Evaluation of Commercialization of Research

Centres of Excellence for Commercialization and Research

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List of Acronyms

AAFC	Agriculture and Agri-Food Canada
AAPS	Advanced Applied Physics Solution centre
BIC	Bioindustrial Innovation Centre
BERD	Business enterprise expenditures on research and development
BL-NCE	Business-led Networks of Centres of Excellence
C3E	Centre of Excellence in Energy Efficiency
CAIP	Canada Accelerator and Incubator Program
CCR	Centre for Commercialization of Research (also called OCE-CCR)
CCRM	Centre for Commercialization of Regenerative Medicine
CDMN	Canadian Digital Media Network
CDRD	Centre for Drug Research and Development
CECR	Centres of Excellence of Commercialization and Research
CEPMed	Centre for Excellence in Personalized Medicine
CIHR	Canadian Institutes of Health Research
CPDC	Centre for Probe Development and Commercialization
CSII	Centre for Surgical Invention and Innovation
EDC	Export Development Canada
GCC	GreenCentre Canada
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
HERD	Higher education expenditure on research and development
HQP	Highly Qualified Personnel
IP	Intellectual Property
IRAP	Industrial Research Assistance Program
IRDI	Industrial Research and Development Internship
IRICoR	Institute for Research in Immunology and Cancer
ISED	Innovation, Science and Economic Development Canada
ICT	Information and Communication Technology
LOI	Letter of Intent
LOOKNorth	Leading Operational Observations and Knowledge for the North
MI	MaRs Innovation (also called MaRs)
MIC2	MiQro Innovation Collaborative Centre
NAMLF	National Accounts Longitudinal micro-data File
NCE	Networks of Centres of Excellence
NEOMED	NEOMED Institute
NRC	National Research Council of Canada
NSE	Natural Sciences and Engineering
NSERC	Natural Sciences and Engineering Research Council
OCE-CCR	Ontario Centres of Excellence – Centre for Commercialization of Research (also called CCR)
OECD	Organization for Economic Co-operation and Development
ONCIC	Ocean Networks Canada – Innovation Centre
PC-TRIADD	The Prostate Centre's Translational Research Initiative for Accelerated Discovery and Development
PREVENT	Pan-Provincial Vaccine Enterprise
PROOF	CECR in the Prevention of Epidemic Organ Failure
PSAB	Private Sector Advisory Board
R&D	Research and Development
S&T	Science and Technology
SMEs	Small- and Medium-sized Enterprises
SSH	Social Sciences and Humanities
SSHRC	Social Sciences and Humanities Research Council
UK	United Kingdom
Wavefront	Wavefront Wireless Commercialization Centre

Acknowledgements

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Executive summary

About the CECR program

Launched in 2007, the Centres of Excellence for Commercialization and Research (CECR) program support the innovation to commercialization continuum by matching clusters of research expertise with the business community to share knowledge and resources that bring innovations to market faster. CECR operates in four priority areas: the environment; natural resources and energy; health and life sciences; and information and communication technologies. To date, the CECR program has funded 29 centres.

Evaluation background

The CECR program was evaluated in 2016-17. The evaluation's scope included the years 2012-13 to 2016-17 and addressed the following questions.

Relevance

- What is the CECR program's niche or added value in addressing the sectors' need for bridging the gap between academic inventions and commercialization?
- Is there a role for the federal government in bridging the gap between academic inventions and commercialization through commercialization centres?
- To what extent is the program aligned with federal government priorities?

Effectiveness

- To what extent are centres achieving self-sustainability and/or developing a legacy?
- To what extent has the CECR program had an impact on the companies served and their technologies, goods and services?
- What are the economic benefits generated by the centres?

Efficiency and economy

- To what extent has the CECR program been delivered in a cost-efficient manner?
- To what extent are efficient and effective means being used to deliver the program?

Evaluating the CECR program has required multiple lines of evidence including: a review of documents and key literature; a financial data review (2008/09 – 2015/16); interviews with key informants (n=71); a web-based survey of centre partners and organizations served (n=423); case studies (n=14); and an econometric analysis (n=1306).

Key limitations included: 1) high variability in centre implementation - mitigated by creating a typology, grouping a sample of centres, by key characteristics; 2) challenges in attributing outcomes specifically to CECR program funding – mitigated through the use of econometric analysis, comparing outcomes of centre-supported companies to similar unsupported companies; 3) positive response bias – mitigated by seeking input from a wide range of stakeholders, including those not receiving funding.

Centre delivery models

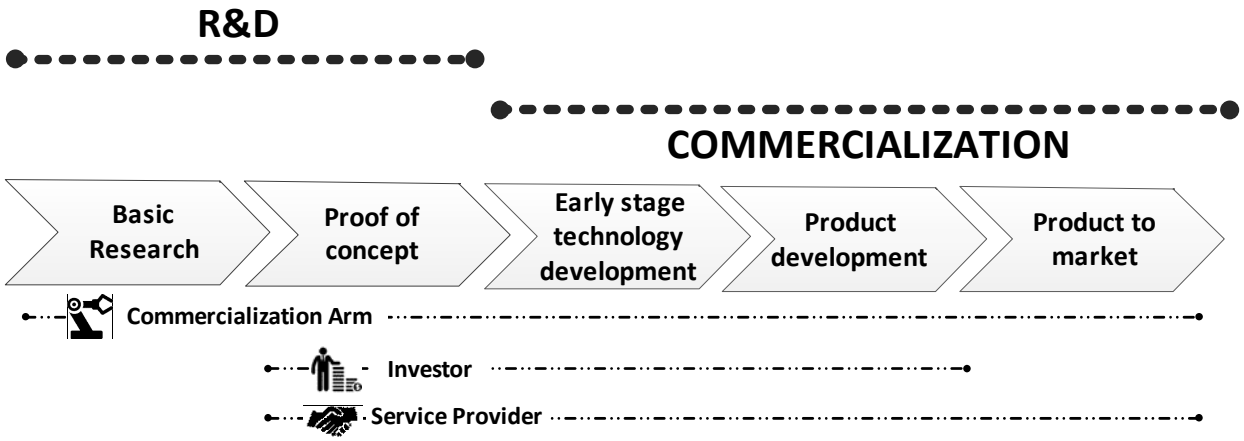
Acknowledging the complexity of innovation needs, the CECR program allows for broad flexibility in centre design and implementation. Funded centres have used this flexibility to develop in different ways, based on their individual objectives and context. These delivery models can be aggregated into three main types. They should be considered as archetypes that describe key characteristics the centres have in common – while centres may exhibit characteristics of more than one archetype, they have been associated with the archetype that most closely reflects their primary characteristics.

Commercialization Arms (n=2) are centres that develop and advance their own companies and/or technologies through the full commercialization continuum. Commercialization Arms are found in the health and life sciences sector. These centres expect to generate income when the product/technology is sold or licensed.

2) Investors (n=5) typically screen for promising technologies, most often through academics in the health and life sciences sector. They further the technology through the mid-stages of the innovation continuum, de-risking it to the point at which it becomes attractive to more traditional investors. Investor centres typically work in exchange for a licensing agreement or equity in the company holding the technology, and aim to sustain themselves by selling their equity or the royalties earned from the licensing agreement.

3) Service Providers (n=7) focus on providing services and supports to small and medium-sized enterprises (SMEs) and start-ups in order to move an existing product to market. They work in sectors other than health, focus on the later stages of the innovation continuum, and generally aim to recover costs by charging a fee for the services they provide.

It is important to note that development of the archetypes required substantial information relating to the centre's operations and so were based only on information obtained from centres that participated in case studies. This represents 14 of a total of 29 Centres funded by the program and excludes those centres that were only recently funded. As a result, although both of the Centres categorized as Commercialization Arms were in the health sector, this archetype is not necessarily exclusive to the health sector, as it is possible that one of the more recently funded non-health centers could fall into this category. Similarly, although none of the centres in the health sector were categorized as Service Providers, is possible that one of the more recently funded centers in the health sector could fall into this category.



Conclusions and recommendations

	Conclusions	Recommendations
Relevance	▪ Canada has gaps in innovation and commercialization capacity, which the CECR program aims to fill by bridging academia to industry and increasing access to early-stage funding, skill development, and enabling access to commercialization infrastructure. Few other federal initiatives address this niche. ▪ Acknowledging the complexity of innovation needs, the CECR program allows for broad flexibility in centre design and implementation. ▪ Program objectives are consistent with all three funding agencies priorities. However, none of the centres funded focuses on commercializing innovations that have emerged from the SSH. ▪ Current implementation of the program may be shifting away from the notion of bridging the gap between academic research and commercialization. The requirement for self-sustainability has likely contributed to such a shift.	**# 1: Continue to deliver the CECR program and allow flexibility in centre delivery models** ▪ Relevance of the CECR program objectives to Canadian needs and agency priorities, as well as achievement of commercialization outcomes, justify continued delivery. ▪ Each delivery model is correlated with different positive outcomes, suggesting flexibility is an asset. ▪ Management should consider the value of/need for direct connection to academia and monitor this aspect in ongoing program delivery.
Commercialization & Economic Outcomes	▪ Centre-supported companies outgrow comparators in sales, R&D expenditures, number of employees, and wages expenditures. ▪ Flexibility in program design helps different centres achieving different outcomes. Investors/health centres most often support new company creation and IP protection. Service Providers/non-health centres most often support speed to market, company growth, and company competitiveness. ▪ It is too early to assess the commercialization or economic outcomes for of the Commercialization Arms.	
Self-Sustainability Outcomes	▪ For every $1 the CECR program provided, centres leveraged an additional $2.30. ▪ Most centres continue operations after CECR program funding. However, discontinuation of CECR funding often results in scaling back activities and may undermine centre alignment with CECR program objectives. ▪ Centers need more time to become self-sustainable, particularly health centres (i.e., Commercialization Arms and Investors) due to longer time frames, higher costs, and more demanding regulatory requirements. ▪ Stakeholders are unclear on how the CECR program defines self-sustainability.	**# 2: Allow more time for centres to achieve self-sustainability and clarify how the CECR program defines self-sustainability.** Specifically, the CECR program should: a. Lengthen funding cycles or provide additional extension opportunities. b. Clarify the program's definition of self-sustainability, distinguishing between independence from CECR funding and total independence from public sector funding. c. Provide guidance on expectations regarding centre activities and impacts after CECR funding.

	Conclusions	Recommendations
Efficiency & Economy	▪ Administrative costs account for 5% of program expenditures. ▪ Operational efficiency is comparable to the NCE and BL-NCE programs. ▪ The CECR program is generally believed to be well delivered. ▪ Advantages to not-for-profit requirement are believed to outweigh challenges. ▪ Respondents identified areas for improvement (described in recommendation).	**# 3: Consider appropriateness and feasibility of the following potential areas for improvement:** a. Clarifying: definition of 'benefit to Canada', relative importance of regional vs. national representation for centres, whether applications are considered on their own merits or in relation to other applications. b. Providing additional opportunities for communication with PSAB as part of the review process as well as more clarification to applicants regarding respective PSAB and Expert Panel roles and mandates. c. Increasing/formalizing coordination with provincial commercialization strategies. d. Increasing opportunities to share lessons learned across centres.

1 Introduction

This report presents key findings, conclusions and recommendations of an evaluation of the Centres of Excellence of Commercialization and Research (CECR) program conducted in 2016.

1.1 About the CECR program

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). "The goal of the CECR program is to create internationally recognized centres of excellences in commercialization in the areas of priority for the Government of Canada to deliver economic, social, health and environmental benefits to Canadians" (NCE 2016). This is done by funding "centres that can build on Canada's Research and Development (R&D) landscape by matching clusters of academic research expertise with the needs of business, health practitioners and other end users" (NCE 2016). The CECR program has been specifically designed to be flexible and open to different centre strategies that may meet these objectives.

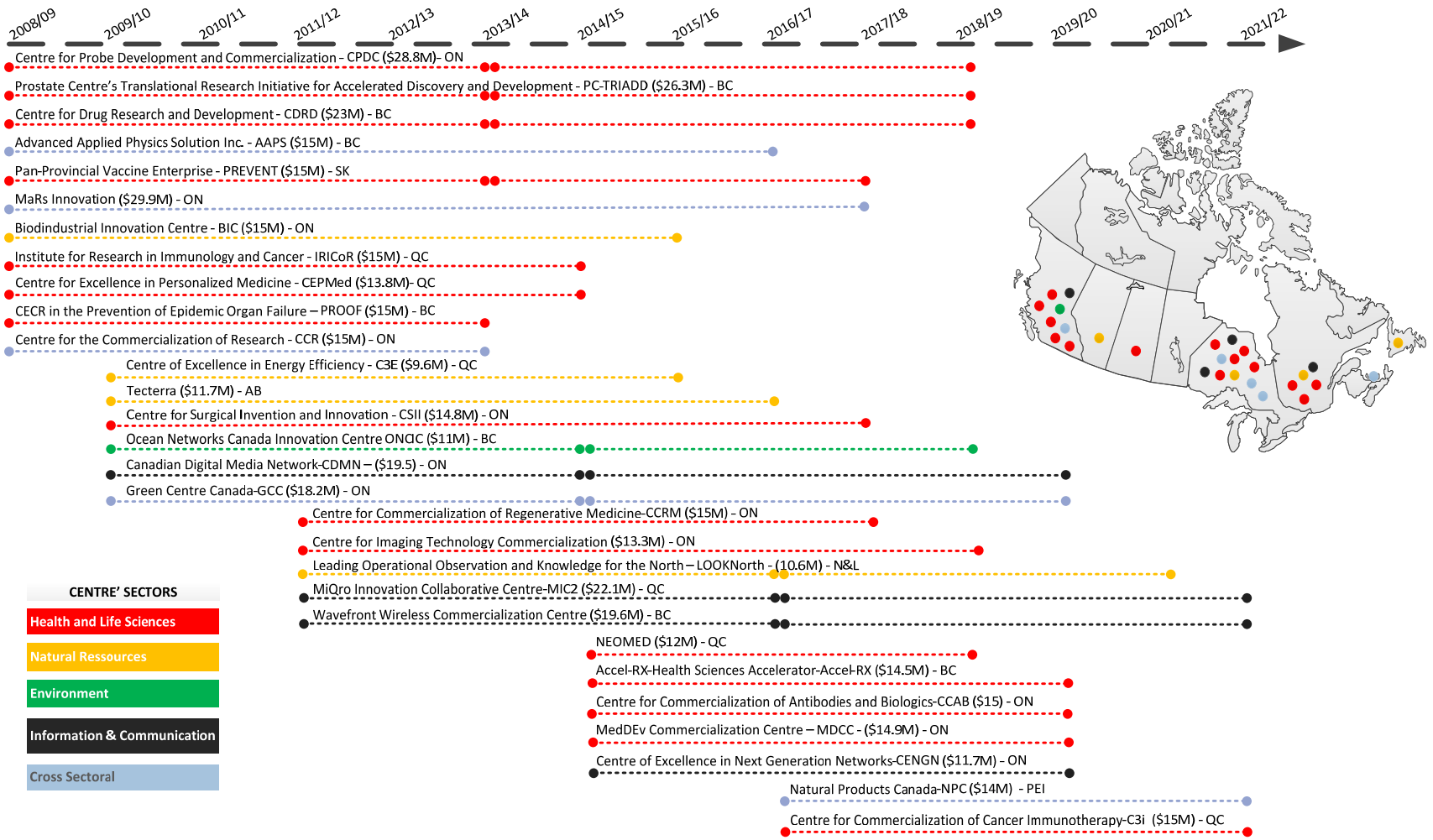
To date, the CECR program has funded 29 centres, 19 of which were still receiving funding at the time of this report. Funded centres facilitate commercialization within the four priority areas articulated in the 2007 Science and Technology Strategy: environment; natural resources; health and life sciences; and information and communication. Furthermore, each centre has a mandate to become self-sustaining while maximizing economic impact for its partners.[1]

Centres receive funding for a period which is typically five years in length, although they can reapply in subsequent competitions for that funding to be renewed for another five year period. Although there is currently no prescribed budget per centre (NCE 2018), it has been the practice of the CECR program to provide a maximum of $15 million over five years. Between 2008/09 and 2014/15, total funding per centre has ranged from $9.6 million over five years to $29.9 million over nine years. The average annual grant value ranges from $1.1 million to $3.3 million per year.

A more detailed program profile is provided in Appendix A. Figure 1 presents an overview of funded centres.

[1] Within the context of the CECR program, sustainability means that centres are able to continue their core activities beyond the CECR funding by establishing a strong business model and partnerships.

Figure 1: Centres funded under the CECR program



1.2 Evaluation scope and questions

The purpose of the evaluation is to provide tri-agency senior management with an assessment of the program's relevance, effectiveness and efficiency and delivery. The CECR program evaluation has been conducted in compliance with the coverage requirements outlined in the *2016 Treasury Board Policy on Results* and the *Financial Administration Act*. In addition to exploring the economic benefits of the program and issues related to design and delivery, the focus of this evaluation is on key intermediate outcomes including: impacts on companies served and commercialization outcomes as well as centre self-sustainability. [2]

The scope of this evaluation covers the five-year period from fiscal year 2012-13 to 2016-17. The evaluation explored and addressed eight questions under three issue areas, as presented below.

Relevance: Continued need for program, alignment with federal government priorities, roles and responsibilities

1. What is the CECR program's niche or value-add in addressing the sectors' need for bridging the gap between academic inventions and commercialization
2. Is there a role for the federal government in bridging the gap between academic inventions and commercialization through commercialization centres?
3. To what extent is the program aligned with federal government priorities?

Performance – Effectiveness: Achievement of expected outcomes

4.1. To what extent has the CECR program had an impact on the companies served and their technologies, goods and services?

4.2. To what extent are centres achieving self-sustainability and/or developing a legacy?

Performance – Efficiency and Economy: Resource utilization in relation to the production of outputs and progress toward expected outcomes

5.1. What economic benefits have been generated by the centres?

5.2. To what extent has the CECR program been delivered in a cost-efficient manner?

5.3. To what extent are efficient and effective means being used to deliver the program?

1.3 Evaluation methodology

The evaluation was guided by an Interagency Evaluation Advisory Committee composed of representatives from the NSERC/SSHRC Evaluation Division, the Networks of Centres of Excellence (NCE) Secretariat, CIHR Evaluation Unit, Innovation, Science and Economic Development Canada (ISED), and an external representative from the research community. It used a hybrid approach, with NSERC/SSHRC evaluators, an evaluation consulting firm (Goss Gilroy Inc.), and analysts from Innovation, Science and Economic Development Canada (ISED) each playing a role in evaluation design and implementation.

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[2] The CECR program was previously evaluated in 2012, at which time the evaluation focused on the early achievement of program outcomes.

Evaluating the CECR program required multiple lines of evidence including: a review of documents and key literature; a financial data review (2008/09 – 2015/16); interviews with key informants (n=71); a web-based survey of centre partners and organizations served (n=423); case studies (14 cases, 104 interviews); and an econometric analysis (n=1306).

Key limitations and mitigating strategies included:

1) High variability in centre implementation, which was mitigated by creating a typology that grouped centres according to key characteristics of their delivery models. Analysis was then conducted based on this typology, allowing identification of the correlation between different types of centres and different outcomes. It is important to note that the typology itself has only been applied to the 14 centres that participated in the case studies, as this data was used to develop and assign the archetypes.

2) Challenges in attributing outcomes specifically to CECR program funding, which was mitigated through the use of econometric analysis, comparing outcomes of centre-supported companies to similar unsupported companies.

3) Positive response bias, which was mitigated by seeking input from a wide range of stakeholders, including those not receiving funding.

Appendix B presents the evaluation matrix, which includes a cross-walk between the evaluation questions and the methods used. Appendix C provides more detailed information on the methodology used as well as limitations and mitigating strategies.

2 Centre delivery models

Summary of findings: Acknowledging the complexity of innovation needs, the CECR program allows for broad flexibility in centre design and implementation. Funded centres have used this flexibility to develop in different ways, based on their individual objectives and context. These delivery models can be aggregated into three main types:

1) Commercialization Arms are centres that develop and advance their own companies and/or technologies. Commercialization Arms are found in the health and life sciences sector, developing mid to late stage technologies. These centres expect to sufficiently develop the technology to the point where they can generate income when the product/technology is sold.

2) Investors typically identify promising technologies, most often through academics, using a screening process. They further the technology through the mid-stages of the innovation continuum in exchange for a licensing agreement or equity in the company holding the technology. Investors typically aim to sustain themselves by selling their equity or the royalties earned from this licensing agreement.

3) Service Providers focus on providing services and supports to small and medium-sized enterprises (SMEs) and start-ups in order to move an existing product to market. They work in sectors other than health, focus on the later stages of the innovation continuum, and generally aim to recover costs by charging a fee for the services they provide.

2.1 Centre delivery models

Centre delivery models

Funded centres avail themselves of the CECR program's flexibility by implementing their own delivery and governance models, developed to address the centre's specific goals and context. Over the course of the evaluation, it became apparent that, while no two centres are entirely alike, the centres can be categorized into three main delivery models: Commercialization Arms; Investors; and Service Providers. These models should be considered as archetypes, which reflect, in a simplified manner, the main characteristics of the three types of centres. It should be noted that centres may exhibit characteristics of more than one archetype, but they have been associated with the archetype that most closely reflects their primary characteristics.

Figure 2 provides an overview of the delivery models, followed by an explanation for each. Note that only centres that participated in case studies (n=14) are classified by these delivery models, as classification required substantial information on the centre's operations.[3]

[3] In order to develop these archetypes, the evaluation team identified key centre characteristics for each of the case study centres (i.e., sector, main clients, main activities, process to access the centre, current revenue generation strategies, intended revenue generation strategies, and target areas on the commercialization spectrum). Centre representatives were then asked to validate their characteristics. The evaluation team then identified patterns in these characteristics, which exhibited three main groups. Titles for these groups (i.e., Commercialization Arm, Investor, and Service Provider) were created by the evaluation team in order to provide some insight into the archetypes' characteristics.

Figure 2: Centre delivery models

	Commercialization Arm	Investor	Service Provider
Predominant sector	Health	Mainly health (4/5)	Non Health[4]
Client	Self (i.e., the centre)	Academics	SMEs, start-ups
Main activity	Advance own technology	Advance technology *or* provide services/advice	Provide services and advice
Process to access	Exclusive	Competitive	Competitive *or* non-competitive
Sustainability model	Core asset development	Investment	Fee for service/ membership
# of centres	2	5	7

Commercialization Arms are centres that develop and advance their own companies and/or technologies through the full commercialization spectrum. These core assets often have their roots in academia. As they don't have traditional 'clients', the concept of a competitive process to access the centre is not applicable; they work exclusively for their own organization. Based on the case studies, commercialization arms are found in the health and life sciences sector. These centres expect to generate income when the product/technology is sold or licensed.

Investors typically identify promising technologies, most often through academics, using a screening process. They further the technology through the mid-stages of the innovation continuum, de-risking it to the point at which it becomes attractive to more traditional investors. This may involve actively developing a technology (Commercialization Arm) or providing services, advice and networking supports (Service Provider). This is done in exchange for a licensing agreement or equity in the company holding the technology. Investor centres typically aim to sustain themselves by selling their equity or the royalties earned from the licensing agreement. It is this revenue generation model that gives 'Investors' their name. Based on the case studies, Investors usually operate within the health and life sciences sector.

Service Providers focus on providing services and supports to clients. These services may include technical/scientific services, business/professional services, coaching/ mentoring, and/or training. Service Providers also often play a connector role, helping clients to reach potential partners, investors, and/or clients of their own. Clients are typically businesses, including start-ups and SMEs. Based on the case studies, it appears that centres operating as Service Providers operate in any sector except in health and life sciences. The Service Provider will help these clients to get their product to market, most often in exchange for a fee. Service Providers expect that, once their client base and delivery offerings are sufficiently developed, these fees will become their primary source of revenue (and basis for self-sustainability).

[4] Natural resources, Environment, Information & Communication and Cross Sectoral.

It is important to note that development of the archetypes required substantial information relating to the centre's operations and so were based only on information obtained from centres that participated in case studies. This represents 14 of a total of 29 Centres funded by the program and excludes those centres that were only recently funded. As a result, although both of the Centres categorized as Commercialization Arms were in the health sector, this archetype is not necessarily exclusive to the health sector, as it is possible that one of the more recently funded non-health centers could fall into this category. Similarly, although none of the centres in the health sector were categorized as Service Providers, is possible that one of the more recently funded centers in the health sector could fall into this category.

Point of intervention

Centres are designed to support innovations in their movement to market. The evaluation found that there is variation across centres in when this support begins and at what point it concludes.[5]

Again based on case study data, the evaluation found that centres generally clustered around specific points of intervention on the innovation continuum, based on the above mentioned typology. Figure 3 below shows how each delivery model emphasizes different stages of the innovation continuum.[6] Specifically:

Commercialization Arms tend to span the entire continuum, staying with a single innovation (or small group of innovations) through its entire research and development and commercialization lifecycle. The two commercialization arms in our sample have yet to bring their products all the way to market.

Investors tend to begin involvement at the proof of concept stage and stay with the innovation until it is ready for market. This aligns with their approach to de-risking technologies so that they will be attractive to more traditional investors (e.g., venture capitalists and/or larger enterprises) that bring the product into the market.

Service Providers tend to become involved in a technology during the early stage technology development phase and exit after the product is on the market. As these centres are most likely to work with SMEs and start-ups, it is logical that the SMEs/start-ups would seek out services, once they have a concept ready for development, in order to access the supports and services needed to push the product to market.

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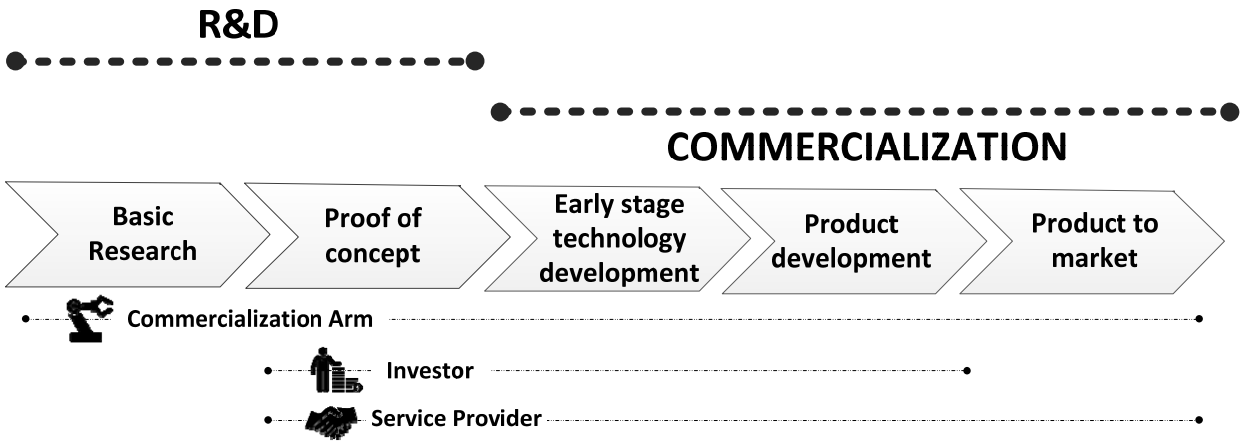
5 Note that there is variation across centres as well as variation within centres (across varying projects). Analysis was conducted based on the most common, or priority points of intervention for each centre.

6 The innovation process is often conceptualized as a continuum ranging from basic research through products in the market. The evaluation chose to adapt a version of this continuum presented in a slide deck by World Bank employees for the Development Impact Evaluation Initiative (Correa and Legovini 2012). This continuum is consistent with the Technology Readiness Levels often used by the Canadian federal government (but presented more simply).

Figure 3: Alignment between delivery models and stages of technology development



3 Relevance of the CECR program

Summary of findings: International sources and the Canadian government recognize that improving innovation and commercialization will benefit Canada's economy and the wellbeing of its citizens. However, Canada's recognized strengths in academic research have not fully transferred to the realm of innovation and commercialization.

Overall, Canada spends less on R&D than other countries, and this disparity is steadily widening over time. More of our R&D funding comes from the higher education sector and less comes from the private sector, suggesting greater emphasis on research than on development. Innovators face substantial challenges in accessing funding/investment for the earlier, riskier stages of commercialization (i.e., the commercialization gap, sometimes dubbed the 'valley of death'), as these are not appealing to traditional profit-motivated investors. In this challenging environment, promising innovations may not reach maturity and therefore do not contribute to the wellbeing of Canadians.

The CECR program aims to fill this gap by building on Canada's existing strengths in research; "matching clusters of academic research expertise with the needs of business, health practitioners, and other end users" (NCE 2016). This is a unique program niche addressed by a very limited number of federal initiatives, even less of which are sector agnostic.

Other key challenges intended to be addressed by the CECR program relate to developing an environment in which innovation can thrive. This includes capacity development (primarily in entrepreneurial skills) and enabling access to commercialization infrastructure.

Supporting the CECR program objectives aligns with federal innovation priorities articulated to date (i.e., 2014 federal ST&I strategy and preceding plans). Program objectives also have a clear and direct connection to NSERC and CIHR strategic plans. The SSHRC strategic plan, however, relates more subtly to CECR objectives. CECR's broad flexibility allows room for centres to support the "connect[ion] of social sciences and humanities research with Canadians" (SSHRC 2016). However, none of the centres funded to date focuses specifically on commercializing innovations that have emerged from the SSH field. Furthermore, several centres (primarily Service Providers) indicated that academics are not amongst their client base and do not appear to draw on academia-generated innovations for the services they provide. This suggests that there may be a shift away from the notion of bridging the gap between academic research and commercialization in the implementation of the program.

3.1 What is the CECR program's added-value?

Innovation and commercialization will benefit Canadians

Innovation is 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" (OECD, Oslo Manual 2005)[7]. Over the past decade, the importance of innovation has become increasingly apparent for Canada's economy, competitiveness, and the well-being of Canadian citizens (Rosenberg 2004; Industry Canada 2014; OECD 2015; World Economic Forum 2016).

> "While not a goal in itself, innovation provides the foundation for new businesses, new jobs and productivity growth and is thus an important driver of economic growth and development. Innovation can help address pressing social and global challenges, including demographic shifts, resource scarcity and the changing climate. Moreover, innovation can help address these challenges at the lowest cost. Innovative economies are more productive, more resilient, more adaptable to change and better able to support higher living standards." (OECD, 2015)

The innovation process can be seen as culminating in commercialization that is, developing new ideas or discoveries into products, services, or technologies that are sold in the marketplace (Statistics Canada 2007; Department of Finance Canada 2004).

Canada is strong in academic research but weak in innovation/commercialization

In the three complementary spheres of science, technology and innovation, Canada exhibits both strengths and challenges. Canada's academic research is considered to be strong and well regarded; while Canada's business innovation and commercialization of academic research is comparatively weak (CCA 2013; Jenkins et. al. 2011; DFC 2006).

Canada's strengths and challenges can be demonstrated by using key "positioning indicators", which are traditionally used to measure the science and innovation profile of a country. These positioning indicators allow for comparison between countries as well as over time. They include: higher education expenditure on R&D (HERD) expressed as a percentage of gross domestic product (GDP)[8]; gross domestic expenditure on R&D (GERD) expressed as a percentage of GDP[9]; and business enterprise expenditures on research and development (BERD) expressed as a percentage of GDP.[10]

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[7] Cited in Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation (2014). https://www.ic.gc.ca/eic/site/icgc.nsf/vwapj/Seizing_Moment_ST_I-Report-2014-eng.pdf/$file/Seizing_Moment_ST_I-Report-2014-eng.pdf

[8] **Higher education expenditure on R&D (HERD) –** The higher education sector is composed of all institutes of post-secondary education (e.g., universities, colleges) regardless of their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, the higher education establishments. (Statistics Canada 2010)

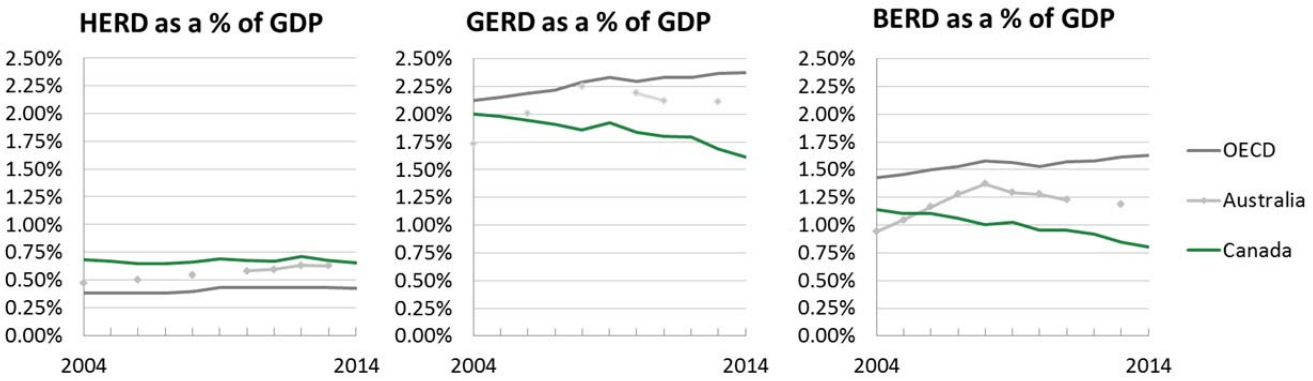
[9] **Gross domestic spending on R&D (GERD)** is defined as the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc., in a country. It includes R&D funded from abroad, but excludes domestic funds for R&D performed outside the domestic economy. (OECD 2017)

[10] **Business enterprise expenditure on R&D (BERD)** covers R&D activities carried out in the business sector by performing companies and institutes, regardless of the origin of funding. The business enterprise sector includes all companies, organisations and institutions whose primary activity is the production of goods and services for sale to the general public at an economically significant price and the private and not-for-profit institutions mainly serving them. (OECD 2011)

In comparison to the OECD as a whole, as well as Australia (the OECD country most similar to Canada in terms of physical environment, population, political and economic climate):

1. Canada's HERD (higher education expenditure on R&D) is a greater percentage of the total country GDP; and
2. Both Canada's GERD and BERD (gross domestic expenditure on R&D and business enterprise expenditures on R&D) are lower percentages of the total country GDP.

Figure 4: Canada's HERD, GERD and BERD as a % of GDP



Source: Main Science and Technology Indicators. www.stats.oecd.org. HERD as a percentage of GDP, GERD as a percentage of GDP, BERD as a percentage of GDP. Retrieved January 24 2017.

The CECR program builds on Canada's strengths by bridging academia and commercialization

Rather than focusing solely on R&D, the federal government believes that Canada should also build on its current strength in fundamental science – connecting academia and industry to commercialize emergent innovations (Industry Canada 2007; CCA 2013; Industry Canada 2014). As the federal government's key vehicles for investment in higher education, the granting agencies (CFI, CIHR, NSERC and SSHRC) make substantial investments to connect industry and academia for enhanced innovation and commercialization. Much of this investment focuses on research collaborations that transfer and develop knowledge that helps businesses innovate. This 'bridging' is expected to increase the translation/mobilization of research to develop products, improve services and improve processes, all with the intent of leading to economic growth.

The need to bridge the gap between academic research and commercialization is recognized in Canada's ST&I strategy (2014) as well as the 2016 mandate letters from the Prime Minister to the Ministers of ISED and Science. Key research organizations (e.g., Colleges and Institutes Canada, Universities Canada) also highlighted the need to focus on bridging the gap between basic research and commercialization of research in their submissions to the 2016 independent review of federal support for fundamental science (Universities Canada 2016; CCI 2016). The CECR program is specifically designed to address this identified need by "matching clusters of academic research expertise with the needs of business, health practitioners, and other end users" to share the knowledge and resources that bring innovations to market faster (NCE 2016).

The CECR program fills a niche

Canada has a range of initiatives in place to support innovation and commercialization, including technology transfer offices at most post-secondary institutions, national, provincial and independent programming. Key characteristics of these programs include:

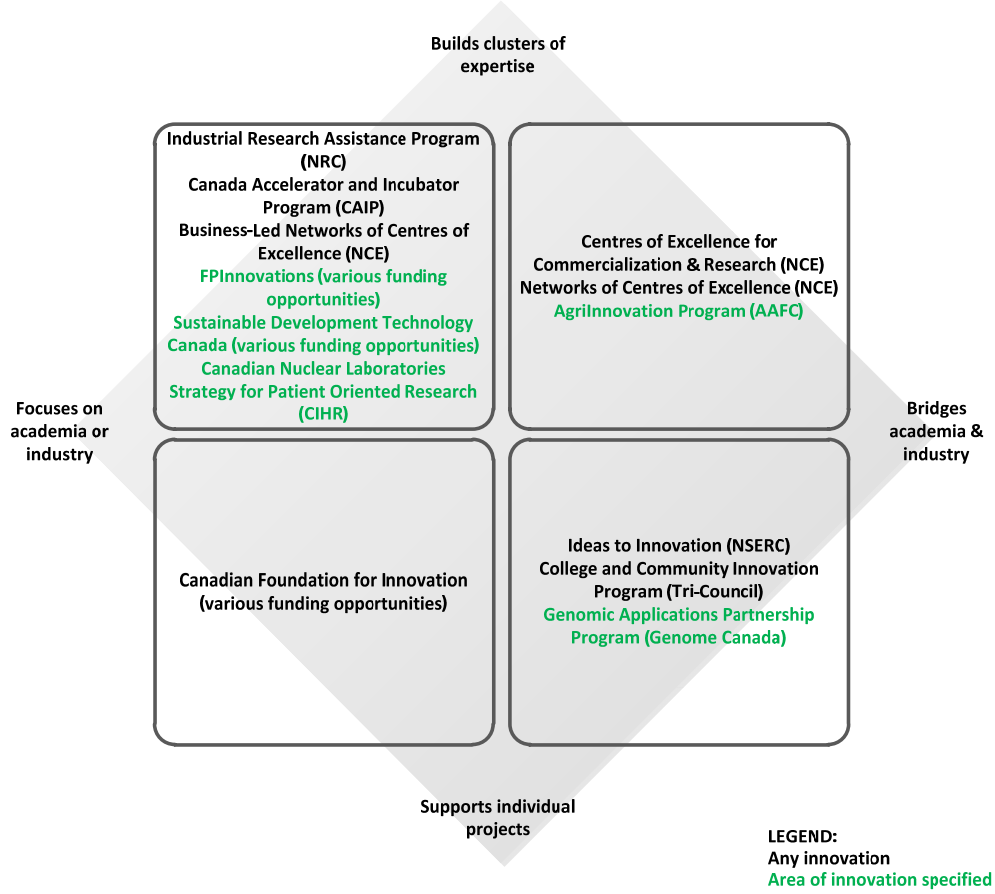
- **Geographic scope** – Programs may be limited to specific provinces, regions and/or municipalities *or* (like the CECR program) they may support national programs.[11]
- **Content area** – Programs may restrict the area of innovation to focus on the funding organization's mandate area *or* (like the CECR program) they may be open to innovation/commercialization projects of all types.
- **Target audience** – Programs may focus specifically on academia or industry *or* (like the CECR program) they may emphasize bridging academia with industry.
- **Project scope** – Programs may support individual innovation/commercialization projects *or* (like the CECR program) they may develop clusters of expertise that then nurture multiple innovation/commercialization projects.

As seen in Figure 5 below, innovation and commercialization programs with the same characteristics as the CECR program are relatively rare; the CECR program is one of the few national programs that address commercialization and research in broad content areas by bridging academia and the private sector and developing clusters of expertise.[12] As such, the CECR program is poised to generate additional value for Canada's ST&I ecosystem.

[11] It should be noted that geographically limited innovation/commercialization programs often leverage federal funding, including CECR program funding.

[12] A broader review of complimentary programs would show that collaborative research programs funded by the tri-agencies often generate substantial amounts of formal IP.

Figure 5: National innovation and commercialization programming in Canada



Case study respondents also commented that the CECR program uniquely provides a relatively high amount of funding (up to $15M per centre over five years) and does so upfront (rather than on a reimbursement basis), which provides centres with sufficient working capital to be active.

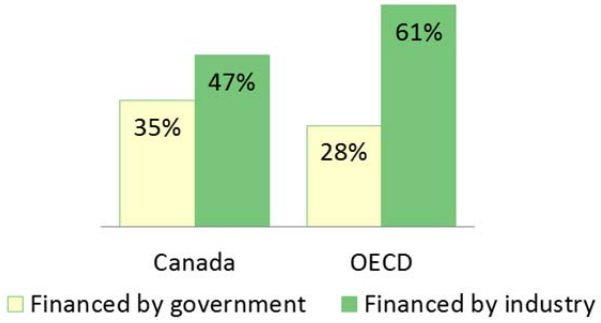
3.2 What challenges does the CECR program address?

Access to funding is a challenge

The most common innovation challenge is the lack of funding or investment to bridge the commercialization gap. All lines of evidence (interview, case study, survey, and literature review) show that there is a gap in financial support at the riskier, early stages of commercialization. This challenge is also recognized globally, with OECD indicating that access to finance is a challenge for young, innovative companies as they begin to grow (OECD 2015). Early stage finance is needed for the creation and development of innovative ventures (OECD 2015). Respondents also suggested that, as innovations in the health and life sciences often take longer to move through these early stages, the lack of funding has a more profound impact on this sector.

54% of survey respondents indicated lack of funding/investment as a challenge

Figure 6: Percent of GERD financed by government vs. industry (2014)



Source: Main Science and Technology Indicators. www.stats.oecd.org. Percent of GERD financed by government, Percent of GERD financed by industry. Retrieved January 24 2017.

Expenditures on R&D are not only lower in Canada (as indicated in Section 3.1 above), they are also less likely to be provided by private sector industry. In Canada, industry finances a lower proportion of research and development (R&D) than in other countries (see Figure 6). The result of the lower private sector interest in R&D is that there are fewer innovations to develop and adopt, and Canada lags behind other countries in productivity and economic growth (Industry Canada 2007; CCA 2013).

The literature suggests that the lack of industry financing for R&D may be linked to an environment in which innovation has appeared unnecessary to many enterprises, including factors such as: the economy relying on natural resources, the privileged trading relationship with the United States, a favourable exchange rate and an abundant labour supply. Furthermore, industry may be further disinclined to invest in R&D due to other gaps in the Canadian ecosystem related to access to business or technical advice, lack of access to cutting-edge equipment and laboratory services, lack of access to talent (i.e., skilled labour), lack of entrepreneurial culture, shortage of commercial receptor capacity, and lack of management/business expertise (CCA 2012).

Skill development and access to infrastructure are challenges

In its Innovation Strategy 2015, the OECD suggests that innovation thrives in an environment with a skilled workforce with the capacity "to generate new ideas and technology, bring them to market and implement them in the workplace, and that is able to adapt to technological and structural changes across society" (OECD 2015). It is also cautioned that current pedagogical approaches emphasize research to the detriment of these commercialization-related skills.

This gap is reflected in the challenges identified by evaluation respondents, who most commonly identified a lack of commercialization skills, including market development skills and entrepreneurial culture as challenges (case studies, key informant interviews, 23% of survey respondents).

Other commonly mentioned challenges for commercialization include:

- Technical or scientific challenges (case studies, 38% survey respondents);
- General lack of expertise (27% survey respondents);
- Ability to navigate regulatory requirements (case studies);
- Access to talent (case studies); and

- Infrastructure, including the need for cutting-edge equipment and laboratory services (case studies, 14% of survey respondents) as well as access to partners and networks (30% of survey respondents).

Centres facilitate access to funding, skill development and infrastructure

Between 2010-11 and 2014-15, funded centres served approximately 4,500 organizations.[13] During the latter three years for which company size data was collected, over three quarters (79%) of the organizations served were SMEs.[14]

79% of organizations served are SMEs

Most of the organizations served (68%) receive financial support from the centre, often in the form of grants, loans, and/or investment, compensating to some extent for the limited industry investment available in Canada. Among those that received financial support, the median level of financial support was about $50K. 61% of organizations received other types of services or supports, including developing/supplementing business expertise, developing/supplementing technical expertise, helping companies access other funding or infrastructure, and networking/connection building. Figure 7 below shows the perspectives of centre clients regarding the services and supports available to them and Figure 8 below shows which services and supports were believed to be the most useful. Both case study and survey respondents believed that centres were supporting organizations in addressing commercialization challenges, with 59% of survey respondents indicating that the centre had addressed their challenges to a good or great extent.

It should be noted that centres within the health and life-sciences typically use a different approach to providing these services and supports, likely in response to the time, cost and regulatory challenges mentioned previously. All Commercialization Arms and most Investor-type centres work in the health and life sciences, while no Service Providers work in this area. This suggests that innovation/commercialization within the health and life sciences requires a longer term involvement in which the centre takes more direct responsibility for the advancement of the technology. This is dissimilar to commercialization in other sectors where an à la carte services (such as those offered by a Service Provider) may be sufficient. Furthermore, the graphs below are not reflective of Commercialization Arms, as these types of centres have no 'clients' in the typical sense of the word, and therefore make up only 1% of the supported organizations that responded to the survey.

[13] Source: Centre Annual Reports, NCE summary tables 2010-11 to 2014-15
[14] Source: Centre Annual Reports, NCE summary tables 2012-13 to 2014-15, N ≈ 3,600.

Figure 7: Types of assistance provided by centres (client perspectives)

Source: Survey of centre-supported organizations (2016), n=176

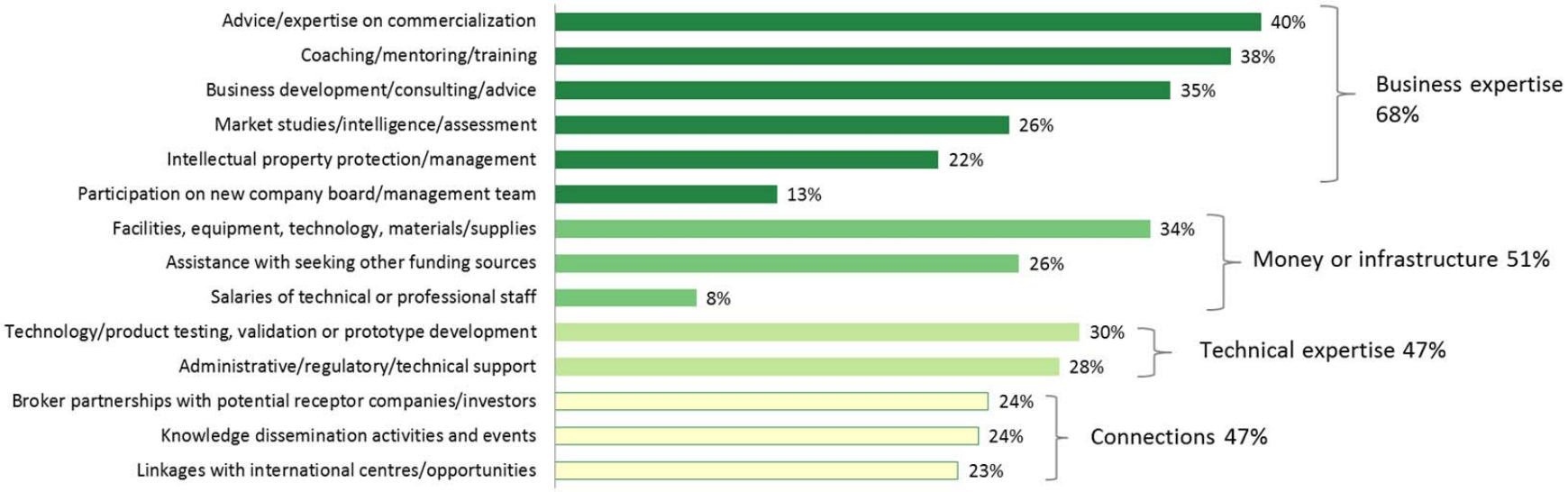
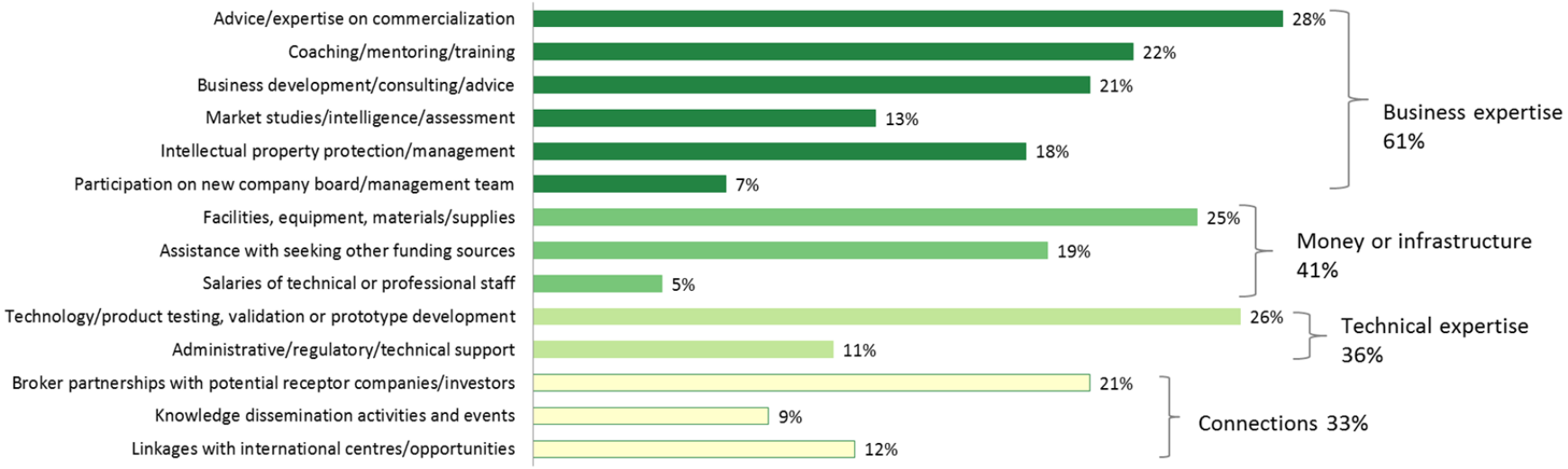


Figure 8: Types of assistance considered by clients to be most useful

Source: Survey of centre-supported organizations (2016), n=126



3.3 How does the CECR program align with federal roles and priorities?

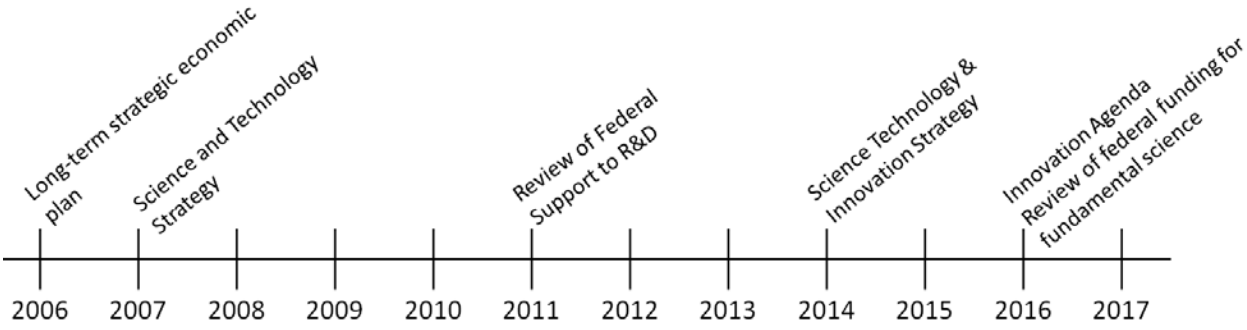
Innovation is an enduring federal priority

According to the OECD Innovation Strategy, "Governments play a key role in fostering a sound environment for innovation, in investing in the foundations for innovation, in helping overcome certain barriers to innovation and in ensuring that innovation contributes to key goal of public policy" (OECD 2015).

The value placed on innovation is mirrored in Canada's growing body of policy intended to address the subject (see Figure 9). This evolving cadre of policy is intended to make Canada more productive and competitive; to address both economic and social challenges (Industry Canada 2014). Collectively, the key documents mentioned in Figure 9, as well as the 2016 mandate letters to the Minister of ISED and Minister of Science, indicate an ongoing recognition by the federal government of the value of innovation and an ongoing commitment to support it.

Canada is currently in the process of developing a new innovation agenda. Once released, the agenda should clarify any changes to Canada's federal government priorities.

Figure 9: Timeline of federal innovation-related strategies and reviews



Federal funding is a catalyst for other potential funders

Key informants remarked that only government can financially support areas deemed too high risk by the private sector. While provincial governments can and do provide financial support, this varies by province and many require that recipients leverage funds from other sources.

Federal funds go beyond financial support and act as a catalyst for other partners (including provincial governments) to become involved. Some respondents commented that as a centre branded under the CECR program, their centre is believed to be more reputable and altruistic, and is therefore more attractive to potential partners and clients.

The CECR program objective is consistent with all three funding agencies strategic priorities

As mentioned above, CECR's broad program objective is to match research expertise with the business community and other receptors (NCE 2016). In the CECR logic model, ultimate

outcomes are articulated as: 1) Canada is known as the host of internationally recognized centres of excellence in commercialization, and 2) centres yield economic, social, health and environmental benefits. These objectives/outcomes are broad, allowing for flexibility and suggesting consistency with aspects of each of the three funding agencies' strategic plans.

Both NSERC and CIHR have clear and direct connections to these objectives/outcomes. **NSERC** aims to "strengthen the dynamic between discovery and innovation," supporting connections between academia and industry, helping researchers move from discovery to innovation, and de-risking discoveries for future investment (NSERC 2016). **CIHR** works to "mobiliz[e] health research for transformation and impact." Within this strategic direction, a top priority is accelerating the discovery, development, evaluation and integration of health innovations into practice. CIHR acknowledges that success in this area will enable commercialization (CIHR 2015). **SSHRC** relates to CECR objectives/outcomes in a somewhat less obvious manner in that it aims to "connect social sciences and humanities research with Canadians," by "advanc[ing] opportunities for the results of its funding – new ideas and trained people – to be more accessible to Canadian organizations in all sectors…" (SSHRC 2016).

Centre implementation may be shifting away from the notion of "bridging the gap" between academic research and commercialization

While each type of centre (i.e., Commercialization Arms, Investors, and Service Providers) has the potential to match research expertise with the business community and 'bridge the gap between academic research and commercialization', this is not always the case in actual implementation. Amongst case study respondents, four (/9) Service Providers and one (/3) Investor indicated that academics were not amongst their client base. This is substantiated by survey results in which only 23% of client respondents are based in universities, research institutes, or hospitals. In addition, for Service Providers in particular, the services provided do not necessarily involve innovations generated within academia.

Furthermore, none of the centres funded to-date focus specifically on commercializing innovations that have emerged from the social sciences or humanities (SSH). Of the 29 centres funded to date, 16 operate within the health and life sciences (best fit alignment with CIHR). The remaining centres focus on natural resources (4), information and communication (3), environment (1), or are cross sectoral (5); and align most closely with the natural science and engineering (NSE) mandate of NSERC.

To some extent, knowledge from the social sciences and humanities is currently being mobilized, less directly, within the centres. Over one third (38%) of centre board members had educational backgrounds in the social sciences and/or humanities.[15] In addition, many of the centres (Service Providers in particular) support clients in developing entrepreneurial skills that have their roots in the social sciences. However, this does not necessarily mean that the centres are tapping into current SSH research or innovations. Recent OECD literature claims that maintaining a robust innovation ecosystem requires "a scope beyond science and technology, involving investments in

[15] In most centres, at least a third of board members have SSH background. In health and life science centres, the proportion of board members with a SSH background ranges from 0% to 56%.

a wide range of knowledge-based assets that extend beyond R&D" and that "[s]ocial and organizational innovations, including new business models, are increasingly important to complement technological innovation" (OECD 2015). This suggests that there is room, and perhaps even a need, within the broader CECR objectives/outcomes to incorporate a broader perspective on what constitutes innovation.

4 Commercialization and economic outcomes

Summary of Findings: Between 2010-11 and 2014-15, centres supported:

- Bringing 643 new products/services to market;
- Obtaining 313 new patents;
- Granting 112 new licences; and
- Creating over 222 new companies.

Centre-supported companies have better commercialization and economic outcomes than unsupported companies. Specifically, they see a significant growth premium in sales (54%), R&D expenditure (25%), number of employees (24%) and wages (8%) in comparison to unsupported companies.

While contributing factors are unclear, evidence does suggest that the flexibility embedded in the CECR program contributes to different centres achieving different positive outcomes. Some of the figures mentioned above are largely influenced by the efforts of one or two individual centres. There also appears to be a correlation between delivery model/sectors and select outcomes.[16] Investors/health sector centres are more often linked to the creation of new companies and IP protection. Service Providers/non-health sector centres are more often linked with accelerated time to market, company growth, and increased company competitiveness. Also, given that Commercialization Arms do not have clients per se, and that their portfolios of supported innovations only contain a small number of products in the early stages of commercialization, commercialization and economic outcomes from these centres are largely unknown.

According to stakeholders, key practices for an effective centre involve having a strong and active board as well as talented staff.

4.1 Does the CECR program move products to market?

Centres help companies bring their products to market

Data sources[17] agree that centres are positively influencing whether companies bring their product to market and how quickly. Specifically, 56% of surveyed companies reported that if the centre's assistance or support had not been provided, there would have been a major negative impact on their commercialization project and 40% reported that the centre's assistance had accelerated the time to bring their innovation to market. Centre annual reports indicate that since

[16] Because all Service Providers are in sectors outside of health and most Investors operate within the health sector, it is difficult to tease out the interplay between sector and delivery model.

[17] Case studies, key informant interviews, surveys, annual reports

2010-11, 643 new products/services have been brought to market by companies served by centres.

Consistent with the longer commercialization cycle for drugs and medical devices, organizations that are commercializing in the health and life sciences sector were less likely to report an impact on their path to market.

IP protection is concentrated among select centres and companies

Centres report that a total of 313 patents were issued and 112 licences were granted for intellectual property supported by the centres since 2010-11. However, given the lack of a point of comparison, it is difficult to assess whether these figures are high, low or moderate.

More interestingly, IP protection seems to be concentrated in a small number of companies and centres. The survey shows that less than a third of companies reported some patent activity (e.g., 26% reported a patent had been filed and 11% reported a patent had been issued). Also, a third of companies (33%) said their involvement with the centre had led to the execution of a confidentiality, non-disclosure or other agreement. Finally, 8% and 4% of companies reported licences being issued and filed, respectively.

A further breakdown of patent and licencing figures from the administrative data shows that this type of activity was more common in Investor type centres (with academics as their main clients and health as the main sectoral focus).[18] During the period under study, three centres with a mix of delivery models were responsible for the 61% of the patents issued (27%, 19%, and 15% respectively).

4.2 Does the CECR program support company development?

Most centres support company creation

According to administrative data, more than half of the centres (19/27) have supported company creation. Based on data from the centres, the NCE Secretariat estimates that 222 new companies have been created. The majority (70%) of newly created companies were supported by two centres (one Investor and one unknown type[19]). There is no administrative data on how many of these companies are still in operation, their size, or whether they originated from within academia. However, from the survey, 23% of companies (n=39) indicated that their involvement with the centre had led to the creation of a start-up or spin-off company(ies) and all of these said that the company(ies) were still operational (although about

> "[The centre] assisted in the creation of another company, getting the structure together, [teaching us] how to access capital, and put in a bit of money towards the venture."
>
> -Case study respondent

[18] Survey results also loosely support this, with companies accessing Investor centres reporting IP protection activities more frequently than expected all other things being equal (count=28, expected count = 16.1)

[19] Only centres participating in case studies were assigned delivery models as classification required substantial data. As this centre did not participate in a case study it is not clear what model best describes the centre.

one-third were not yet revenue-generating). Also, in the survey there was a significant correlation between creation of a start-up or spin-off an involvement with an Investor.

Case studies reinforced these findings although actual figures pertaining to the creation of start-ups/spin-offs was not available. However, centre representatives were able to provide many examples of support provided to develop and maintain start-up companies.

Centre involvement is correlated with higher sales

The survey of companies and the econometric analysis (which included a comparison to matched companies that had not received services from a centre) found that some companies have grown as a result of the assistance provided by a centre.

In terms of sales growth, the econometric analysis found that centre-assisted companies grew faster than the comparison group. Specifically, in the first year following the match, centre-assisted companies enjoyed a statistically significant premium in sales growth of 18%. The growth premium reflects both the growth of centre-assisted companies as well as a decline in the comparison group.[20] This decline is consistent with concerns confirmed by the literature that young innovative companies may struggle to grow. Moreover, sales growth continued to be significantly higher than the comparison group over a three-year span. The econometric analysis also tracked a subset of centre-assisted companies (and non-assisted comparison companies) over three years: in these cases the sales growth premium improved over time, growing from 36% after 1 year to 54% after 3 years.

> "Using the [centre] research lab's capacity contributed to cost-savings for the company and an opportunity to demonstrate the economic viability of the technology to investors – resulting in the longer-term viability of the spin-off."
>
> -Case study respondent

The survey explored the concept of growth as well, although it included the number of employees as an example of growth whereas the econometric analysis considered employment growth separately (presented below). Despite this inconsistency in the definition of growth, 27% of companies responding to the survey said that their company had already grown and another 30% said that they are likely to grow.

Centre involvement is correlated with growth in R&D expenditures

The econometric analysis also revealed that centre-assisted companies had a small but statistically significant growth with regards to R&D expenditures in their first year: supported companies increased R&D by 2% while unsupported companies declined by 11% (for a 13% growth premium). However, this slight increase in R&D expenditures was temporary; after three years, the supported companies only maintained their initial level of expenditures on R&D. In contrast, the comparison group continually reduced their R&D expenditures below their initial level, resulting in a 25% statistically significant premium for assisted companies after 3 years.

[20] Growth premium refers to the absolute difference in growth between centre-supported companies and the comparison group. For example, in year one, centre-supported companies increased sales by an average of 1.5% while the control group decreased sales by an average of 16.7%, expressed as a 18.2% growth premium.

From the survey, 44% of supported companies said that they had increased their investment and/or capacity in R&D and another 15% said this outcome was likely to occur.

Since both sets of companies started out with the same level of expenditures and the comparison group of unassisted companies suffered a significant decline, the econometric analysis findings are consistent with the explanation that without some form of support (such as that provided by centres), many of these companies may have simply not been able to continue to finance their research or commercialization activities to the same extent.

Centre-supported companies hire more employees and pay more wages

Based on centre annual reports, almost 4,000 jobs were created in 2014-15 as a result of centre activities.[21] The econometric analysis confirmed that centre-assisted companies saw a 10% increase in employment in their first year. Considering both growth by centre-assisted companies and the decline in employment of the comparison group, the employment growth premium was 15% and statistically significant. Additionally, this employment growth premium increased over time, to 24% after three years.

Impacts for individual companies are variable. According to the survey, among the 27% of companies that indicated an impact on growth as a result of their involvement with the centre, the number of jobs created at their company ranged from 1 to 75. The administrative and survey data confirm that job creation is associated with successful company creation (i.e., centres reporting larger numbers of start-ups also reported larger number of jobs created). The administrative data also show that employment growth is concentrated in the information and communication technology (ICT) sector, although this has been largely fueled by the significant job creation reported by one centre. As a general rule, however, companies commercializing in the health sector are less likely to report growth.

Wage expenditures is another way of looking at company performance as an increase in wages paid suggests either hiring more employees or more skilled employees with higher wages. Looking at the results on the average wages paid by the company, the econometric analysis saw no significant difference between centre-assisted companies and unsupported companies in their first year. However, after a 3-year timeframe, the difference in growth rates for the average wage rate is 8% and statistically significant, offering some evidence that centre-assisted companies end up paying higher wages than otherwise similar companies.

Centre-assisted companies have attracted additional investments

Centre annual reports indicate that substantial investments have been made in centre-supported companies from both Canadian and foreign sources between 2012-13 and 2014-15. The data indicate that over $10B in investment has been obtained (about 10% of this from foreign investors) by companies served by the centres (see Figure 10).

[21] Centres report annually on the number of positions created, which can include positions created and sustained from previous years. Therefore, it is not possible to aggregate job creation numbers over the study period.

Figure 10: Investments accessed by centre-supported companies

	Canadian Investments	Foreign Investments	Total Investments
2012-2013	$674 million	$409 million	$1.08 billion
2013-2014	$384 million	$396 million	$780 million
2014-2015	$8.19 billion[22]	$363 million	$8.55 billion
Total	**$9.24 billion**	**$1.17 billion**	**$10.41 billion**

Source: Centre Annual Reports

According to the survey, 32% of companies reported receiving investments as a result of their work with the centre. The most common sources of additional investments are government (federal (46%) or provincial (30%)), and venture capital/angel investors (37%) or other private industry sources (24%).

Econometric analysis shows that growth in total assets is significantly higher for centre-supported companies than non-centre companies. In year one, centre-supported companies increased assets by an average of 4% while unsupported companies decreased by 7% (for a growth premium of 11%). Results over a three year time frame were not statistically significant.

> "The centre helped to promote our technology at national and international events, increasing our credibility in scientific institutions and in the marketplace. [Because of this, we] were able to attract funding and investments, and to establish a global presence in the market. Company growth has since tripled."
>
> -Case study respondent

4.3 What factors influence commercialization and economic outcomes?

Sector and delivery model have some relationship with achievement of outcomes

The evaluation found that companies receiving services from non-health[23] centres were more likely than those working with health centres to report: economic, social, or cultural benefits; accelerated time to market; company growth; and increased company competitiveness. Similarly, companies receiving services from Service Providers were more likely than those accessing Investors to report: economic, social or cultural benefits; accelerated time to market; and attraction of new funding. Finally, companies receiving services from Investors were more likely than Service Providers to report creation of a new start up or spin off.

Given that all Service Providers operate in sectors outside of health and life sciences, it is not clear whether it is the sector or the delivery model that most accurately predicts the two outcomes with similar trends (economic/social/cultural benefits and accelerated time to market).

[22] The large one-year increase is due to a large jump in reported investment by one centre where three organizations/companies served attracted 8 billion dollars in Canadian investments.

[23] Given the relatively small number of centres funded, it was not possible to conduct analysis based on each sector. However, as health and life sciences centres represent more than 50% of funded centres it *was* possible to compare them to other sectors in general.

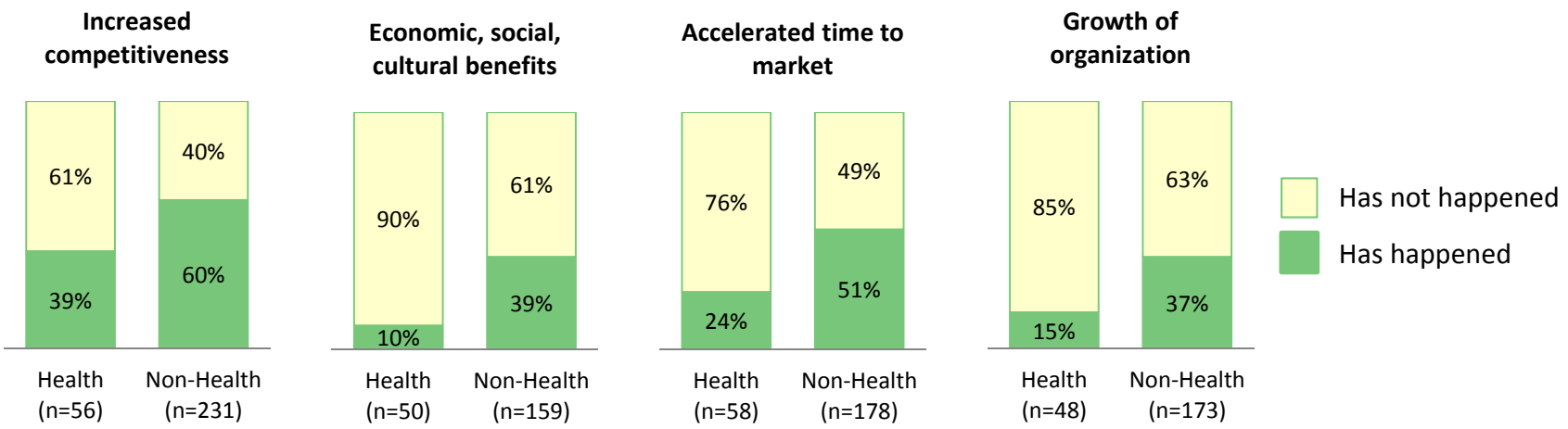
Also, stakeholders from case studies and interviews cautioned that commercialization within the health and life sciences sector is a particularly lengthy process. As such, it is possible that survey data speaks to results achieved first – and not necessarily results achieved overall.

Also, given that Commercialization Arms do not have clients per se, and that their portfolios of supported innovations only contain a small number of products in the early stages of commercialization, it is difficult to determine the specific strengths of this delivery model. Commercialization and economic outcomes from these centres are largely unknown as it is too early for their products to have reached the market.

Figure 11A shows, out of those clients that indicated they have already achieved each of the specified outcomes, the proportion that are clients of centres in the health and life sciences and the proportion that are clients of centres in other sectors. Similarly, Figure 11B shows, out of those clients that indicated they have already achieved each of the specified outcomes, the proportion that are clients of Investor centres and the proportion that are clients of Service Providers. In both figures, only outcomes with statistically significant variations between sectors or delivery models are shown ($P<.05$).[24]

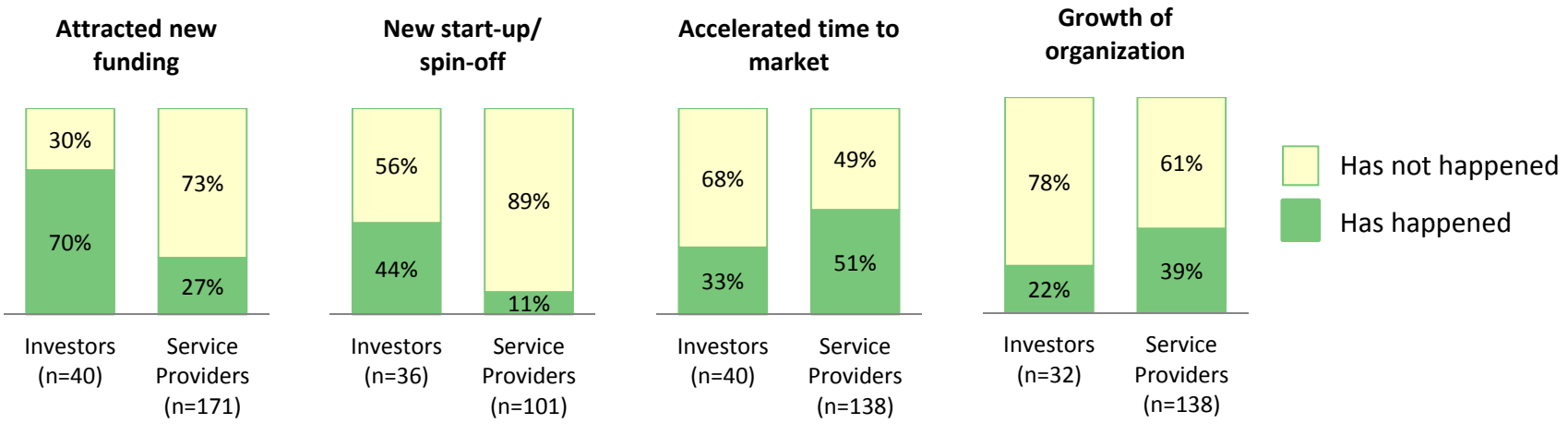
[24] Respondents were asked about a series of potential outcomes including those shown in Figures 11A and 11B, as well as: increase to organization's knowledge base, new or improved product/process/service, increased investment or capacity in R&D, environmental benefits, and health benefits.

Figure 11A: Commercialization outcomes by sector



Source: Survey of centre-supported organizations (2016)

Figure 11B: Commercialization outcomes by delivery model



Source: Survey of centre-supported organizations (2016)

Both figures show the only outcomes for which a significant relationship has been measured between the fact that the client had experience or not, the outcome and the sector or the delivery model of the centre (P<.05).Note that econometric analysis showed no statistically significant differences between centre sectors with regards to growth relative to their respective comparison groups in employees, sales, wages or R&D expenditures.

It is unclear which services are most effective

The evaluation evidence points to a number of factors that may have an influence on companies' achievement of outcomes. However, there is no clear case for centres to provide one set of services over another. For example, multiple case studies and the survey of companies noted the importance and usefulness of aspects of the centres' services such as providing marketing/business expertise that SMEs lack, access to centres' networks (including potential clients and collaborators) and proximity of and access to laboratory facilities and/or equipment. Access to technology/product testing and prototype development was also mentioned as being a useful service by about a quarter of survey respondents. However, it cannot be said that the centres that do not provide one or more of these services are less effective than those that do. Similarly, while benefits were identified when services were tailored by a centre for a specific sector, there were also instances where the cross-sectoral nature of a centre benefitted the companies they served.

The type and extent of impacts on companies may also depend on other factors not explored through the evaluation, such as the maturity of the centre.

Lessons learned in centre management

As part of the case studies, centres were asked to identify lessons learned and best practices from the centre's management and delivery of services. Almost all centres highlighted the importance of a strong and active board as well as dedicated and talented staff as key success factors (i.e., having access to the right expertise).

Other trends in centre management best practices included:

- Focused and consistent project selection/centre strategy;
- Leveraging infrastructure/resources of other organizations;
- Making strategic investments in tools and processes;
- Making centre interventions at the right stage and/or in the right way;
- Ensuring that the right team/people are in place; and
- Flexibility/creativity.

Expert panel/PSAB interviewees commented on the value of engaging industry support early. They noted that some centres have engaged industry "from the beginning" which has allowed for cash and in-kind contributions as well as mentorship.

5 Self-sustainability

Summary of findings: Most centres are moving towards self-sustainability, leveraging CECR grants to obtain additional funds and decreasing their reliance on the CECR program. Just over half (12/22) of centres secured other income (i.e., contributions and revenues) greater than the value of their CECR grants within their first five years. Furthermore, to date (including funding extensions) for every $1 the CECR program has provided, centres have leveraged an additional $1.89 in cash and 41¢ in in-kind contributions.

For the most part, centres are able to continue their operations once CECR funding has discontinued. However, centres caution that discontinuation of CECR funding is often associated with a scale back in centre activities and may also undermine the extent to which centres maintain alignment with the CECR program's other objectives.

Establishing the correlation between centre characteristics and self-sustainability is a difficult task and is mainly based on data collected through case studies. However, it can be said that within the first five years:

- Service Providers/non-health centres have the greatest decrease in reliance on CECR funding while Commercialization Arms have the smallest decrease in reliance on CECR funding.
- Service Providers and Investors both have increases in income from non-government sources greater than Commercialization Arms. Non-health centres have increases in income from non-government sources greater than health centres.

The evaluation suggests that additional time (beyond the initial five years of funding) is necessary to achieve self-sustainability without negatively impacting the centre's ability to pursue its original mission. The required time frame may be even longer for centres operating within the health and life sciences sector, which involves longer technology development times, higher costs, and increased regulatory requirements.

Finally, there appears to be some confusion regarding the CECR program's definition for and expectations regarding self- sustainability. It is unclear to some PSAB members and centre representatives whether success is defined as the ability to continue operations without CECR funds or the ability to continue operations in the absence of *any* public funding.

5.1 Are centres becoming self-sustainable?

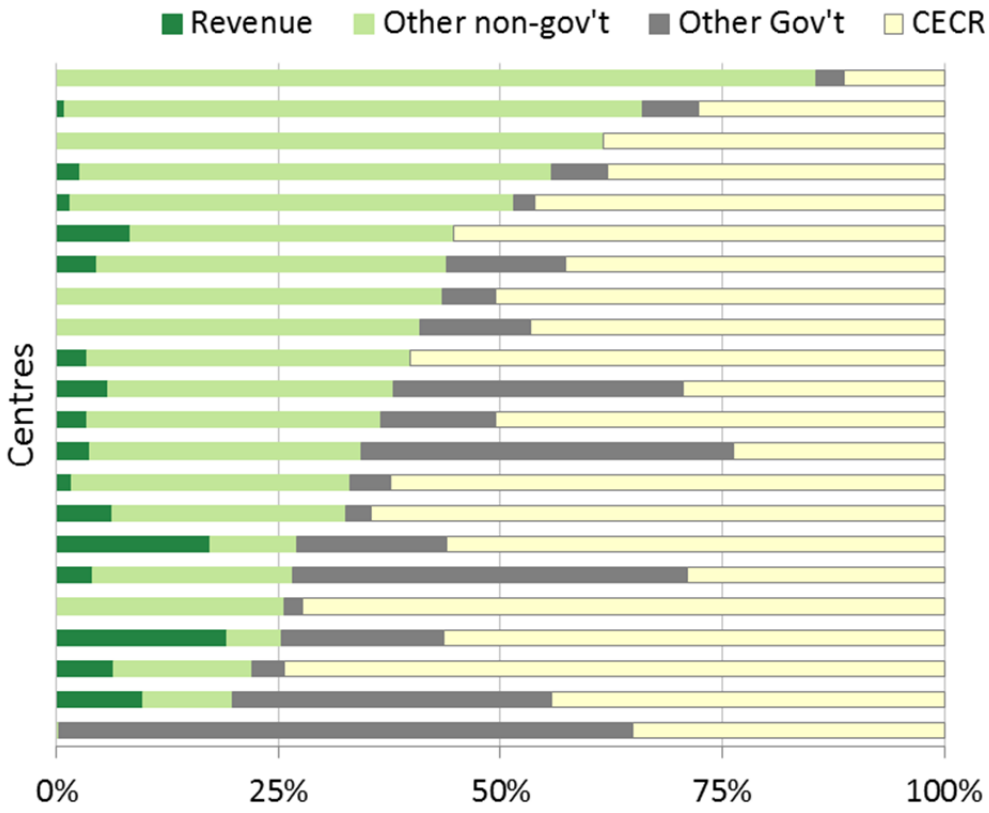
Self-sustainability is one of the CECR program's intermediate outcomes. Specifically, centres are expected to develop investment, financial returns and partnerships allowing them to develop a legacy and become self-sustainable (NCE 2013). "Within the context of the CECR program, self-sustainability is defined as centres being able to continue their core activities beyond the CECR funding by establishing a strong business model and partnerships" (NCE 2016). In theory, by centres achieving self-sustainability, the CECR program is enabled to fund new centres and expand its influence.

Centres leverage CECR funds[25]

Just over half (12/22) of centres secured other income (i.e., contributions and revenues) greater than the value of their CECR grants within their first five years. This varies widely, with centres receiving an average of 54% of income from sources other than the CECR program in their first five years. To date (including funding extensions), for every $1 the CECR program has provided, centres leveraged an additional $1.89 in cash and 41¢ through in-kind contributions. [26]

Furthermore, all but one centre has received at least some income from non-government sources (i.e., revenue and/or contributions from industry, academia, host organizations, and 'other'). Non-government income ranged from 20% to 86% of total centre income, with an average of 39% (shown in Figure 11 below). Average centre revenue (i.e., a subset of non-government income; income generated through fees, equity exit, etc.) is just 5% of total income and almost a fifth (4/22) of centres have no revenue. Industry investment (another subset of non-government income) is on average 22% of centre income, again with a wide range of 2% to 77% (excluding one centre with no industry investment).

Figure 11: Centre funding sources



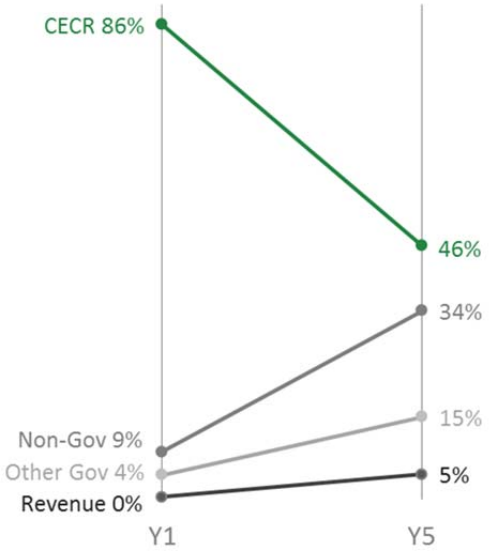
Source: Centre annual reports, NCE summary tables 2008-09 to 2014-15 (includes first five years of each centre's operations).

[25] Unless otherwise specified, all data in this section include both cash and in-kind revenues and contributions from the first five years of each centre. Unless otherwise specified, all data in this section exclude centres funded in the 2014 and 2016 cohorts as these centres are still in their early developmental stages.

[26] Including all years of centre operation and excluding 2014 and 2016 cohorts, CECR has granted $345,500,527 and centres have leveraged an additional $651,384,425 in cash and $143,015,218 through in-kind contributions.

Most centres have decreased reliance on CECR funds[27]

Figure 12: Change in percent of funding from each source



Source: Centre annual reports, NCE summary tables 2008-09 to 2014-15

All but one centre decreased their dependency on CECR funds over time, moving from an average of 86% of income from CECR in year one to 46% of income from CECR in year five. The extent of that decrease ranged from 19% to 78%, depending on the centre (excluding one centre with no decrease in reliance). Figure 12 shows the average cumulative percent of income from each source in year one and year five. As seen, while revenues (i.e., income generated through fees, equity, etc.) were relatively low, the proportion of income from non-government contributions increased over time.

Eight of the nine centres no longer receiving CECR funding continue to operate, which can be interpreted as becoming self-sustainable beyond CECR funding. These centres have maintained operations through income from provincial government funding, host institution funding, or revenues from reaching milestones, product launch, or royalties.

Stakeholders believe centres are becoming self-sustainable and creating a legacy

Stakeholder perceptions gathered though case studies, interviews and documents suggest that most centres are moving towards self-sustainability. Centre management, interviewed as part of the case studies, believe that their centres are on track to achieve self-sustainability.

Respondents from all but one case study centre believed they were creating a legacy. When asked to explain what this legacy included, centre representatives said:

- Building the industry and creating a hub of entrepreneurial activity in the sector;
- Creating technologies that will benefit Canadians in the future;
- Increasing innovation/entrepreneurial culture;
- Creating a model for commercialization that could be applied in other contexts;
- Training HQP; and
- Supporting the success of the companies the centre helps.

There was no discernible trend in projections regarding self-sustainability, perceptions of legacy, or ability to leverage funds based on sector, sustainability model, or type of centre.

[27] Unless otherwise specified, all data in this section include both cash and in-kind revenues and contributions from the first five years of each centre. Unless otherwise specified, all data in this section exclude centres funded in the 2014 and 2016 cohorts as these centres are still in their early developmental stages.

Discontinuation of CECR funding may result in scale back of activities

Representatives from centres no longer receiving funding commented that the discontinuation of funding decreased their ability to invest in additional projects. About half of these centres mentioned that their centres struggled and shifted focus after CECR funding ended. Also, a small number of representatives from centres no longer receiving funding mentioned that the discontinuation of CECR funding has decreased their ability to leverage other funders. This was mirrored by case study respondents, most of whom felt their centres would continue after CECR funding, but often with scale back of scope/operations and/or a change their area of focus/mission. In some cases, however, centre representatives believed their centre would discontinue entirely.

5.2 What factors influence self-sustainability?

Centres follow different sustainability models

Centres have taken different approaches to achieving self-sustainability. Considering only the centres that participated in case studies (since the evaluation has the most information on those centres), the evaluation identified four main models of self-sustainability: core asset development, investment, fee for service and funding. Each of these sustainability models is described in Figure 13 below. For the most part, these models align with the three types of centres, Commercialization Arms, Investors, and Service Providers. However, a small number of centres use business models that generate minimal/no revenue and must rely primarily on government funds, and a small number use sustainability models that are not typical of delivery model.

Figure 13: Sustainability models

	Core asset development	Investment	Fee for service	Government funding
Definition	Centre develops its own company and/or technology	Centre supports other companies/IP holders in exchange for equity or license	Centre charges a fee for the services it offers	Centre primarily relies on government funds
Approach to revenue generation	Royalties/license fees Selling equity Income from sales	Royalties/license fees Selling equity	Fee per service Membership fees Rent/fee for use of equipment/space	No revenue
Centre type	Commercialization arm 	Investor 	Service Provider 	N/A 
# of centres	3	3	6	2

Additional time is necessary to achieve self-sustainability, particularly in the health and life sciences sector

It is unrealistic to expect that centres will become self-sustainable within five years and, in some cases, self-sustainability may take much longer. To date, every centre has applied for additional funding at the end of their first cycle, suggesting a need for public funding that extends beyond the first five years. Of those that are not successful in their second funding request, PSAB often indicates that their sustainability plans are not achievable within the extended time frame. Case study respondents from most centres, as well as a few provincial representatives interviewed, agreed that more than five years is necessary to become self-sustainable. Provincial government representatives cautioned that provinces often only provide short term or limited funding and therefore cannot 'take over' when CECR funding ends.

Stakeholders also commented that centres operating within the health and life science sector require additional time to achieve self-sustainability as technologies within this sector take longer to move to market and are often higher risk. According to interview respondents (case studies and key informants), the health and life sciences sector involves longer timelines for technology development, higher costs for technology development, and increased regulatory requirements. This is supported by centre financial records – within the first five years of operation, centres operating in the health and life sciences sector remain more dependent on CECR funding.[28]

Centres have received mixed messages on expectations

Any assessment of achieving self-sustainability also depends on how sustainability is defined and measured. As mentioned above, the CECR program guide specifies that "[w]ithin the context of the CECR program, self-sustainability is defined as centres being able to continue their core activities beyond the CECR funding by establishing a strong business model and partnerships" (NCE 2016). However, some centre representatives indicated that they have received inconsistent messaging, with the suggestion that they are expected to become sustainable independent of *any* government/public funding.

For example, in at least two unsuccessful applications for a second round of funding, PSAB reports indicated that the centre included primarily public sector funding (i.e., provincial government) and this was a weakness. This lack of clarity was also identified by a few respondents from case study centres and most expert panel and PSAB members interviewed for the evaluation. In particular, expert panel/ PSAB respondents felt that the expectations of sustainability need to continue to be refined and better articulated. Specific areas to strengthen include outlining expectations of partnership commitments, the length of time to be sustainable (such as five or seven years), definition of attributes of sustainability (revenue streams, other funders), other success measures (number of patents and spin-offs) and any variations of expectations by sector.

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[28] Health centres decrease the proportion of their funding provided by the CECR program by an average of 32% between year one and year five. This decrease is 48% for non-health centres and the relationship is statistically significant ($p = <.05$).

Several centre representatives mentioned that centres would benefit from additional guidance on how sustainability is defined as well as NCE expectations regarding ongoing centre activities.

Self-sustainability may undermine CECR program objectives

The CECR program exists within an international cadre of initiatives with similar objectives. For example, France funds Les Sociétés d'accélération du transfert de technologies and the UK delivers their Catapult Centres Network. In both cases, program officials have determined that public funding will be required on an ongoing basis to maintain programming that benefits citizens in the same manner. Key informants from both programs cautioned that, to become profitable within a limited time frame would require adopting strategies that are contrary to the organizations' objectives.

> "…the explicit objective of profitability within ten years was a mistake. The only way it could be achieved would be with short-term strategies on patents and selling services that would basically undermine the long-term objectives of the institution."
>
> -Reforms in the French Industrial Ecosystem

Some centre representatives echoed this idea, most frequently commenting that they would be required to scale back their activities, mandate, and/or clients in the absence of CECR funds. Some cautioned that striving towards self-sustainability led them towards short term decision making, mission drift and distraction/resource drain from their actual mission. Respondents from one centre indicated that profit motive was inconsistent with the mandate of their centre. Also, a few respondents cautioned that there is a contradiction between encouraging centres to participate in high risk opportunities (i.e., fill a needed gap in the commercialization continuum) while expecting financial returns.

At the same time, it should be recognized that many case study centres did mention that striving towards self-sustainability had positive impacts, including focusing activities on key objectives, encouraging innovative thinking and planning, and refining services.

Other barriers and enablers to self-sustainability

Centres with above average revenues or non-CECR funding have limited common characteristics, with one exception: non-health centres/Service Providers have greater decreases in their reliance on CECR funds within the first five years. Because no Service Providers work in the health and life sciences sector, it is not possible to determine if the delivery model or the sector has a greater influence. It should also be noted that this does not necessarily mean that Service Providers/non-health centres are more likely to become self-sustainable – only that they make greater progress towards this objective within the first five years of operation.

According to stakeholder perspectives obtained through a review of PSAB/expert panel reports and case study interviews, other key aspects of sustainability primarily relate to:

- **Strength and maturity of the centre's revenue model**, including: an already growing revenue stream from existing services and products (not speculative), securing multiple sources of revenue, presence of many long-term contracts already signed, a pipeline with

diverse inputs, an appropriate budget that has been managed effectively thus far, and established partnerships (with strong financial commitments);

- **Organizational culture,** including a strong growth strategy, a strong IP strategy, a culture aimed at achieving self-sustainability, and planning that is focused on self-sustainability and/or achieving outcomes; and
- **Organizational capacity,** including in-house skills and a strong management team.

Challenges to self-sustainability commonly mentioned during case study interviews included the time frame required for achievement, lack of clarity around the self-sustainability objective, challenges accessing funding or attracting investments, and challenges generating sufficient revenues.

Several centre representatives commented that centres would benefit from sharing best practices from successful self-sustainable models.

6 CECR program delivery

Summary of findings: For every $1 spent by the CECR program, approximately 5¢ are used for administrative costs. This is comparable to, but slightly higher than the NCE and BL-NCE programs.

The CECR program is generally seen to be well delivered with the selection criteria and NCE Secretariat involvement in centres perceived as assets. While several challenges were identified regarding the requirement that centres be not-for-profit entities, the advantages were believed to outweigh these. Several opportunities for improvement were pointed out including:

- Clarifying key aspects of the selection criteria;
- Providing additional opportunities for communication with PSAB as part of the review process as well as more clarification to applicants regarding respective PSAB and Expert Panel roles and mandates.
- Increasing coordination with provincial commercialization strategies; and
- Increasing opportunities to share lessons learned across centres.

6.1 Operational efficiency

The CECR program's operational efficiency is similar to comparable programs

A common measure of operational efficiency of grant programs is to assess the ratio of operating expenditures[29] to the total amount of grant funds awarded. This ratio represents the cost of administering $1 of grant funds awarded. The granting agencies also commonly report operating expenditures as a percentage of total program expenditures (i.e., operating expenditures plus grant expenditures).

In order to assess the program operational efficiency, CECR's administrative expenditures were compared to those of other tri-agency programs administered by the NCE Secretariat, including the Networks of Centres of Excellence (NCE) program and the Business-Led NCE (BL-NCE) program.

CECR's average annual administrative expenditures (2012-13 to 2015-16) are approximately $1.3 million and average annual grant expenditures are approximately $23.8 million. This means that, for every dollar spent by the program, approximately 5¢ are used for administrative costs. Alternately, one could say that operating expenditures are 5.1% of total program expenditures.

[29] Operating expenditures include both direct and indirect costs of administering the program. Direct costs are comprised of salary and non-salary costs, which are related primarily to the adjudication of the award. Non-salary costs also include a share of the costs related to corporate representation and general administration of the Research Grants and Scholarships Directorate. Other direct costs associated with administering the program, such as post-award management (which is a centralized function carried out by the Finance division) and indirect costs, such as common administrative services for NSERC (e.g., finance, human resources and IT) have also been included in the total calculation of costs and were estimated using the ratio of total Discovery Grant awards to total NSERC grant funds.

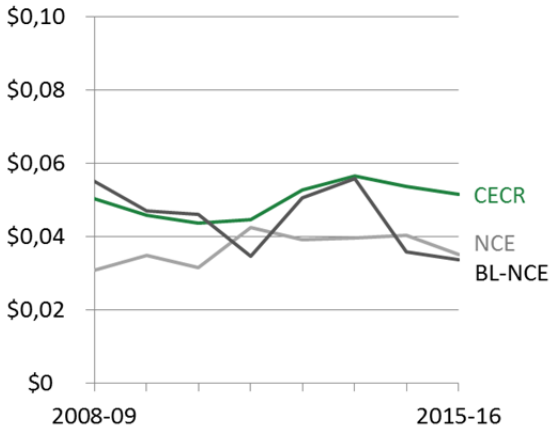
Figure 14: Comparison of CECR, NCE and BL-NCE average annual expenditures

	CECR	NCE	BL-NCE
Admin. expenditures	$1,290,252	$2,659,912	$441,103
Grant expenditures	$23,777,914	$66,391,575	$9,843,180
Total expenditures	$25,056,610	$68,958,732	$10,267,868
Admin expenditures per $1 of grant expenditures	5.4¢	4.0¢	4.5¢
Admin expenditures as a % of total expenditures	5.1%	3.9%	4.3%

Source: Finance and Awards Administration Division, NSERC/SSHRC (2012/13 to 2015/16)

This ratio is comparable to, but slightly higher than the NCE and BL-NCE programs, which have operating ratios of 4.0¢:$1 and 4.5¢:$1 respectively (shown in Figure 14). It is hypothesized that the NCE program has a lower operating ratio due to economies of scale. The BL-NCE, a smaller program more similar in size to CECR, is closest to CECR in operating ratio.

Figure 15: Longitudinal trends in operating ratios



Source: Finance and Awards Administration Division, NSERC/SSHRC

Figure 15 shows the longitudinal trends in operating ratios for the CECR program, the NCE program and the BL-NCE program from 2008-09 to 2015-16. Note that CECR's annual operating ratio ranges from 4.4¢:$1 to 5.7¢:$1, a relatively small variation of 1.3¢. The NCE program exhibits similar stability over time, varying by 1.2¢ (ranging from 3.1¢:$1 to 4.3¢:$1) and BL-NCE shows somewhat larger variation of 2.2¢ (ranging from 3.4¢:$1 to 5.6¢:$1).

6.2 Features of CECR program delivery

The NCE Secretariat is seen to be a strength of CECR program delivery

Centre interviewees cited positive interactions with the NCE Secretariat. The NCE Secretariat is represented on centres' board of directors, performs reviews annual reports, and is available for discussion. A few interviewees suggested improvements, such as increased communication, and/or noted a challenge in continuity due to staff turnover at the NCE Secretariat.

Selection criteria generally appropriate although there are opportunities for further clarity

The key informant interviews (including individuals interviewed during case studies) discussed the criteria used for the selection of centres to be funded. According to NCE Secretariat interviewees, there are three primary elements to selection criteria: the strength of the business plan, the management team experience, and benefits to Canada. The NCE provides supporting material and discussions take place to clarify the intent of the selection criteria. Most interview

respondents believed that the current selection criteria allow the CECR program to fund centres that use a variety of approaches for supporting commercialization.

However, some indicated that further clarity and "strategic thought" should be provided in some elements of program objectives and selection criteria such as:

- The definition of "Benefit to Canada;"
- The relative importance of whether a centre has regional, national or sector representation;
- The extent to which applications for round two funding are considered on their own merits and/or assessed in relation to other applications.

As mentioned in Section 4, there is also confusion regarding the expectations related to self-sustainability.

Some centres seek different membership of and more interactions with PSAB

Some interviewees perceive the PSAB to be knowledgeable and engaged in the CECR program. From case studies, many centre representatives commended the business knowledge of the PSAB; however, some felt that members should be specialized in the sector under review and offer more integrated and specific areas of improvement for the centres. Also, a few respondents from centres had concerns about the lack of French-speaking and bilingual members on PSAB.

Respondents from a few centres indicated that they would benefit from increased and direct interaction with the PSAB. Specifically, they believed it is necessary to have an opportunity to present their proposal to PSAB and discuss merits, weaknesses and necessary clarifications. In discussions with centre representatives, it also became apparent that there is confusion with regards to CECR program's funding decision making process. Specifically, centres were unclear on how Expert Panel and PSAB input are each used, and which group makes final decisions.

Provinces want more coordination by the program

Provincial interviewees suggested several improvements to the CECR program to better support the commercialization of research in provinces. All provincial representatives interviewed requested more coordination between the CECR program and the provinces. Other suggestions for improvement included funding to establish additional centres, centres in more regions throughout Canada and support for centres with visionary projects.

Opportunities to share lessons learned between centres are strongly valued

NCE Secretariat interviewees indicated that there are activities created within the program to share lessons learned among the centres through workshops, orientation sessions, and webinars. Interviewees from most respondent types (including Expert panel/PSAB and centres) indicated that information sharing between centres has been key to success, "to cross communicate and network with each other." A few centre interviewees also specifically mentioned that they would like to see more opportunities to share best practices among other centres.

Additionally, a few interviewees indicated that information sharing could be further expanded to link centres to Canadian international trade organizations such as Export Development Canada (EDC) or other business advisors.

Most centres believe the advantages of being a not-for-profit entity outweigh the disadvantages

Related to delivery of the program, the evaluation sought to gather feedback on the fact that centres must be not-for-profit entities. During the case studies, all but one centre saw advantages, including positive impacts on their reputation and ability to establish partnerships, ability to focus on the public good, ability to manage their resources more effectively, ability to focus on commercialization, and better access to regulators.

However, disadvantages were also cited by a sizeable number of centres (half). These disadvantages included limits of the amount of revenue centres can generate (and subsequent impact on their ability to be self-sustainable), investors and partners questioning how serious the centre is about commercialization, the amount of overhead and bureaucracy associated with the status and the inability of the centre to apply for some funding programs, challenges recruiting top talent and potential for conflict of interest.

7 Conclusions and recommendations

Relevance

International sources and the Canadian government recognize that improving innovation and commercialization will benefit Canada's economy and the wellbeing of its citizens. Innovation is seen as a driver for economic growth as well as a strategy for addressing social and global challenges. However, Canada's recognized strengths in academic research have not fully transferred to the realm of innovation and commercialization.

Overall, Canada spends less on R&D than other countries, and this disparity is steadily widening over time. More of our R&D funding comes from the higher education sector and less from the private sector, suggesting greater emphasis on research than on development. Innovators face substantial challenges in accessing funding/investment for the earlier, riskier stages of commercialization (i.e., the commercialization gap, sometimes dubbed the 'valley of death'), as these are not appealing to traditional profit-motivated investors. In this challenging environment, promising innovations may not reach maturity and therefore do not contribute to the wellbeing of Canadians.

The CECR program aims to fill this gap by building on Canada's existing strengths in research; "matching clusters of academic research expertise with the needs of business, health practitioners, and other end users" (NCE 2016). This is a unique program niche addressed by a very limited number of federal initiatives.

Other key challenges intended to be addressed by the CECR program relate to developing an environment in which innovation can thrive. This includes capacity development (primarily in entrepreneurial skills) and enabling access to commercialization infrastructure.

Acknowledging the complexity of innovation needs, the CECR program allows for broad flexibility in centre design and implementation. Funded centres have used this flexibility, developing in different models based on their individual objectives and context. These delivery models can be aggregated into three main types, as follows: [30]

1) Commercialization Arms are centres that develop and advance their own companies and/or technologies through the full commercialization spectrum. The centres expect to sufficiently develop the technology to the point where they can generate income when the product/technology is sold. These technologies often have their roots in academia and, within the context of this evaluation, are always in the health and life sciences sector.

2) Investors identify promising technologies to further through the mid-stages of the innovation continuum in exchange for a licensing agreement or equity in the company holding the technology, which will later be sold for a return. Most Investors work in the health and life

[30] Delivery model types were developed as part of the evaluation to support interpretation of data. They should be considered as archetypes, which depict main characteristics of centres in a simplified manner. It should be noted that centres may exhibit characteristics of more than one archetype, but they have been associated with the archetype that most closely reflects their primary characteristics.

sciences sector and promising technologies are most often identified from within academia (although Investors may also support other types clients).

3) Service Providers work in sectors other than health, providing services and supports to move an existing product to market in exchange for a fee. Service providers may have clients of all types, but typically focus on SMEs and start-ups.

Supporting the CECR program objectives aligns with federal innovation priorities articulated to date (i.e., 2014 federal ST&I strategy and preceding plans). Program objectives are consistent with all three funding agencies strategic priorities. CECR's broad flexibility allows room for centres to support the "connect[ion] of social sciences and humanities research with Canadians" (SSHRC 2016). However, none of the centres funded to date focuses specifically on commercializing innovations that have emerged from the SSH field. Furthermore, several centres (primarily Service Providers) indicated that academics are not amongst their client base and do not appear to draw on academia-generated innovations for the services they provide. It is possible that some SMEs may be start-ups started by academics, but it is not possible to discern this from Centre data. As such, current implementation of the program may be shifting away from the notion of bridging the gap between academic research and commercialization. The requirement for self-sustainability has likely contributed to such a shift, as it has influenced the decisions Centres have made regarding the services they provide as they seek to develop revenue streams.

Commercialization and economic outcomes

Between 2010-11 and 2014-15, centres supported:

- bringing 643 new products/services to market;
- obtaining 313 new patents;
- granting 112 new licences; and
- creating 222 new companies.

Centre-supported companies have better commercialization and economic outcomes than unsupported companies. Specifically, they see a significant growth premium in sales (54%), R&D expenditure (25%), number of employees (24%) and wages (8%) in comparison to unsupported companies.[31]

While contributing factors are unclear, evidence does suggest that the flexibility embedded in the CECR program contributes to different centres achieving different positive outcomes. Some of the figures mentioned above are largely influenced by the efforts of one or two individual centres. There also appears to be a correlation between delivery model/sectors and select outcomes.[32] Investors/health sector centres are more often linked to the creation of new companies and IP protection. Service Providers/non-health sector centres are more often linked

[31] Growth premium refers to the absolute difference in growth between centre-supported companies and the comparison group at year three.

[32] Because all Service Providers are in sectors outside of health and most Investors operate within the health sector, it is difficult to tease out the interplay between sector and delivery model.

with accelerated time to market, company growth, and increased company competitiveness. Also, given that Commercialization Arms do not have clients per se, and that their portfolios of supported innovations only contain a small number of products in the early stages of commercialization, commercialization and economic outcomes from these centres are largely unknown.

According to stakeholders, key practices for an effective centre involve having a strong and active board as well as talented staff.

Recommendation 1: Continue to deliver the CECR program and allow flexibility in centre delivery models.

The CECR program objectives respond to an identified gap in Canada's innovation and commercialization capacity and align with federal and tri-agency priorities. Furthermore, the evaluation shows evidence that the CECR program is achieving several intended outcomes including increasing growth in sales, R&D expenditures, number of employees, and wages among supported companies.

Centres are naturally adopting a range of delivery models which correlate with different positive outcomes (e.g., Investors are more likely to drive IP protection while Service Providers are more likely to accelerate time to market and drive company growth). This suggests that flexibility is an asset, allowing the CECR program as a whole to address multiple commercialization challenges.

At the same time, some centres (primarily Service Providers) seem to have limited connection to academia and none appear to be directly tapping into current SSH research/innovations. As such, senior management should consider the value of/need for direct connection to academia as well as the value of/need for incorporating a broader perspective on what constitutes innovation.

Self-sustainability

Most centres are moving towards self-sustainability, leveraging CECR grants to obtain additional funds and decreasing their reliance on the CECR program. Just over half of centres (12/22) secured other income (i.e., contributions and revenues) greater than the value of their CECR grants within their first five years. Furthermore, to date (including funding extensions) for every $1 the CECR program has provided, centres have leveraged an additional $1.89 in cash and 41¢ in in-kind contributions.

For the most part, centres are able to continue their operations once CECR funding has discontinued. However, centres caution that discontinuation of CECR funding is often associated with a scale back in centre activities and may also undermine the extent to which centres maintain alignment with the CECR program's other objectives.

Establishing the correlation between centre characteristics and self-sustainability is a difficult task and is mainly based on data collected through case studies. However, it can be said that within the first five years:

- Service Providers have the greatest decrease in reliance on CECR funding while Commercialization Arms have the smallest decrease in reliance on CECR funding.
- Service Providers and Investors both have increases in income from non-government sources greater than Commercialization Arms. Non-health centres have increases in income from non-government sources greater than health centres.

The evaluation suggests that additional time (beyond the initial five years of funding) is necessary to achieve self-sustainability without negatively impacting the centre's ability to pursue its original mission. The required time frame may be even longer for centres operating within the health and life sciences sector, which involves longer technology development times, higher costs, and increased regulatory requirements.

Finally, there appears to be some confusion regarding the CECR program's definition for and expectations regarding self- sustainability. It has been unclear to some stakeholders whether success is defined as the ability to continue operations without CECR funds or the ability to continue operations in the absence of *any* public funding.

Recommendation 2: Allow more time for centres to achieve self-sustainability and clarify how the CECR program defines self-sustainability.

Most centres are moving towards independence from CECR funding. However, evidence suggests that building an international-caliber centre of excellence is a long term commitment. This is particularly true for centres in the health and life sciences where the path to market (and the corresponding path to financial solvency) is substantially longer than in many other sectors. Furthermore, even if a centre can maintain some operations without CECR funding, ending program involvement prematurely may reduce services and detract from focus on CECR program goals.

Specifically, the CECR program should:

a. Allow more time to achieve self-sustainability by lengthening funding cycles or providing addition extension opportunities.

b. Clarify to stakeholders (centres, PSAB members, and others) the program's definition of self-sustainability, distinguishing between independence from CECR funding and total independence from public sector funding.

c. Provide additional guidance on expectations regarding how centres will contribute to 'benefit to Canada' after CECR funding.

Delivery

For every $1 spent by the CECR program, approximately 5¢ are used for administrative costs. This is slightly higher than the NCE and BL-NCE programs.

The CECR program is generally seen to be well delivered with the selection criteria and NCE Secretariat's involvement in centres seen as assets. Several challenges were identified regarding the requirement that centres be not-for-profit entities, such as limits of the amount of revenue centres can generate, increased overhead and bureaucracy, challenges recruiting top talent, etc. However, the advantages were believed to outweigh these challenges. These include the ability to focus on public good, improved reputation, ability to establish partners, etc.

Several opportunities for improvement were identified during interviews and case studies which should be considered by program management.

Recommendation 3: Consider appropriateness and feasibility of the following potential areas for improvement:

a. Clarifying key aspects of the selection criteria, such as the definition of "Benefit to Canada"; the relative importance of whether a centre has regional, national or sector representation; the extent to which applications for round two funding are considered on their own merits and/or assessed in relation to other applications.

b. Providing additional opportunities for communication with PSAB as part of the review process, as well as more clarification to applicants regarding respective PSAB and Expert Panel roles and mandates.

c. Increasing/formalizing coordination with provincial commercialization strategies due to the importance of regional presence and the potential for increasing focus on clustering.

d. Increasing opportunities to share lessons learned across centres, including sustainability strategies, business practices, etc.

Appendix A: Program profile

CECR is a tri-agency program funded in part by Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR), and the Social Sciences and Humanities Research Council (SSHRC). The CECR program supports the commercialization of innovation by matching clusters of research expertise with the business community to share the knowledge and resources that bring innovations to market faster.[33] This is done by creating individual centres, each of which operates according to its own delivery model.

To date, the CECR program has funded 29 centres, 19 of which were still receiving funding at the time of this report. Funded centres facilitate commercialization within the four priority areas articulated in the 2007 Science and Technology Strategy: environment; natural resources; health and life sciences; and information and communication. Furthermore, each centre has a mandate to become self-sustaining while maximizing economic impact for its partners.[34]

Centres receive funding for a period which is typically five years in length, although they can reapply in subsequent competitions for that funding to be renewed for another five year period. Although there is currently no prescribed budget per centre (NCE 2018), it has been the practice of the CECR program to provide a maximum of $15 million over five years. Between 2008/09 and 2014/15, total funding per centre has ranged from $9.6 million over five years to $29.9 million over nine years. The average annual grant value ranges from $1.1 million to $3.3 million per year.

Program history

The Networks of Centres of Excellence (NCE) was created in 1989 as a joint initiative of CIHR, NSERC, SSHRC, Innovation, Science and Economic Development Canada (ISED) and Health Canada. The NCE offers a suite of programs that mobilize Canada's best research, development and entrepreneurial expertise and focus it on specific issues and strategic areas.

The 2007 federal science and technology (S&T) strategy *Mobilizing Science and Technology to Canada's Advantage* greatly expanded the NCE mandate by adding the Centres of Excellence of Commercialization and Research (CECR), Business-led Networks of Centres of Excellence (BL-NCE) and Industrial Research and Development Internship (IRDI) programs.

Program objectives and expected outcomes

The CECR program is specifically designed to support the operation of centres of excellence that bring together people, services and research infrastructure to position Canada at the forefront of the commercialization of innovations in priority areas.

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[33] Within the context of the CECR program, commercialization is defined as everything a company does that transforms knowledge and technology into new goods, processes or services to satisfy market demands.

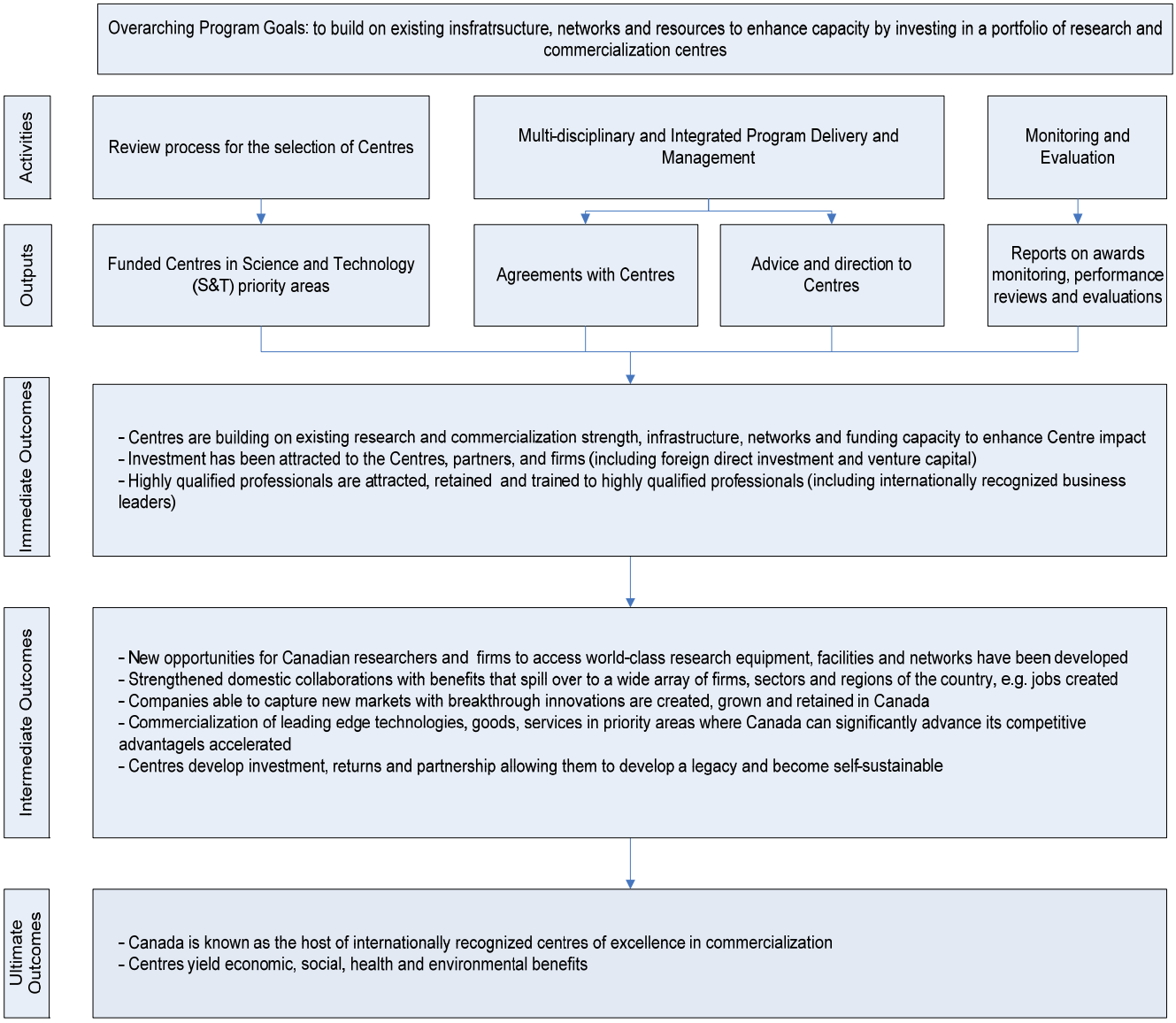
[34] Sustainability means that centres are able to continue their core activities beyond the CECR funding by establishing a strong business model and partnerships.

The CECR program is expected to:

- Brand Canada as the host of internationally recognized centres of excellence that will yield economic, social, health or environmental benefits to Canadians;
- Draw on existing research and commercialization strength, infrastructure, networks and funding capacity to enhance their impact;
- Attract, retain and provide training to highly qualified personnel (HQP), and internationally recognized business leaders;
- Open up new opportunities for Canadian researchers and companies to access world-class equipment, facilities and networks;
- Create, grow and retain companies in Canada that are able to capture new markets with breakthrough innovations;
- Accelerate the commercialization of leading edge technologies, goods and services in priority areas where Canada can significantly advance its competitive advantage;
- Attract investment (including foreign direct and venture capital investments);
- Strengthen domestic collaboration and ensure that benefits spill over to a wide array of companies, organizations, sectors and regions of the country; and
- Centres develop investment, returns and partnership allowing them to develop a legacy and become self-sustainable.

Figure 16 below presents the CECR program's logic model, which identifies the set of program activities and the sequence of outcomes that are expected to flow from these activities.

Figure 16: CECR program logic model



Source: **2013 CECR program performance measurement strategy**

Centre selection process

The CECR program launches national competitions on an irregular schedule. The application process involves two stages: 1) a letter of intent (LOI), and 2) a full application. Applications are assessed against three selection criteria: benefits to Canada; track record and potential of applicants; and strength of the business plan.

Applicants first submit a LOI that provides information on the proposed centre in relation to the goals and objectives of the CECR program. The LOI process involves collaboration with stakeholders, provision of a budget, a business plan, a market assessment and letters of support from contributing organizations. These preliminary applications are evaluated by the Private Sector Advisory Board (PSAB), which recommends a short-list of applicants for advancement.

Those applicants with a successful LOI complete a full application that includes complete information on the proposed centre and its intended operations, funding requirements, the partnerships among supporters, their duties and respective contributions, and the expected research and commercialization outcomes and benefits of the project. The full application consists of a business and financial plan, detailed performance indicators, targets and milestones, letters of support and biographies (NCE 2016).

Each application undergoes a review by an expert panel established by the NCE Secretariat. These panels are comprised of domestic and international experts, who evaluate the applications, meet with the applicants, and produce in-depth written assessments. The expert panel report, along with a copy of the applicant's presentation, will then be forwarded to the PSAB. The PSAB reviews all applications and their associated expert panel reports, to develop recommendations to be presented to the NCE Steering Committee.

The NCE Steering Committee makes the final decision regarding the amount and duration of funding for centres, based on the recommendations of the PSAB. The decisions reached by the NCE Steering Committee are final. There is no appeal process.

Centres that submitted applications in excess of 5 years during the course of past competitions (when this was allowed) are subject to an international panel review at the end of the initial five year period, prior to being awarded the remaining funding (NCE 2016).

CECR program competitions

The CECR program has held five competitions and three opportunities for extension/renewal. In each competition, the emphasis of the program has evolved in the following manner:

- 2007-08 was open to any centres with a strong orientation towards commercialization or research;
- 2008-09 responded to sector imbalance by emphasizing projects in information and communication technology and environmental science and technology;
- 2010-11 shifted the focus to commercialization;
- 2014-15 again emphasized commercialization as well as developing a robust business plan and feasible sustainability plan; and
- 2015-16 focused on matching clusters of academic research expertise with end users.

Role of the NCE Secretariat

The NCE Secretariat is the primary point of interaction between centres and the three granting agencies (i.e., CIHR, NSERC, and SSHRC). Funding disbursements are managed by the NCE Secretariat and disbursed to the centres through a funding agreement under the legal authority(ies) of the relevant granting agency(ies). Any major changes that would affect the general mission or key objectives of a centre must be submitted to the NCE Steering Committee for approval prior to implementation.

NCE staff may: support centres in resolving technical or administrative issues; provide guidance related to the CECR program's rules and guidelines; and/or help coordinate a centre's activities with those of other centres or of other government-funded programs. NCE staff are also assigned

to attend and observe Board of Director meetings of individual centres, and provide clarification regarding the CECR program as necessary.

Centres are required to submit annual reports to the NCE Secretariat, for the purposes of monitoring the use of financial resources and the centre's progress towards stated objectives. The progress of a centre is assessed annually through a monitoring review process. This may result in continued funding, further review, or phasing out of funding to the centre. If a further review is required, this may involve an in-depth assessment of the performance of a centre by a panel of experts assembled by the NCE Secretariat. The NCE Steering Committee ultimately has the discretion to terminate the funding agreement and provide no further funding if the results of the annual review are not to its satisfaction.

Appendix B: Evaluation matrix

Evaluation Question & Purpose	Indicator	Data Source	Method
Relevance: Continued need for program, alignment with federal government priorities, roles and responsibilities **Q.1 -** What is the CECR program's niche or added value in addressing the sectors' need for bridging the gap between academic inventions and commercialization.	1-1 Evidence of challenges in Canada in bridging the gap between academic inventions and commercialization (with reference to specific sectors)	▪ Program documents, Terms and Condition, PMS ▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Planning and policy documents and public literature ▪ Previous program evaluations (2009, 2012) ▪ Documents on similar Canadian programs	▪ Document review
	1-2 Evidence of gaps in array of programs that are currently responding to commercialization challenges	▪ Program documents, Terms and Condition, PMS ▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Federal government policy documents, S&T Strategy ▪ Previous program evaluations (2009, 2012) ▪ Documents on similar Canadian programs	▪ Document review
	1-3 The extent to which the niche of the CECR program contributes to addressing an identified need in the current programming landscape (with reference to CECR program features such as sustainability, support at the different stages of commercialization, flexibility to respond to changing needs and challenges etc.)	▪ Program documents, Terms and Condition, PMS ▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Planning and policy documents and public literature ▪ Previous program evaluations (2009, 2012) ▪ Documents on similar Canadian programs	▪ Document review
		▪ NCE Secretariat senior management ▪ Expert panel and PSAB members ▪ Representatives from granting agencies, HC and ISED ▪ Unsuccessful applicants ▪ Centres for which funding has ended ▪ Representatives from provincial and territorial governments ▪ External stakeholders	▪ Key informant interviews

Evaluation Question & Purpose	Indicator	Data Source	Method
		▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
		▪ Centre contributors ▪ Centre organizations served	▪ Survey
Relevance: Continued need for program, alignment with federal government priorities, roles and responsibilities **Q.2** - Is there a role for the federal government in bridging the gap between academic inventions and commercialization through commercialization centres?	2-1 Extent to which delivering the CECR program is an appropriate role for the federal government (with reference to federal versus provincial jurisdictions and other federal programming)	▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Program documents, Terms and Conditions, PMS ▪ Planning and policy documents and public literature ▪ Previous program evaluation s (2009, 2012) ▪ Documents on similar Canadian programs	▪ Document review
		▪ NCE Secretariat senior management ▪ PSAB members ▪ Representatives from granting agencies, HC and ISED ▪ Representatives from provincial and territorial governments ▪ Non-stakeholders	▪ Key informant interview
		▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
	2-2 Nature and extent of involvement of provinces and territories in centres	▪ Representatives from provincial and territorial governments	▪ Key informant interview
		▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
Relevance: Continued need for program, alignment with federal	3-1 Extent of alignment between the CECR program objectives, the Government of Canada's	▪ Previous program evaluation (2009, 2012) ▪ Planning and policy documents and public	▪ Document review

Evaluation Question & Purpose	Indicator		Data Source	Method
government priorities, roles and responsibilities **Q.3** - To what extent is the program aligned with federal government priorities?		priorities in S&T, commercialization, and tri-agencies mandate and priorities	literature	
			▪ NCE Secretariat senior management ▪ Representatives from granting agencies, HC and ISED	▪ Key informant interview
			▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
Performance - Effectiveness: Achievement of expected outcomes **Q. 4.1** - To what extent has the CECR program had an impact on the companies served and their technologies, goods and services?	4.1-1	Nature and extent of services offered by the centres to the companies served	▪ Centre contributors ▪ Centre organizations served	▪ Survey
	4.1-2	Source, nature (cash and in-kind) and level of contributions leveraged by centres over time (including an analysis of the diversity of sources and duration/frequency), as well as reasons for changes over time	▪ Centre representatives (management, contributors, organizations served, stakeholders) Host organizations	▪ Case study
	4.1-3	Extent to which contextual factors influence the services and leveraging	▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Environmental scan (comparable programs for Indicators 4.1-1, 4.1-3 and benchmarking for measuring commercialization outcomes) ▪ Previous evaluation (2009, 2012) ▪ Program File Review	▪ Document review
	4.1-4	Number and profile of start-up companies created to commercialize research results in priority areas (e.g., sector, number of employees, life-span, performance over time, level of investments obtained, contribution of the centres)		
	4.1-5	Nature and extent of new or improved technologies, goods and services in priority areas (e.g., prototypes, patents, licenses, transfer agreements and non-disclosure agreements)		
	4.1-6	Extent of company growth and economic sustainability (in particular SMEs)		
	4.1-7	The extent to which partners, organizations served and companies created has been able to attract funding/investment as a result of their participation		
	4.1-8	Stakeholder perspectives on the value of the		

Evaluation Question & Purpose	Indicator		Data Source	Method
		centre within sectors		
	4.1-9	The extent to which outcomes would have been achieved in the absence of the CECR program		
	4.1-10	Stakeholder perspectives on the relevance of services offered by the centres		
	4.1-11	Stakeholder perspectives on the level of accessibility of services offered by the centres		
Performance - Effectiveness: Achievement of expected outcomes Q. 4.2 - To what extent are centres achieving self-sustainability and/or developing a legacy?	4.2-1	Extent to which previously funded centres have achieved self-sustainability and extent to which currently funded centres are moving towards self-sustainability	▪ Centre documents, progress reports, performance reports, PSAB's reports, etc., ▪ Previous evaluation (2009, 2012) ▪ Documents on similar Canadian programs	▪ Document review
	4.2-2	Extent to which contextual factors influence the achievement of self-sustainability	▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
	4.2-3	Nature and extent of leveraged funding		
	4.2-4	Extent to which the self-sustainability goal has contributed to unintended outcomes (e.g., had an impact on securing future funding rather than focusing on achieving objectives related to "benefit to Canada")	▪ Centres for which funding has ended ▪ External stakeholders	▪ Key informant interviews
	4.2-5	Extent to which centres have created a legacy, or are demonstrating progress towards creating a legacy		
	4.2-6	Evidence of unintended outcomes related to the goal of self-sustainability and/or creating a legacy (positive or negative)		
	4.2-7	The extent to which outcomes would have been achieved in absence of the CECR program		
	4.2-8	The extent to which centres that are no longer funded by the program have maintained their operations	▪ Centres for which funding has ended	▪ Key informant interviews
Performance – Efficiency and Economy: Resource utilization in	5.1-1	The extent to which centres have had an economic impact on its sector	▪ Statistics Canada administrative databases ▪ Surveys of the Innovation and Business	▪ Econometric analysis

Evaluation Question & Purpose	Indicator		Data Source	Method
relation to the production of outputs and progress toward expected outcomes **Q. 5.1 –** What are the economic benefits generated by the centres?			Strategy (2009, 2012)	
			▪ Centre representatives (management, contributors, organizations served, stakeholders)	▪ Case study
Performance – Efficiency and Economy: Resource utilization in relation to the production of outputs and progress toward expected outcomes **Q. 5.2** - To what extent has the CECR program been delivered in a cost-efficient manner?	5.2-1	Ratio of admin to total program costs of the CECR program compared to that of other similar programs	▪ Program financial data ▪ Program files	▪ Financial data review ▪ NCE Management
	5.2-2	Stakeholder perspectives on the ratio of administrative to total program costs (to be discussed)		
Performance – Efficiency and Economy: Resource utilization in relation to the production of outputs and progress toward expected outcomes **Q. 5.3** - To what extent are efficient and effective means being used to deliver the program?	5.3-1	Stakeholder perspectives on the role, effectiveness and transparency of the Public Sector Advisory Board (PSAB)	▪ NCE Secretariat senior management ▪ Expert panel and PSAB members	▪ Key informant interview
	5.3-2	Comparison of the CECR centre model with alternative design and delivery approaches	▪ Documents on similar Canadian programs (and possibly international programs)	▪ Document review
			▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
			▪ NCE Secretariat senior management ▪ Expert panel and PSAB members ▪ External stakeholders	▪ Key informant interview
	5.3-3	Nature of business models and management practices used by centres and stakeholder perspectives on the effectiveness of the models and management practices implemented (e.g., lessons learned and promising practices)	▪ Centre representatives (management, contributors, organizations served, stakeholders) ▪ Host organizations	▪ Case study
			▪ NCE Secretariat senior management ▪ Expert panel and PSAB members ▪ External stakeholders	▪ Key informant interview
	5.3-4	Centre representatives' perspectives on the support provided by the NCE Secretariat to	▪ Centre representatives (management, contributors, organizations served,	▪ Case study

Evaluation Question & Purpose	Indicator		Data Source	Method
		meet program objectives and suggestions for improvements (e.g., self-sustainability, communication of success stories)	stakeholders)	
	5.3-5	Stakeholder perspectives on the extent to which the program goal of self-sustainability is clear, realistic and appropriate	▪ Centre representatives (management)	▪ Case study
			▪ NCE Secretariat senior management ▪ Expert panel and PSAB members ▪ Centres for which funding has ended	▪ Key informant interview

Appendix C: Evaluation methodology

Methods used

Purpose	Scope/Sample
Document and Literature Review	
The purpose of the document review was to systematically extract relevant secondary data from identified documents, focusing on achievement of expected outcomes. An additional literature review was also conducted to address program relevance and situate the CECR program within a Canadian and international context.	Documents reviewed include: 46 centre annual reports; 40 centre competition documents (i.e., expert panel and Private Sector Advisory Board (PSAB) reports); 12 CECR program documents (i.e., plans and reports); 2 NCE documents (including the website); NSERC's Departmental Performance Report; and an evaluation of CIHR's Commercialization Programs. The evaluation also explored key literature regarding the OECD (Organization for Economic Co-operation and Development) innovation review and comparable programs in France, the UK, and Germany.
Financial Data Review	
This line of inquiry determined if the CECR program was delivered in an efficient manner. The analysis examined total administrative expenditures relative to grant expenditures for the CECR program and results were compared to the cost-efficiency analyses for two similar programs, the NCE and BL-NCE programs.	The most recent complete set of financial data covered the fiscal years 2008-09 to 2015-16. Data from 2008-09 to 2010-11 was extracted from the previous CECR program evaluation while data for 2011-12 to 2015-16 was provided directly by the NSERC-SSHRC Finance and Awards Administration Division.
Key Informant Interviews (31 Canadian key informants, 33 case study representatives, 7 international experts)	
Key informant interviews were used to gain a greater understanding of the opinions of individuals who have had a significant role in or experience with the CECR program, or who have a key stake in it. A small number of interviews were also conducted with international experts (from the UK and France) who have been involved in similar programs in their own countries.	Interviews were conducted with representatives from: the NCE Secretariat (n=3); CECR expert panel/PSAB (n=4); provincial government representatives (n=12); centres no longer receiving funding (n=5); and unsuccessful applicants (n=7). Interviews were also conducted seven international experts. In addition, design and delivery questions posed to centre management at the 14 case study centres (n=33) was incorporated into key informant interview findings.
Web-Based Survey with centre participants (n=427, 32% response rate)	
The purpose of the survey was to obtain quantitative data on respondents' experiences with and perceptions regarding the centres, as well as information on the economic impacts of the centres from organizations that have benefited from their interactions with the centres. The survey of centre	The survey included centre participants from 25 of the 27 centres funded in the 2008, 2009, 2011 and 2014 competitions.[35] 1,591 potential respondents were identified, of which 1,340 has valid contact information. 427 participants completed the survey, indicating a response rate of 32%. Note that response

[35] Stakeholders from the Centre for Commercialization of Research (OCE-CCR) and the Centre for Probe Development and Commercialization (CDPC) were not included as contact information was not received within the survey implementation window.

Purpose	Scope/Sample
participants built on a survey of centre participants conducted in 2012 as part of the previous CECR program evaluation. Where possible and appropriate, comparisons to the 2012 survey have been examined.	rate ranged from 0% to 63% depending on the centre.
Case studies (14 case studies, 104 interviews)	
The case studies collected data on the operation, performance and achievement to date of expected research and commercialization benefits as a result of the CECR program. The aggregation and cross-case analysis of the case study findings contribute to overall analysis of relevance, performance and implementation.	Case studies were conducted with 14 out of 16 eligible centres (centres funded prior to 2015 and still receiving funding as of April 1 2016). Each case study included: a review of available files, documents and data; a review of the centre's website; and interviews with centre management, host organization representative(s), key contributors, and organizations served (as appropriate and available). Depending on the centre, between six and ten interviews were conducted for a total of 104.
Econometric analysis (653 CECR-supported companies, 653 non-CECR companies, 97% matching rate)	
The econometric analysis examined whether companies served through the CECR program outperform otherwise similar companies in terms of growth across several metrics. The analysis matched centres-supported companies to unsupported companies with similar characteristics, by linking with Statistics Canada's National Accounts Longitudinal Micro-data File (NAMLF). It then observed whether, over time, the two groups diverged with regards to their number of employees, sales, average wages, and/or research and development (R&D) expenditures.	4,490 companies were served by the centres between 2010-11 to 2014-15. Of these, 677 had both sufficient information and less than 100 employees (large companies were excluded as the incremental impact of a centre on these companies is assumed to be minimal). 653 of these companies had suitable matches from the general population, indicating a 97% matching rate. Detailed information on the econometric analysis' methodology and findings is provided in Appendix D.

Limitations and mitigating strategies

While the evaluation benefitted from multiple lines of inquiry there are several limitations to the evaluation data, as follows. When possible, mitigation strategies were employed to facilitate data collection and/or analysis.

High variability in centre implementation– The CECR program is highly flexible, giving funded centres the opportunity to tailor their design to context and need. This variation means that individual centres place different emphasis on each expected outcome *and* use different strategies to achieve these outcomes. As a result, it is difficult to compare outcomes across centres or aggregate outcomes in a meaningful way.

To address this limitation, the evaluators developed a typology in which centres are grouped according to key design and delivery characteristics. Outcomes were then analyzed based on this typology, allowing the evaluators to draw conclusions based on centre type. Where appropriate and possible, analysis was also conducted based on sector.

Attribution of outcomes to CECR funding – While the CECR program is an important source of funding for centres; it is not the only source of funding. Indeed, centres are encouraged to seek funding from other sources, including other public sources as well as other sources of revenue. Moreover, there are often other players (e.g., other organizations providing support, professional networks, etc.) involved in assisting companies achieve their commercialization objectives.

Because both the centres and the companies they support often access supports unrelated to the CECR program, it is difficult to assess the extent to which the program has had an incremental impact on achieving outcomes. This challenge is mitigated in several ways. Firstly, the evaluation sought informed perspectives on the CECR program's contribution to centres and the centres' contribution to companies. Centre staff, clients, and other stakeholders were asked hypothetical questions regarding how their centre and/or company would be progressing without CECR program support.

Furthermore, the evaluation conducted an econometric analysis that drew on Statistics Canada data to assess incremental improvement in client companies against a comparison group of similar companies that do not receive centre support. This novel approach provides statistical certainty regarding key claims of centre impact on companies. It is also consistent with current methods being used by France to evaluate similar innovation/commercialization programming. (Hassine and Mathieu, 2017).

Respondent Bias – As is the case with most evaluations, the findings are limited by who was consulted to provide evidence. In both the case studies and surveys, centre management were key in developing the sample frames of potential respondents. This allowed the evaluation team to benefit from the centre's unique knowledge of their stakeholder but also may create a positive response bias (i.e., those most intimately involved in the centre are invested in reporting positive outcomes). This limitation was mitigated through the conduct of interviews with members of the expert panels and Private Sector Advisory Board (PSAB), non-centre stakeholders, provincial representatives and unsuccessful applicants.

Appendix D: Detailed econometric analysis

Econometric analyses were conducted by Innovation, Science, and Economic Development Canada (ISED). At the time of writing this report results were preliminary.

Data

The NCE provided information on 4,490 organisations served by centres during fiscal years 2010-11 to 2014-15. This information included the names and addresses of the organisations, and corresponding centre.

In order to assess outcomes for these organisations, their data was linked to Statistics Canada's (STC's) National Accounts Longitudinal Micro-data File (NAMLF), which includes a rich set of characteristics, e.g., employment, payroll, sales, R&D expenditures, industry of operation, and age.[36] Overall, 2,988 of the 4,490 organisations served through the CECR program during 2010-2014 were linked to the STC companies data – a 67% linkage rate. These linked organisations were associated with 1,845 enterprises that reported basic financial information under T2 and 1,283 enterprises that reported employment information under T4.

It was necessary to exclude some of the centre-supported companies. Specifically, companies were excluded if:

1. Key information for their initial year of involvement with the centre was unavailable;
2. Their first year of involvement with the centre was also the last year of the sample (i.e., companies first accessing centres in 2014-15 were excluded as they had insufficient time to achieve any outcomes); or
3. They employed 100 or more individuals.[37]

Methodology

Centre-supported companies were expected to differ substantially from the average company operating in Canada across several important characteristics that may influence their growth prospects. In particular, during their first year of support from the program, supported companies are younger and more R&D intensive relative to the general population. Without some method of accounting for this, it would be difficult to interpret differences in performance as they could be the result of initial differences in company characteristics rather than the impact of the program.

To address this, the analysis used a matching strategy. Each centre-supported company was matched with an unsupported company – that is otherwise similar across observable characteristics that might affect company performance – during the first year the company was served by a centre.

To select the control group of otherwise similar companies, the evaluation used propensity score matching. This methodology involves estimating the probability that a company will be served

[36] This data is developed using Statistics Canada's Business Register, as well as several administrative data sets including, Corporation Income Tax (T2 tax files), Payroll Account Deductions (PD7), Statement of Remuneration paid (T4 slips), and Goods and Services Tax (GST). These data sources collect information at the enterprise-level (henceforth company).

[37] Large companies make up less than 15% of centres' client bases. Due to the size of these companies, it was difficult to find suitable comparison companies without compromising their confidentiality.

by a centre (i.e., their propensity score) based on the characteristics outlined in Figure 17. The propensity score is then used to match treatment (centre-supported) companies with control (unsupported) companies.

Figure 17: Matching variables

Data Source	Company Characteristic
T4 slips	Average wages
	Employees
T2 tax files	Sales
	Gross Profits
	R&D Expenditures
	Total Assets
	Total Liabilities
	Shareholder Equity
	Retained Earnings
Business Registry	Age
	NAICS code (4-digit)
	Province / Region*

Control group not statistically different from CECR treatment group

Control group is identical to CECR treatment group for these characteristics

*Atlantic provinces and Northern provinces / territories are aggregated into their respective regions for matching.

Ultimately, there were 677 supported companies with 99 employees or less that filed adequate information during their first year being served by a centre. Out of these companies, 653 had suitable matches from the general population – a 97% match rate. This resulting control group was not statistically different at the time of the match in any of our matching characteristics.38

Growth Performance Results: 1 Year

The treatment group (centre-supported companies) and control group (non-centre companies) are statistically similar across a variety of company financial and demographic characteristics during the year they are matched. Accordingly, we are able to make robust comparisons regarding how these groups change over time.

Figure 18 presents the average growth rates for the treatment and comparison groups one year after the match year, i.e., the first year the supported company accessed centre services. Starting with growth metrics related to company size, supported companies were found to grow faster than the control group of otherwise similar unsupported companies. Specifically, supported companies enjoyed a performance premium in both employment growth and sales growth of 15% and 18%, respectively. The growth premium reflects both the growth of supported companies as well as a decline in the comparison group; this decline is consistent with concerns that innovative companies may struggle to grow.

[38] While the evaluation controls for a wide range of company characteristics, it is important to note that this methodology only accounts for observable factors in the data. Un-observable differences – e.g., use of other support programs, a better business plan, management team, intellectual property portfolio – could also drive the results.

Figure 18: Average growth rates* (1 year following match)

	Mean CECR	Mean Control group	Difference in Growth rates	P value of difference
Employees	10.4%	-5.0%	15.3%	0.00
Sales	1.5%	-16.7%	18.2%	0.01
Average wages	1.8%	0.0%	1.9%	0.41
R&D expenditures	1.9%	-11.3%	13.2%	0.03
Total assets	3.8%	-6.7%	10.5%	0.02
Gross profits	-1.8%	-15.6%	13.9%	0.05

*Growth rates calculated using log differences, conditional on companies reporting in both periods. Financial variables were adjusted to 2014 dollars based on the Consumer Price Index; accordingly, growth estimates for financial variables are net of inflation. Differences in growth rates are in bold if significant at 10% or better.

We also assess growth rates for the average wages paid by the company and their annual expenditures on R&D. Company activities associated with commercialization are often thought to involve highly qualified personnel, which could raise the average wages of the company. However, while centre-supported companies posted higher wage growth than the comparison group, the difference was not statistically significant. In contrast, centre-supported companies were found to have statistically significant growth premium with regards to their R&D expenditures.

Growth Performance Results: 3 Years

While informative, a single year of growth likely does not capture the full impact that the centres may have on the companies they serve, which may accrue over several years. Accordingly, we track the progress of the cohort of companies that were first served in 2010-11 or 2011-12 (a subset of the initial group), which allows us to assess their growth performance for up to three years. These results are presented in Figure 19.

Focussing on employment and sales growth, centre-supported companies maintained a statistically significant performance growth premium in these metrics over a three year span. The employment growth premium among supported companies grew from 21% after 1 year to 24% after three years. The growth premium for sales also improved over time, growing from 36% after 1 year to 54% after 3 years.

Turning to the results on the average wages paid by the company, we see that supported companies roughly maintained their initial wage level while companies in the control group reduced their wages. After a 3 year span, the difference in growth rates for the average wage rate is statistically significant at the 10% level offering mild evidence that centre-supported companies end up paying higher wages than otherwise similar companies.

Figure 19: Average growth rates* for 2010-11 cohort (1, 2, and 3 years following match)

		Mean CECR	Mean Control group	Difference in Growth rates	P value of difference
Employees	*after 1 year*	10.4%	-10.1%	20.5%	0.00
	after 2 years	18.6%	-5.2%	23.7%	0.00
	after 3 years	18.9%	-5.2%	24.1%	0.00
Sales	*after 1 year*	6.4%	-29.5%	35.9%	0.00
	after 2 years	10.9%	-13.9%	24.7%	0.03
	after 3 years	16.6%	-37.2%	53.8%	0.00
Average wages	*after 1 year*	0.9%	-1.3%	2.1%	0.53
	after 2 years	-0.9%	-6.7%	5.8%	0.18
	after 3 years	0.9%	-7.2%	8.2%	0.08
R&D expenditures	*after 1 year*	11.6%	-9.0%	20.6%	0.01
	after 2 years	4.5%	-10.5%	15.0%	0.14
	after 3 years	0.1%	-25.2%	25.3%	0.06
Total assets	*after 1 year*	4.3%	-7.8%	12.1%	0.07
	after 2 years	1.3%	-2.4%	3.7%	0.67
	after 3 years	-2.0%	-12.8%	10.8%	0.32
Gross profits	*after 1 year*	0.9%	-25.1%	25.9%	0.04
	after 2 years	8.6%	-12.6%	21.2%	0.07
	after 3 years	13.5%	-36.0%	49.4%	0.00

*Growth rates calculated using log differences, conditional on companies reporting in both periods. Financial variables were adjusted to 2014 dollars based on the Consumer Price Index; accordingly, growth estimates for financial variables are net of inflation. Differences in growth rates are in bold if significant at 10% or better.

The results on R&D expenditures show that the centre-supported companies in this cohort posted statistically significant growth in the initial year after being served by a centre. However, this bump in R&D expenditures was temporary; after three years, the supported companies only maintained their initial level of expenditures on R&D. In contrast, the control group continually reduced their R&D expenditures below their initial level, resulting in a statistically significant premium for supported companies after 3 years. The reduction in R&D expenditures among the control group is not necessarily surprising. Without some form of support, many of these companies may have simply not been able to finance their research or commercialization activities.

Overall, these results, both the temporary surge in R&D expenditures and sustained growth in sales, are consistent with an acceleration of the commercialization process.

Comparison of results by centre sector

The analysis also tested whether the estimated growth premiums between centre-supported and unsupported firms differed significantly based on the sector of the centre with which they were associated using a regression analysis. No significant differences were found based on sector, nor were differences found to be significant when non-health centres were grouped and compared against health centres

Appendix E: References

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