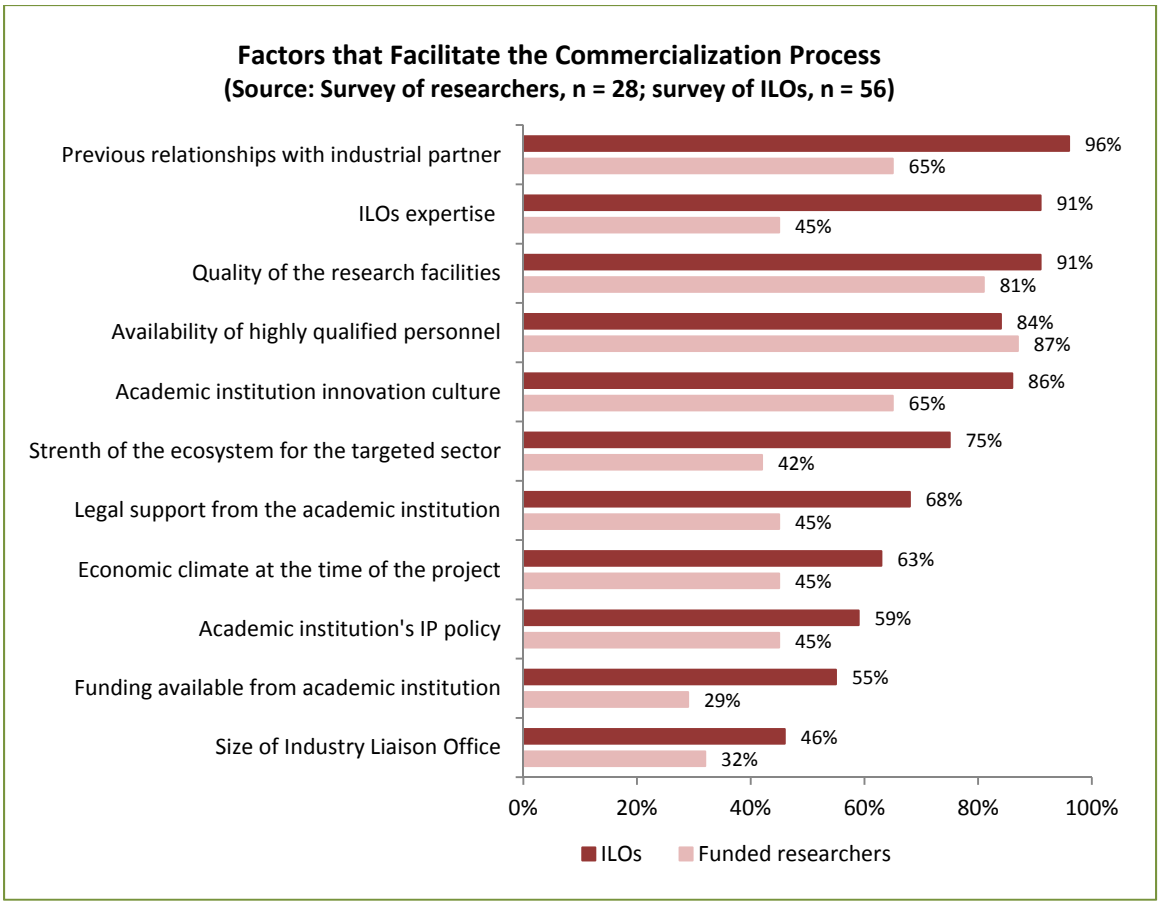


Figure 10

The ILOs surveyed noted that I2I had a positive impact on the overall approach of their institution in relation to commercialization. In particular, they noted that I2I had a positive impact on the overall strategy for technology transfer, investments made by their institutions supporting commercialization, how researchers partnered with their respective ILOs, and the overall culture of innovation within the institution.

Outcomes of Unfunded Projects

The evaluation provided insights, albeit limited, on projects that unsuccessfully sought I2I funding. These findings largely come from the surveys conducted with researchers and ILOs.

According to the ILOs, commercialization projects that did not receive I2I funding tended to be halted, with some exceptions. The prevailing view among ILOs was that about a quarter of unfunded projects would be taken further down the path of commercialization. In order to do so, ILOs would, depending on the circumstances, seek other government programs, submit another application to I2I, or try to use funds from private sources or from their research institution. According to the ILOs surveyed, unfunded projects were most often not likely to be commercialized. As illustrated in Figure 11, if an unfunded project were to be commercialized, it would most likely be done by an established Canadian company.

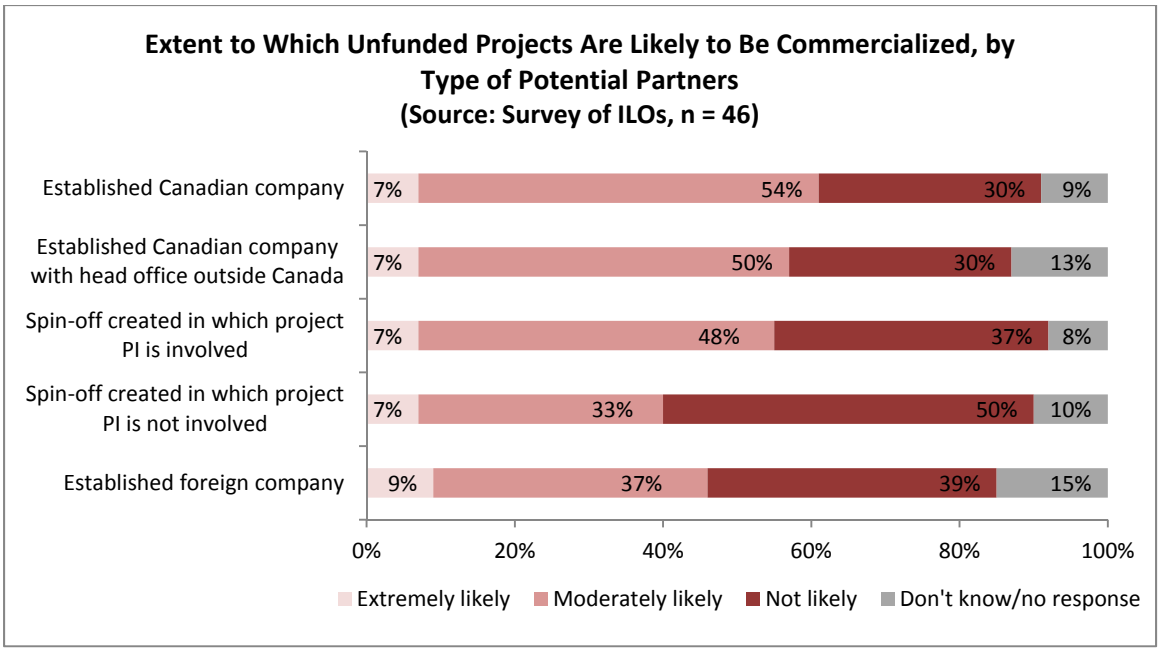


Figure 11

Unfunded researchers who were surveyed as part of this evaluation indicated that their technology had either been transferred to the market or is expected to be transferred in the future. The technologies these researchers were involved in were expected to be transferred through means that were largely the same as those identified by funded researchers. In terms of the type of partners that were expected to be engaged, however, half of the unfunded researchers surveyed indicated that a spin-off company was the likeliest option. Finally, unfunded researchers have sought funding from the same sources as those identified by funded researchers, including the private sector, governments (especially other NSERC funding programs) and academic institutions, in addition to their own personal savings.

2.2 The Relevance of I2I

Summary of findings: I2I occupies a unique niche when it comes to supporting commercialization projects. Its current eligibility criteria allow researchers to strengthen their case for securing both partners and funding from other sources. As such, I2I supports the government-wide priority of encouraging key stakeholders in the academic, industry, and government sectors to collaborate in supporting innovation.

Relevance From the Perspective of Researchers, ILOs, and Partners

These evaluation findings show strong support from ILOs, researchers, and partners for the type of assistance that I2I is providing. According to individuals interviewed as part of this evaluation, there are a number of funding options available to support initial research activities, but fewer options exist for undertaking the development phase leading up to commercialization. As illustrated in Figure 12, this is the primary reason that motivates researchers to apply for I2I funding.

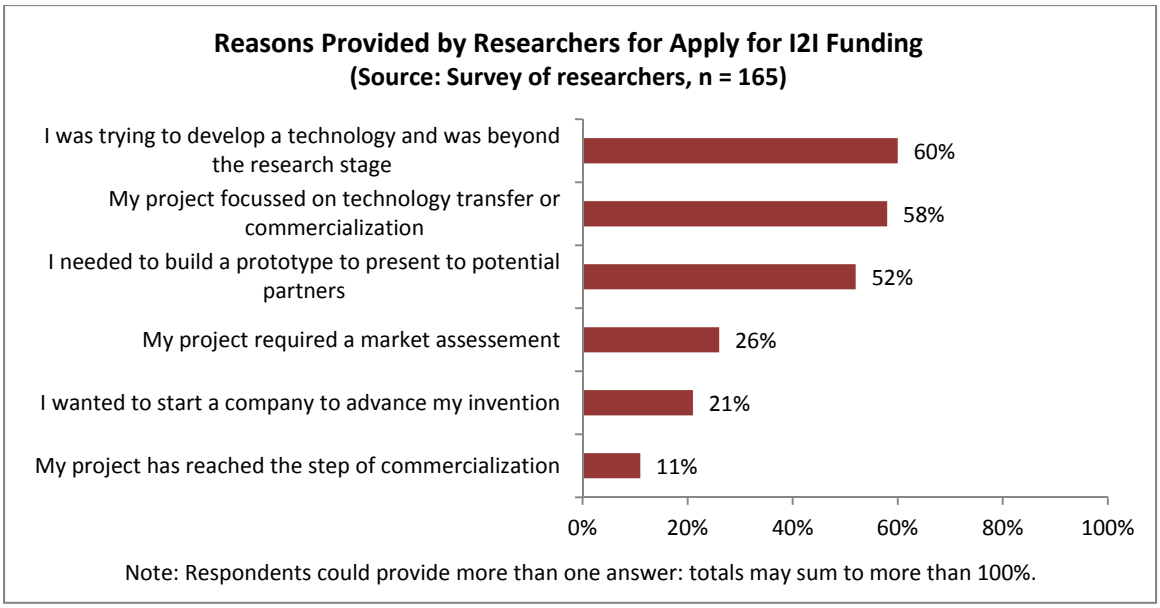


Figure 12

As already noted, Phase I funding does not require matching funding from a partner and this is seen as a significant characteristic that distinguishes the program from other programs supporting commercialization. As such, I2I supports innovations that are somewhat earlier in the commercialization chain and allows researchers to pivot as required to steer the technology toward the likeliest path to success. By building a stronger case, I2I also strengthens the position of researchers and ILOs during their negotiations with potential partners.

Market assessment funding is also perceived as being particularly relevant, as it focuses the work of researchers and provides validation by a third party. It also allows researchers to proceed with a more thorough analysis of market needs. It can ultimately save time and resources, especially in situations where the assessment determines that the project should not be pursued at all, or not in its present form.

These evaluation findings leave little doubt that, in the absence of I2I, there would be a gap in commercialization assistance that would be challenging to address through other programs. As already documented in this report, the commercialization process would likely take longer to complete and some valuable projects might not be able to proceed at all.

Relevance from the Perspective of NSERC and the Federal Government

While Canada is recognized for the strength of its academic research, it has yet to reach its full potential when it comes to translating research discoveries into innovation and commercialization projects.

Overall, Canada spends less on R&D than the average OECD country, and this disparity is steadily widening (NSERC, 2017a, p. 11)[3]. More of Canada's R&D funding comes from the higher education sector and less comes from the private sector, suggesting greater emphasis on research than on commercial development. In this environment, academic innovators face substantial challenges accessing funding and investment for the earlier, riskier stages of commercialization (i.e., the commercialization gap, sometimes dubbed the "valley of death"), as this type of support is not particularly appealing to traditional profit-driven investors. Promising academic inventions might therefore not reach maturity and provide the resulting social and economic benefits.

Canada has a range of initiatives in place to support innovation and commercialization, including technology transfer offices at most post-secondary institutions, as well as national, provincial, and independent programming. For instance, NSERC offers other programs, such as the Industry-driven Collaborative Research and Development program, "which represents NSERC's largest suite of initiatives supporting industry–academic partnerships. However, this program's main target is to foster partnerships in natural sciences and engineering that facilitate the transfer of knowledge and skills to the user sector through awards supporting research projects and network activities intended for socioeconomic impact. It is expected that the partnerships encouraged and enabled by these awards will also increase the commercialization of Canada's research through new products, services, and processes for the benefit of all Canadians."[4]

In terms of supporting innovations in their transition to market, the most relevant point of comparison for I2I is the Centres of Excellence of Commercialization and Research (CECR) and the former CIHR Proof of Principle programs (POP).

CECR is a tri-agency program funded in part by the Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR), and the Social Sciences and Humanities Research Council (SSHRC). Funded centres implement their own delivery and governance models, developed to address the centre's specific goals and context. They build on Canada's R&D landscape by matching clusters of academic research expertise with the needs of businesses, health practitioners, and other end users (NCE 2016). Funded centres are designed to support innovations in their transition to market and facilitate commercialization within the four priority areas articulated in the 2007 Science and Technology Strategy: the environment; natural resources; health and life sciences; and information and communication. The main differences between CECR and I2I are the scopes of the projects and supported areas of innovation. I2I supports individual innovation and commercialization projects, while CECR develops clusters of expertise that then nurture multiple innovation and commercialization projects. Moreover, CECR's broad flexibility allows room for centres to support the "connect[ion] of social sciences

[3] Source: Evaluation of Commercialization of Research: Centres of Excellence for Commercialization and Research Evaluation Report (2017) http://www.nserc-crsng.gc.ca/NSERC-CRSNG/Reports-Rapports/evaluations-evaluations_fra.asp

[4] Source: Industry-Driven Collaborative Research and Development Evaluation Report (2016), http://www.nserc-crsng.gc.ca/NSERC-CRSNG/Reports-Rapports/evaluations-evaluations_eng.asp

and humanities research with Canadians" (SSHRC 2016). Several centres (seven centres, out of a total of 14 centres studied) indicated that academics were not a part of their client base and did not appear to draw on academia-generated innovations for the services they provide.

Launched in 2001 by CIHR and ended in 2015[5], POP encompassed discoveries in health sciences, from diagnostics to devices and drugs. It provided funding through two phases: the POP I program was seen as a best practice in supporting early-stage research on the commercialization pathway; POP II supported projects to move further along the commercialization pathway. The program's main goal was to provide a platform to better enable an academic institution or researcher to move the discovery/invention further down the innovation pipeline with the participation of industry partners. The main difference between the two programs was the fields that were eligible: POP was centred on health whereas I2I focused on NSE. However, NSERC modified the I2I model over the years to be more responsive to its community by adding different options to the program (e.g. Market Assessment and Phase Ib).

Where I2I distinguishes itself is in being an "academic-driven" model, as opposed to an "industry-driven" one. In such a model, academic leadership initially drives the transition process to the point where industry can then take over the commercialization of the invention. In its recent report, Canada's Fundamental Science Review panel suggested that academic-driven models of innovation support a number of benefits: "A key lesson emerging […] is that governments must give researchers the support and freedom to pursue their very best ideas, any one of which holds the potential to result in a discovery or insight that is the seed of a future innovation or industry" (Canada's Fundamental Science Review, 2017, p. 25). One interesting finding stemming from the CECR evaluation was that several centres indicated that academics were not a part of their client base and did not appear to draw on academia-generated innovations for the services they provide.

2.3 Program Efficiency

Summary of findings: I2I has a solid program delivery structure that is able to provide funding within a fairly limited timeframe and without undue burden in terms of applications and reporting. The costs of administering I2I activities is reasonable and in line with similar programming.

Delivery Structure

Evaluation findings indicate that I2I is delivered effectively and that it compares well with other programs providing similar support. The evaluation also identified some areas where the delivery of the program could be further strengthened.

The availability and support provided by I2I staff are seen as a key asset of the program. Interactions with program staff were described by both researchers and ILOs as being positive

[5] Commercialization projects can currently be considered for funding as part of the Commercialization Peer Review Committee of the Project Grant Competition. Source: http://www.cihr-irsc.gc.ca/e/50439.html

and helpful. Staff often answer questions from applicants, providing valuable feedback for their applications and identifying areas for improvement. This is particularly helpful for researchers who may not be used to applying for grants for a commercialization program.

The findings of the evaluation also indicate that both the application process and the reporting requirements are perceived as reasonable and can be completed in a fairly straightforward manner. Both interviews and survey findings indicated that applicants were generally satisfied with the time taken to make decisions and the fact that applications could be submitted at four different times during the year according to a timeframe that reflects the requirements of commercialization.

As for potential improvements to the program delivery, the following emerged from the evaluation:

- Some of the researchers and ILOs interviewed suggested improving the feedback mechanism in the review process to address questions from reviewers. They pointed to examples where their applications were rejected but where explanations could have been provided to address reviewers' objections. Some key informants also noted a lack of clarity in the feedback provided by the Program Selection Committee when applications were rejected.
- The extent to which foreign partners can be involved could be further clarified. While key informants understand the rationale for favouring Canadian firms, they noted that it may prove challenging in some sectors and that many opportunities come from the United States or overseas.
- Several key informants were unsure about the exact scope of Phase I. In particular, some saw a "grey zone" with respect to the mandate of Phase I, as they were unclear as to the level of maturity that must be achieved before Phase I funding could be secured. Another concern noted regarding Phase I funding related to the level of detail required in a letter of support from potential partners.
- For market assessments, some key informants would appreciate obtaining further clarification on the level of market knowledge that must already be known and on the level of maturity that an innovative technology must achieve before market assessment funding can be granted.

Administrative Costs

In terms of administrative resources for running the program, the evaluation found that I2I is a relatively efficient program. Over a five-year period, from 2011–12 to 2015–16, a total of $2.2 million was required in administrative costs to provide $33.3 million in grants. Therefore, it cost $0.072 to administer $1 of grant funding.

While comparisons must be considered with caution, as each program has its own characteristics and requirements that may affect the level of administrative support required, the evaluation selected the College-University Idea to Innovation (CU-I2I) grants for comparison purposes.

Recognizing that the level of total allocated funding provided by CU-I2I on a yearly basis is substantially lower than that of I2I, both programs provide similar support and are administered by the same division of NSERC. Over the same period, a total of $0.5 million was required in administrative costs to provide $9.7 million in CU-I2I grants, meaning it cost $0.066 to administer $1 of grant funding.

In sum, both programs are largely operating within the same ratio of grants to operating expenditures.

3 Conclusions and Recommendations

I2I's Contribution to Commercialization

Commercialization is a multidimensional concept that typically unfolds over a period that, in the case of innovations targeted by I2I, may extend over several years. During its first 13 years of operation, I2I supported close to 700 projects. The predominant type of funding granted by I2I has been used to support the reduction-to-practice phase, during which researchers work on the development of a prototype. While the financial support provided for market assessment was only added to I2I in 2010, it represents an option that is increasingly sought after by ILOs and researchers.

I2I is expected to provide assistance at targeted stages of the commercialization process (typically the early stages). Projects necessarily require other sources of funding as they evolve along the commercialization continuum and the technologies reach a higher level of maturity toward commercialization. This evaluation found that I2I funding represents approximately 25% of the total financial support provided. In addition to financial resources, potential or confirmed partners also provide in-kind support that includes market knowledge, access to facilities, tools, instruments, or complementary data.

Projects that have received I2I funding have normally completed a market assessment, funded either through I2I or through other sources. In most cases, this assessment was done formally, while other assessments were conducted more informally by ILOs. Findings from these assessments either led researchers to pursue their innovation or proceed with modifications. Some assessments convinced researchers to abandon their projects altogether due to the lack of an identifiable market.

Securing appropriate IP protection is an essential component of a successful commercialization project. I2I has been used to promptly secure the appropriate IP protection, which facilitates the process of attracting potential partners.

Once a partner is engaged in the commercialization process, the transfer of research results is achieved through various means, including licencing arrangements, patents, publications, reports provided to the partner, or informal discussions. This new knowledge allows partners to not only launch a new or improved product, process or service, but also acts as a stimulus for new R&D activities or enhances the skill set of the partner. The majority of projects that reach the point of a formal transfer (through licensing or the selling of IP rights) either enter the market or are

expected to enter the market. I2I contributes to this transfer by providing support at key stages, by engaging partners in a more formal setting, and by strengthening the case for investment. I2I is also reported to have a positive impact on broader factors, such as research institutions' cultures of innovation and technology transfer policies, the level of investment made by these institutions, and how researchers collaborate with their ILOs. Projects that do not secure I2I funding are less likely to proceed to commercialization and those that do proceed tend to do so over a longer period.

Relevance of I2I

In the context of the current political climate, where supporting innovation has been recognized as a government-wide priority, I2I occupies a unique niche as one of the few academic-driven programs that bridges academia and the private sector and supports individual projects. In this environment, I2I supports the transition process that is driven by academic leadership to the point where industry can take over the commercialization of the invention. The fact that no matching funds are required as part of Phase I funding is seen as a key asset, which further distinguishes I2I from other funding sources. It allows researchers to strengthen their ability to attract potential partners, in additional to securing funding from their own research institution.

Program Delivery

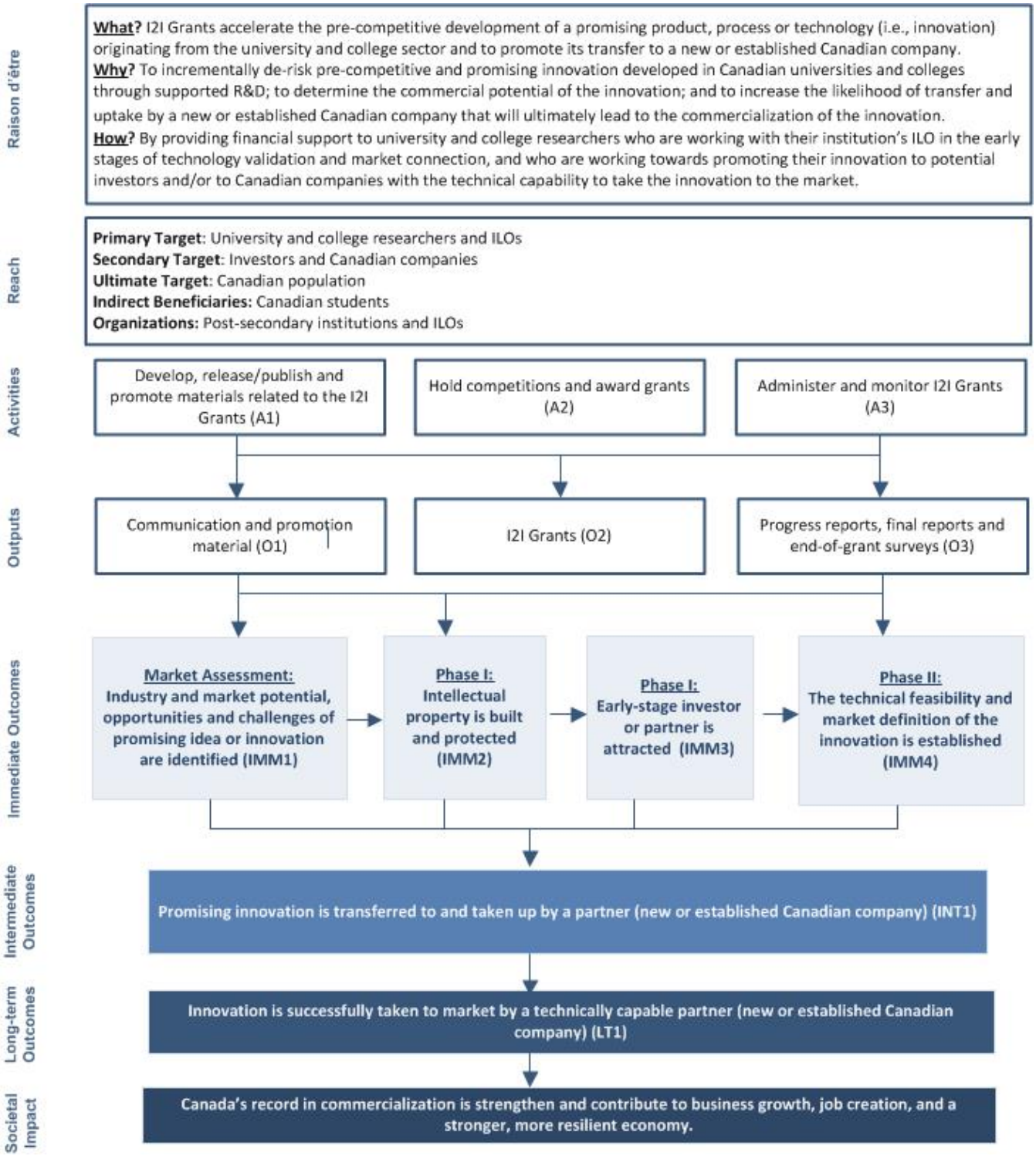
I2I has an efficient delivery structure. Regular intake opportunities, the support provided by program representatives, the prompt decision-making process, and the information required during both the application and the reporting process are all seen as factors that contribute to effective program delivery. In terms of potential areas for improvement, suggestions were provided for the feedback mechanism that is currently used and the requirements and eligibility criteria related to market assessment and Phase I funding. Finally, the ratio of administrative costs to grants provided was found to be fairly in line with similar programs.

Recommendations

1. ***The federal government should continue to support the commercialization of Canadian innovations through the three types of funding currently offered by I2I.*** While each type of funding serves its own purpose, and while Phase I funding remains the most relevant form of funding, there is also a strong rationale for supporting market assessments and Phase II funding when applicable.
2. ***Idea to Innovation program management should employ a more systematic approach to document the long-term outcomes of the I2I projects it supports.*** Program management already collects, using a semi-structured process, valuable information on project outcomes, particularly as these outcomes unfold during the post-funding period. Having a more systematic approach for these monitoring activities would provide additional evidence on the rationale for the types of funding provided and on the impacts of the program.

Appendix A: I2I Logic Model

The following diagram summarizes the I2I grant logic. A narrative description of each component follows.



Raison d'Être

The goal of the I2I grants is to accelerate the pre-competitive development of a promising product, process, or technology (collectively referred to as "innovation") originating from the university and college sector and to promote its transfer to a new or established Canadian company. It does this to incrementally de-risk pre-competitive and promising innovation developed in Canadian universities and colleges through supported R&D; to determine the commercial potential of the innovation; and to increase the likelihood of transfer and uptake by a new or established Canadian company that will ultimately lead to the commercialization of the innovation.

I2I grants aim to achieve their goal by providing financial support to university and college research faculty members who are working with their institution's ILO in the early stages of technology validation and market connection and who are working toward promoting their innovation to potential investors and/or to Canadian companies with the technical capability to take the innovation to market.

Reach

Target Groups

The target group is a set of individuals and/or organizations that experience the change of state at the long-term outcome level of a logic model, although they could also be targeted in the immediate and intermediate outcome levels (also referred to as "reach" or "target population").

The primary targets of I2I grants are:

- university and college researchers; and
- university and college ILOs.

- The secondary targets are investors who principally invest in pre-competitive Canadian innovation with market potential; and
- Canadian companies with receptor capacity, technical ability, and market connection.

Canadians are the ultimate target group; while the long-term societal impact of the grants aims to strengthen Canada's record in commercialization and to contribute to business growth, job creation, and a stronger, more resilient economy.

Indirect Beneficiaries

Indirect beneficiaries benefit from an initiative as a result of the change experienced by target groups.

The indirect beneficiaries of the I2I grants are Canadian students, as they are engaged in applied research training and technology transfer activities. By participating, they gain knowledge and skills specific to early-stage technology validation and technology transfer.

Recipient Organizations

Recipient organizations are groups, institutions, or government bodies that are not a target group of an investment/grant; they are only the target of select activities that will lead to a change in the target groups. The recipient organizations of I2I grants are post-secondary institutions.

Activities

Activities are carried out by NSERC and are within the control of NSERC staff.

- *Develop, release/publish, and promote materials related to I2I grants (A1)* – NSERC publishes funding opportunity literature on its website that includes a description of I2I funding opportunities, eligibility, selection criteria, application deadlines, and other relevant information.
- *Hold competitions and award grants (A2)* – All eligible Phase I, Phase IIa and Phase IIb applications are peer-reviewed by external reviewers who are scientific or technical experts and often successful entrepreneurs and technology specialists, as well as by the I2I Selection Committee. Market Assessment applications are reviewed by the I2I Selection Committee only. Unsuccessful applicants are provided feedback from the Committee, while both successful and unsuccessful applicants receive feedback from external reviewers on application strengths and weaknesses.
- *Administer and monitor I2I grants (A3)* – Administration and financial monitoring of grant awards are conducted by the NSERC Finance Division. Financial information is gathered for council-wide reporting, grant payments are processed, and various monitoring activities are conducted to ensure compliance with regulations, such as the *Policy on Transfer Payments*. In cases where an I2I grantee is collaborating with a partner, grant payments are released on condition that the partner has met its financial commitment to the project and has confirmed its continued support.

Outputs

- *Communication and promotional material (O1)* – Information on I2I funding opportunities is made available to potential applicants via the NSERC website, and is usually updated annually.
- *I2I grants (O2)* – There are four distinct funding options offered by I2I grants (Market Assessment; Phase I & Phase Ib; Phase IIa; and Phase IIb), where Phase I grants fund reduction-to-practice projects and Phase II grants fund technology enhancement projects. (A full description of each grant can be found in the program description. The outcomes associated with each funding option are described in the immediate outcomes section below.)
- *Progress reports, final reports, and end-of-grant surveys (O3)* – Grantees, ILOs, and partners (investors or companies) submit interim and/or final reports as required according to the I2I option they are pursuing. The final report provided by a partner company includes an assessment of the impact the project has had on the organization as well as the plan to commercialize the project innovation. ILOs participate in a "Commercialization Activities Survey" 18 months after the end of the grant.

Outcomes

I2I grants' outcomes are expected to occur at a variety of levels and points in time. The achievement of outcomes relies on activities of and decisions made by grantees, which are not under direct control of NSERC.

Immediate Outcomes

Immediate outcomes are a direct result of the outputs.

I2I grants help researchers get a technology closer to market by providing assistance in the early stages of technology validation and market connection. Researchers can use each of the four funding options independently or in sequence. What is appropriate depends on the stage of the technology or innovation and whether or not the researcher is working with a partner. For example, researchers can choose to begin with a Phase I grant (i.e., a reduction-to-practice project), followed by a Phase II grant (technology enhancement project) or, if the project is at a later stage of development, they can choose to bypass Phase I altogether and start with a Phase II grant.

When the potential market of the technology is unknown, researchers can benefit from the Market Assessment grant, before applying for a Phase I or Phase II grant. The Market Assessment enables researchers and their institutions to contract an external consultant to conduct an independent market study, where the *industry and market potential, opportunities, and challenges of the promising idea or innovation are identified (IMM1).* The study can also be used to better position the proposed technology or innovation in subsequent I2I Grant application(s) or other NSERC funding opportunities.

Researchers can receive Phase I project funding when the potential market of the innovation is known; its potential to work in a "product" environment or its intended use has been tested; there is indication of support from potential receptors, end users/clients, and industrial value-chain players; and, in the case where the plan is to create a spin-off company, there is involvement of experienced business mentors[6]. In Phase I projects, prototypes are developed to demonstrate market suitability of the innovation, whereby valuable *intellectual property is built and protected* (*IMM2*). In practice, this means that there will be a well-defined process in place for protecting the intellectual property. All Phase I projects involve developing a partnership plan, which aims to ensure that *early-stage investors or partners are attracted* (*IMM3*). The plan includes a "go/no-go" decision point for the partnership at the end of the Phase I project and describes how the partnership will work, for example, how an early-stage investor will provide seed funding or how a company with capacity to commercialize will further develop the innovation for market. Phase I grantees may choose to apply for a Phase Ib supplement when there is high promise of securing an investor or a licensing company. While Phase I and Ib serve the same goal, ILOs apply for Phase Ib funding on behalf of the project when the convincing process requires additional funds.

[6] Note that this was first introduced in January 2016.

Phase II is the most appropriate funding option for researchers that have an established partnership and whose intellectual property has already been built with a well-defined protection process (i.e. intellectual property is usually protected at this point). Researchers who have partnered with an early-stage investor can benefit from Phase IIa funding while a researcher who has partnered with a new (start-up) or established Canadian company can benefit from Phase IIb funding.

In projects where the researcher has partnered with an early-stage investor (a Phase IIa project), further market research is conducted, potential buyers are identified, technology transfer terms are disclosed, and a budget that describes the future financial requirements and the plan to secure these funds is established. The partnering investor provides input on the technology transfer plan, contributes at least a third of the funds required for the project, and has the financial capacity to carry the project into a Phase IIb project or directly to market. Involvement of experienced business mentors is required when the team plans to spin off a new company[7]. The end of the project includes a "go/no-go" decision point that determines whether or not the innovation should be enhanced further by a new (start-up) or established Canadian company.

In projects where the researcher has partnered with a company (a Phase IIb project), a prototype is already in existence; a strong business plan is in place; the receptor capacity to manufacture, distribute, and license the innovation has been substantiated; the budgets required to ensure that the innovation will be at the marketing/manufacturing stage at the end of the project are available; and experienced business mentors are engaged where the plan is to spin off a new company[8]. Phase IIb grants enable partnering companies to carry out further market studies, innovation development and engineering, and sales and marketing planning with the goal of producing a successful, market-viable innovation. It is expected that by the end of the project, the company will have been or will be able to acquire the technical capability to undertake any further development necessary to get the innovation to market.

At the end of a Phase II Grant, or thereafter, the project should have *established the technical feasibility and market definition of the innovation (IMM4)*.

The time required to achieve immediate I2I Grant outcomes (*IMM1*, *IMM2*, *IMM3*, and *IMM4*, inclusively) varies largely among projects, and may occur at the end of the grant or post-grant.

Intermediate Outcomes

Intermediate outcomes are expected to logically occur once one or more immediate outcomes have been achieved.

The pathway from technology to market is not necessarily sequential or the same for all innovations. It is influenced by multiple internal factors (e.g., the nature of the innovation, the relative performance of the technology) and external factors (e.g., the extent of market opportunities, the need for and access to financial support, buy-in from business value chain

[7] Ibid
[8] Ibid

players). The diversity in paths from technology to innovation highlights the fact that any of the immediate outcomes or sequence of immediate outcomes has the potential to contribute to the intermediate outcome: a *promising innovation being taken up by a partner (new or established Canadian company) (INT1).* This outcome is generally expected to occur up to four years after the completion of the I2I Grant. In practice, this outcome could also occur earlier on, during the course of the grant. In some cases, it could even trigger an application for a Phase II project.

Long-Term Outcomes

Long-term outcomes are the highest-level change that can reasonably be attributed to an organization, policy, program, or initiative in a causal manner and are the consequence of one or more intermediate outcomes. Long-term outcomes usually represent the *raison d'être* of an organization, program, or initiative and take the form of a sustainable change of state among the beneficiaries (target groups).

The intermediate outcomes of I2I grants contribute to technology and innovations from the university and college sector entering the marketplace over a four- or five-year period.[9]

With I2I grants accelerating the pre-competitive development of these university- and college-derived technologies and innovations and promoting their transfer to a new or established Canadian company, the level of risk associated with this process is reduced. When sufficiently reduced, this creates an opportunity for a company to take on the risk associated with commercializing the technology or innovation. By creating these opportunities, I2I grants thus contribute to the *innovation being successfully taken to market by a technically capable partner (new or established Canadian company) (LT1).*

Societal Impact

The societal impacts are the broad impacts on society that the I2I grants will contribute toward, along with many other NSERC programs and initiatives. This impact is not usually measured at the program level due to difficulties in tracking and measuring attribution; however, it is assessed at a departmental or governmental level using aggregate measures.

Technically capable Canadian companies that take technology and innovations originating from the university and college sector to the marketplace will, over time, contribute to *strengthening Canada's record in commercialization,* leading to benefits such as *business growth, job creation, and a stronger, more resilient* Canadian *economy.*

[9] Technology is very often considered out-of-date after five years.

Appendix B: I2I Evaluation Matrix

Evaluation Questions	Indicators	Methods and Data Sources			
		Secondary data analysis	Survey of researchers	Surveys of ILOs	Interviews
Effectiveness: *Achievement of expected outcomes*					
1. To what extent has I2I contributed to successfully taking innovations to market by a partner (new or established Canadian company)? *(LT1)*	a. Proportion of I2I supported innovations that have been successfully taken to market in comparison to non-supported innovations		X	X	
	b. Time to market for I2I-supported innovations in comparison to non-I2I supported innovations		X	X	X
	c. Stakeholder perceptions of I2I's contribution to moving innovations to market		X	X	X
	d. Extent and nature of other factors (e.g., sector, economic climate) influencing success in taking innovations market	X	X	X	X
	e. Extent and nature of unintended outcomes		X	X	X
2. To what extent has I2I contributed to the transfer and uptake of supported innovations by partners (new or established Canadian companies)? *(INT1)*	a. Extent to which marketing plans were developed for the technology	X			
	b. Extent to which research results were transferred to different types of partners (e.g., early-stage investment partner, established company, university spin-off)	X	X	X	X
	c. Extent and mode of transfer (e.g., licensing agreement[s], IP sold or assigned to a partner, option agreement, confidentiality agreement, other)	X	X	X	X
	d. Extent to which research results are being used and/or will be used by the partners and nature of actual/planned use		X	X	X
3. To what extent has I2I contributed to achieving the immediate outcomes associated	a. Number of new collaborations initiated *(IMM1, IMM2, IMM3, IMM4)*	X			
	b. Extent and nature of intellectual property protection at the end of the grant[1], 18 months after the end date of the grant[2], and/or at the time of the survey[3] *(IMM2)*	X	X	X	

[1] Data gathered from the researcher final reports.
[2] Data gathered from the ILO post-grant surveys.
[3] Survey that is part of data collection for the I2I evaluation.

Evaluation Questions	Indicators	Methods and Data Sources			
		Secondary data analysis	Survey of researchers	Surveys of ILOs	Interviews
with each of the I2I funding options? *(IMM1, IMM2, IMM3, IMM4)*	c. Extent to which early-stage investors or partners were attracted at the end of the grant, 18 months after the end date of the grant, and/or at the time of the survey *(IMM3)*	X	X	X	
	d. Extent to which the technical feasibility and market definition of the innovation was established at the end of the grant, 18 months after the end date of the grant, and/or at the time of the survey *(IMM4)*	X	X	X	
	e. Extent and nature of cash and in-kind contributions committed and received from partners and other sources (i.e., investors) *(IMM4)*	X	X	X	X
	f. Number of projects that went ahead in absence of I2I funding, their funding sources, partner participation and results *(IMM1, IMM2, IMM3, IMM4)*		X		
Relevance: *Continued need for the program, alignment with federal government priorities, roles and responsibilities for the federal government*					
4. What is I2I grants' niche or value add in addressing the need for bridging the gap between academic inventions and commercialization?[4]	a. Rationale for applying for I2I grants identified by applicants	X	X	X	X
	b. Evidence of national/federal challenges in Canada in bridging the gap between academic inventions and commercialization	X			X
	c. Extent and nature of researchers' use of the different funding options the I2I grants provide	X			X
5. To what extent are the objectives of I2I grants aligned with NSERC and government priorities?	a. Extent of alignment between the I2I funding opportunity objectives and NSERC and Government of Canada priorities	X			
Efficiency: *Resource utilization in relation to the production of outputs/outcomes and progress toward expected outcomes*					
6. To what extent are I2I grants being delivered in an effective and cost-efficient manner?	a. Ratio of administrative to total costs compared to that of other similar programs	X			
	b. The extent to which I2I is perceived as being delivered in an effective manner	X	X	X	X

[4] Note that this evaluation question covers two of TBS's core issues, the need for the program and the roles and responsibilities of the federal government.

Appendix C: Methodology

The four lines of evidence used as part of the I2I evaluation are described in the following table, while further methodological information is included in each technical report.

Lines of Evidence
Secondary data analysis
The first portion of the secondary data analysis was a document review that addressed evaluation questions related to relevance (i.e., funding opportunity niche and NSERC priorities). It provided a conceptual understanding of the funding opportunity, its rationale, and the broader environment in which I2I operates. To this end, the information collected and analyzed as part of a document review completed for the tri-council evaluation of the Centres of Excellence for Commercialization and Research (CECR) program was used. Given the similarities between I2I and CECR's objectives, the CECR document review informed an understanding of Canada's innovation funding environment and priorities. This was supplemented by a review of NSERC's I2I-specific materials (e.g., program descriptions, application guidelines, etc.). The second portion of the analysis was a file review including Final Research Reports (FFR) provided by funded researchers and stored in NSERC's Award Management Information System (NAMIS). A total of 190 FFRs were analyzed. The FRR response rate for the six years covered by the analysis (2010–11 to 2015–16) was 75.4%. Considering the sample size, the design effects, and the population sizes, for a proportion of 50%, at a confidence level of 95%, the sample margin of error is estimated at ±3.5 percentage points. The file review also included an analysis of post-grant survey questionnaires completed by ILOs. A total of 368 survey questionnaires, covering the same period as the FRRs, were analyzed. Considering the sample size, the design effects, and the population sizes, for a proportion of 50%, at a confidence level of 95%, the sample margin of error is estimated at ±0.8 percentage points.
Survey of researchers (funded and unfunded)
The survey of researchers was conducted from April to May 2017 as an online survey. The total sample included 805 researchers, extracted from NAMIS for fiscal years 2003–04 to present. The survey closed in late May 2017, resulting in 212 completed surveys (26% response rate). Since some researchers applied for I2I grants more than once, the survey specified a reference project/application based on which the researcher answered the survey questions. The following selection criteria were applied to determine which application to use as the reference project: • Funded projects > unfunded projects: For two applications (from the same applicant), priority was given to projects that received I2I funding (regardless of application date) because the respondents' ability to recall information accurately is greater for projects that received funding. In addition, there are fewer funded projects than unfunded projects. • Phase II projects > Phase I projects: For two applications (from the same applicant) with the same funding status, priority was given to the Phase II project since there were fewer in the sample. Phase II projects were also likely to be completed more recently and, therefore, more directly linked to program impacts. • Oldest application > more recent application: For two applications (from the same applicant) with the same funding status and for the same phase, priority was given to the oldest application, as this provides more time to observe results/impacts.

Survey of Industry Liaison Officers

The survey of ILOs was conducted throughout late April to June 2017 as an online survey. The total sample available included 258 ILO representatives provided by the I2I program management group at the onset of the evaluation. Additional contacts were added to the sample during survey fielding.

In total, 26 ILOs received email invitations for the survey as part of a survey pretest in late April 2017. The invitations to the full sample were sent in mid-May, as well as a reminder email to non-respondents in late May 2017. The survey invitation also requested the ILOs provide the names and contact information of other people who may be better positioned to complete the survey. The evaluation team sent an invitation to any of these additional individuals after the initial launch of the survey. The survey closed in early June 2017, resulting in 67 completed surveys (26% response rate).

Key informant interviews

The primary goal of the key informant interview process was to provide additional and complementary insights on findings that had already been gathered through the other lines of evidence (secondary data analysis and surveys). In order to provide a range of insights, interviews were conducted with funded researchers, partners, and ILOs, using both grant-specific as well as more general questions pertaining to the program itself and the broader environment in which funded research projects are implemented.

Key informants were selected based on a number of criteria, including, as applicable: nature of funding provided (market assessment, Phase I and Ib, Phase IIa and IIb), experience with funded and unfunded proposals, size of university with which researchers or ILOs are associated, gender, geographic distribution, and language. In the specific case of partners, only those who participated in funded projects were invited to participate.

A total of 25 interviews were conducted, including 8 interviews with researchers, 7 interviews with partners, and 10 interviews with ILOs. These interviews were conducted throughout late August and September 2017.

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