RESTORING CANADA'S COMPETITIVENESS
IN FUNDAMENTAL RESEARCH:

The View from the Bench

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June 2017

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Executive Summary

Scientific discoveries benefit every dimension of society, from human health and public well-being to aspects of our security, economy and quality of life. Fundamental research—the pursuit of knowledge and understanding of humanity or the natural world without consideration for an end product—is the foundation of this scientific innovation.

Supporting applied research at the expense of fundamental research erodes innovation. It limits the discoveries that are available to catalyze new scientific innovations and it diminishes the pool of talented scientists, most of whom want to be part of both fundamental and applied research endeavours.

In addition to its practical benefits, fundamental research plays a major role both in inspiring the next generation of Canadians to choose science as a career and in fulfilling a basic and widely-shared human need to understand the universe and our role in it. Despite their usual absence from any quantitative metric of the importance of science, these roles are critical and should no longer be discounted.

In this report, we investigate the breadth and significant impact of declining support for fundamental research in Canada. We first analyze publicly-available international data on research expenditures to compare Canada's recent performance in this arena with other countries. Next, focusing on Canadian researchers within academia (because these researchers lead most fundamental research in Canada), we evaluate trends in funding for fundamental and applied research within each of the tri-council agencies (Natural Sciences and Engineering Research Council (NSERC), Social Sciences and Humanities Research Council (SSHRC), Canadian Institutes of Health Research (CIHR)), which are the primary funding sources for these researchers. We then assess trends in a critical, but rarely measured, metric: availability of research funding per higher-education researcher. We complement these quantitative analyses with a timeline of recent key events and related public commentary on shifting support for fundamental research in Canada in high-profile media sources. We also present results and supporting statements from our 2016 on-line survey, which provided a voice for Canadian researchers to communicate the impacts of declining fundamental research support on their research programs and the consequences of these changes for sustaining research excellence in Canada. We conclude with clear recommendations based upon our analyses regarding the specific measures and investments needed to reverse the erosion of support for fundamental research in Canada.

In contrast to many other countries, Canada's gross domestic expenditures on research and development (GERD) declined considerably over the decade from 2005 to 2014, from 1.98% of GDP to only 1.61%. By comparison, the world's research-leading countries spend more than 4% of their GDP on R&D. As a consequence of these changes, Canada dropped from fourteenth to twentieth place amongst the 34 OECD member countries in GERD rankings between 2006 and 2014, and Canada now lags significantly behind both the overall OECD average and the G8 average in terms of its investment in R&D. Analyses of the proportion of Canada's GERD dedicated to fundamental research and comparisons of these investments to other nations could not be undertaken because—unlike every other G8 nation—Canada does not report these data to the OECD. Reduced investment in overall R&D does, however, reflect diminishing capacity for discovery and innovation across Canada's research landscape.

Fundamental research was hit particularly hard by general declines in federal research support in Canada as revealed by analyses of trends at the three major research councils (NSERC, SSHRC, CIHR) between 2005 and 2015. Sharp declines in success rates for grant applications to fundamental research programs at SSHRC (from 40% to 23%) and CIHR (from 28% to 14%) are one indicator of this change. CIHR researchers in particular were confronted with a volatile funding landscape over this period, with sharp increases in grant funding for applied research and declining expenditures on fundamental research grants. At NSERC, although declines in success rates were less drastic over this period, real expenditures on fundamental research declined significantly while expenditures on applied research more than doubled.

Erosion of Canada's three major research councils' capacity to support excellent fundamental research is clearest once growth in numbers of researchers needing access to funding is taken into account. Between 2005 and 2015, this loss amounts to 35.55% in Natural Sciences and Engineering (NSE) and 30.96% in Social Sciences and Humanities (SSH). The extent of these declines is not evident in standard reporting metrics, but the end result is undeniable: increasing numbers of Canadian researchers now receive no federal research funding. Trends in health-related fields cannot be tracked because numbers of researchers in these areas are not available.

Dismantling fundamental research support has changed the very nature of how science is conducted in Canada and has had a profound impact on the Canadian research community as evidenced by their responses (n>1,300) to our on-line survey. Canadian researchers are, for example, keenly aware (82%) that success rates for fundamental research grant applications have declined over the past decade. Although they have attempted to adapt by diversifying their funding portfolios, this has often come at the expense of being able to conduct fundamental research; several researchers noted that fading research support had excluded them or their colleagues from the funding system. The view that applied research grant success rates have increased, which is held by a majority of researchers, is not empirically supported. This view likely arises from awareness of increased expenditures on applied research programs at both NSERC and CIHR, as well as increases in the number of applied grants awarded at NSERC and in the average value of applied grants at CIHR.

Strikingly—and primarily in response to the loss of fundamental research funding—the proportion of researchers who reported that they only conducted fundamental research collapsed from 24% for 2006-2010 to only 1.6% for 2011-2015. Overall, 40% of researchers substantially changed their research program foci during this time, most commonly away from fundamental research; and, whereas three-quarters of researchers had research programs dominated by fundamental research between 2006 and 2010, this was the case for only 58% of researchers by 2011-2015. Almost half of the respondents cited changes to available research funding as the reason for this, indicating that federal funding priorities between 2006 and 2015 effectively pushed researchers away from fundamental research in Canada.

A predictable consequence of Canadian researchers refocusing their programs on applied research is that almost all survey respondents (88%) reported that their research now includes some external partners. One potential outcome of these changes is that research directions may increasingly be influenced by partnerships and availability of government funding than by the scientific priorities identified by researchers themselves. Beyond this change, half of the respondents believe that recent federal funding changes will lead to fewer young Canadians choosing to pursue research careers in the future; Canada's capacity to compete as a scientific powerhouse on the world stage will be greatly diminished if this is the case.

A decade of strong growth in numbers of researchers and the erosive effects of inflation mean that restoring fundamental research funding availability to 2005 levels in the NSE would require an investment of $232 million. These funds would need to flow predominantly to NSERC's Discovery programs. The accumulated funding gap in SSH over the same period is $71 million in Insight programs. Although the figure needed to redress the imbalance for fundamental research programs at CIHR cannot be calculated because of the lack of data on changes in numbers of researchers in health-related fields, it is likely to be similar in magnitude to that required for NSERC Discovery programs. The 2016 re-establishment of Statistics Canada's University and Colleges Academic Staff System will improve such measurements in the future.

Overall, the accumulated funding gap for fundamental research in Canada was approximately $535 million by 2015, $76 million of which was added to the three granting councils in the 2016 federal budget, leaving an outstanding funding gap of $459 million. This figure could be viewed as a short-term need simply to level the playing field for today's researchers relative to that of their predecessors in 2005. Achieving real leadership amongst international comparator nations would require that Canada more than double its investments in research as a proportion of national economic activity.

The key recommendation that emerges from analyses of funding trends and the reported experiences of Canadian researchers in this report is that **fundamental research funding should be linked to the number of active researchers in the Canadian research ecosystem**. The purpose of this recommendation is to include a broader community of researchers in fundamental research enterprises leading to greater research impact.

This leads to the second recommendation: **The federal government should at minimum invest $459 million in fundamental research programs at NSERC, SSHRC and CIHR**. While identifying the "correct" level of support that should be accessible to excellent Canadian researchers is beyond the scope of this report, working toward full recovery from the erosion of research support between 2005 and 2015 is a sensible starting point.

Three key outcomes from these recommendations are: 1. stabilization of grant application success rates, 2. the integration or reintegration of accomplished, but unfunded, researchers in investigator-led research programs, and 3. improvements in intergenerational equity so that researchers choosing science careers today have opportunities comparable to their predecessors a decade earlier.

What these numbers cannot fully convey is the passion hundreds of scientists communicated to us in their comments about the vital role of fundamental research. The media review we conducted amasses the voices of Canadian Nobel laureates and leading scientists offering impassioned pleas for what they know to be the essential building block of discovery in our world. They are sounding the alarm bell for our future as a global leader for innovation, discovery and thoughtful progress in a world where the reasoned search for truth has never been more important. Canada's brightest scientific minds have spoken: they make a powerful case that stronger research investments will serve the interests of Canada and Canadians.

Acknowledgements

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Finally, we acknowledge the Global Young Academy for supporting this project financially.

Glossary and Acronyms

CANSIM	Canadian socioeconomic database from Statistics Canada
CFI	Canadian Foundation for Innovation
CIHR	Canadian Institutes of Health Research
FTE	Full-time equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development in Canada. GERD represents the total intramural expenditure, both public and private, on research and development (R&D) performed on the national territory annually (1)
NRC	National Research Council
NSE	Natural Sciences and Engineering
NSERC	Natural Sciences and Engineering Research Council
OECD	Organisation for Economic Co-operation and Development
S&T	Science & Technology
SBDA	Science-Based Departments and Agencies
SSHRC	Social Sciences and Humanities Research Council
SSH	Social Sciences and Humanities
R&D	Research and Development, defined by the OECD as the aggregation of basic research, applied research, and experimental development (2)

1. Fundamental Research: The Foundation of Innovation

1.1 What is Fundamental Research?

The results of scientific discovery are in plain sight in every dimension of human society. For some, fundamental, or basic, research is easiest to appreciate when it leads to applications that benefit society directly, whether they are chemotherapies or smartphones, water purification processes or electric cars. The tremendous benefits derived from science-driven applications in terms of human health, public well-being or monetary returns on investment, can, however, obscure an important truth: Transformative applications of science depend on foundations laid by fundamental research.

There are many ways to categorize research sectors, but there are few true boundaries between different aspects of the research enterprise. A common approach to classifying research is to rank a particular research enterprise by the extent to which it seeks to achieve fundamental understanding of some phenomenon and, second, by how impactful that research is. This results in three research sectors, each of which can lead to important scientific advances (Figure 1):

- ***Fundamental research*** is a study in the pursuit of knowledge and understanding of humanity or the natural world. It is executed without consideration for an end product, and instead asks fundamental questions. Fundamental research is also referred to as basic research, blue sky research, or curiosity-driven research. If, for example, one is considering proteins, an example of fundamental research would be how and why proteins fold and make complex shapes that affect chemical reactions in living organisms.
- ***Use-inspired research*** strives to understand phenomena and processes that are required to address long-term societal challenges. For example, the capacity for certain chemicals to interact with proteins to produce effects that might reduce the prospects for survival of an organism.
- ***Applied research*** seeks to use existing knowledge—discovered through fundamental or use-inspired research—to develop practical solutions to specific challenges, such as the development of an antiviral medication that targets a particular protein in a virus.

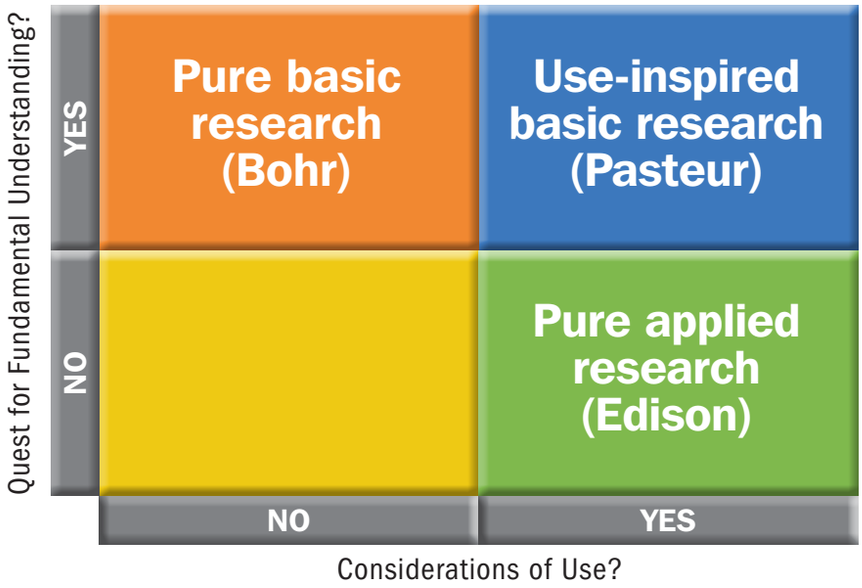


FIGURE 1. Donald Stokes' classification of scientific research, known as "Pasteur's Quadrant." The classification demonstrates the differences between research that is clearly motivated by curiosity (exemplified by Bohr's quest to understand the structure of the atom) and strongly applied research (represented by Edison's determination to develop commercial electric lighting) (3). Stokes introduced the term *Pasteur's quadrant* to represent use-inspired research, based on Pasteur's commitment both to understand microbiological processes and to control their effects on human lives and products (3). Figure adapted from (3).

Discoveries and knowledge that emerge from one type of research do not remain locked in that sector but readily flow into each of the others. This movement of knowledge is aided and mirrored by the movements and interactions of researchers themselves, who are commonly active in more than one of these research sectors.

Practical benefits of research typically require fundamental or use-inspired discoveries before their eventual application. Indeed, decades of fundamental and use-inspired research may be necessary to lay the foundations for a breakthrough with practical societal benefits. Conversely, many applications have arisen rapidly and serendipitously from transformational discoveries that were initially motivated by nothing more than curiosity. Each part of this research process is vital, but applied research is likely to have the greatest public visibility because it is directed towards tangible benefits.

1.2 Why is Fundamental Research Important?

1. Fundamental research is the foundation of innovation. It may be tempting to conclude that new scientific applications, technologies and products are enabled simply by supporting applied research. However, this discounts the key role that fundamental research plays as the base of a pyramid on top of which applied research lies. In their report on science policy and public spending, Kay and Llewellyn illuminated this point, noting that "to equate the useful with the applied is to display the same level of understanding as the child who thinks that the hands are the most important parts of a watch because they are the ones that tell the time" (4).

> ***"To equate the useful with the applied is to display the same level of understanding as the child who thinks that the hands are the most important parts of a watch because they are the ones that tell the time."***
>
> – J.A. Kay (economist) and C.H.L. Smith (physicist), Oxford University, 1985

Transformative discovery is normally just a particularly exciting moment in a longer, gradual process, not a single *Eureka* moment as depicted in cartoon abstractions of the research enterprise. Transformative discoveries depend strongly on previous work, just as more common, incremental discovery does, a point Sir Isaac Newton immortalized in his famous comment, "If I have seen further, it is by standing on the shoulders of giants" (5).

> ***"If I have seen further, it is by standing on the shoulders of giants."***
>
> – Sir Isaac Newton, 1675

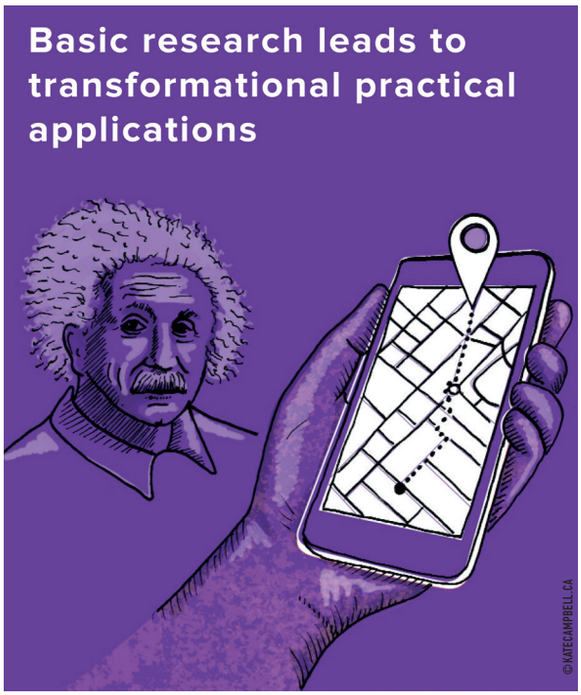
Supporting applied research at the expense of fundamental research erodes innovation by both limiting the availability of discoveries that catalyze technological innovation and diminishing the pool of talented and passionate scientists who want to be part of both fundamental and applied research endeavours. A strong fundamental research sector is necessary to provide the creative atmosphere and training environment required for the advancement of applied research and technology. As Nobel Laureate George Porter explained, "To feed applied science by starving basic science is like economising on the foundations of a building so that it may be built higher. It is only a matter of time before the whole edifice crumbles" (6).

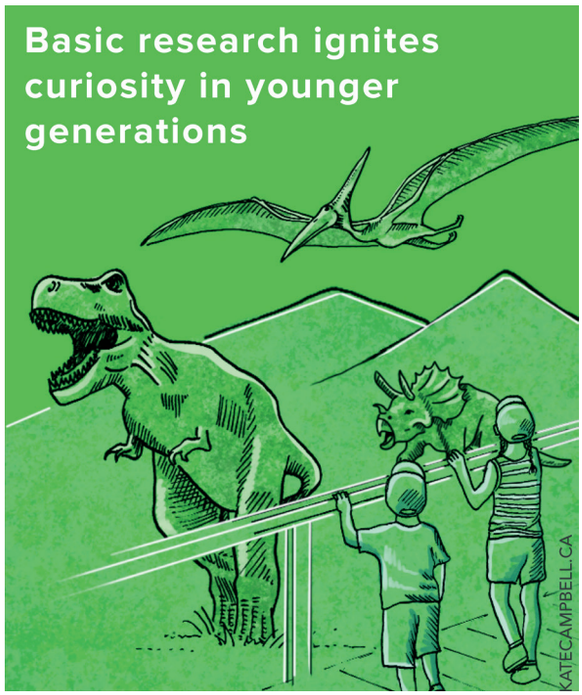
> ***To feed applied science by starving basic science is like economising on the foundations of a building so that it may be built higher. It is only a matter of time before the whole edifice crumbles.***
>
> – George Porter, Nobel Laureate in Chemistry ,1986

2. Fundamental research can lead to practical applications. Fundamental research has led to groundbreaking practical applications. Medical researcher and past president of the University of Toronto David Naylor noted that "countless discoveries that had no immediate application turned out to be the foundations for life-changing and life-saving innovations in clinical care" and that the most useful discoveries cannot be predicted in advance (7). For instance, Magnetic Resonance Imaging (MRI) is a practical implementation of Nuclear Magnetic Resonance (NMR) spectroscopy, which was developed for use in fundamental chemistry research (8). The accuracy of GPS readings is based on Einstein's theories of special and general relativity (9). And, lasers developed in fundamental research programs are used widely in an impressive array of technologies, including medical surgeries, construction and film projectors (10).

New fundamental research is required to continually drive applied research forward. Although innovations with worldwide impacts continue to be developed today as a result of existing fundamental work, these could suffer if support for fundamental research fades. Relying on past discoveries for short term innovation is insufficient to grapple with emerging challenges. New fundamental discoveries in materials science are, for example, currently revolutionizing the possibilities of solar technologies, increasing their potential to displace carbon-polluting power generation (11). Breakthroughs in fluid dynamics are critical to improving designs for wind turbines (12); and recent fundamental research on the distribution of contaminants in the environment has shown that plastic microbeads now permeate many aquatic ecosystems (13).

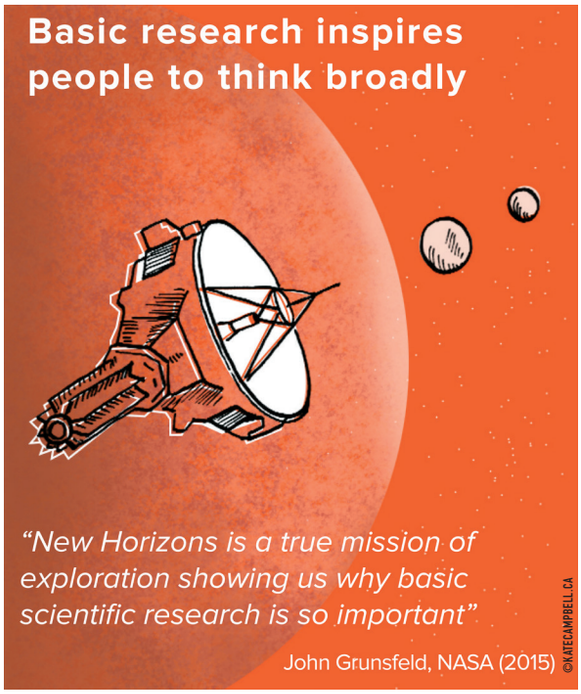
3. Fundamental research inspires the next generation of scientists. Fundamental research also inspires the younger generation to pursue research careers (4, 14). Just as children are curious about why the sky is blue, what dinosaurs ate, the size of the universe, and how birds fly, for many researchers, the attraction of complex, scholarly challenges motivates a lifelong dedication to research more than does the immediate utility of discoveries (15). If fundamental research were given persistently lower funding priority than applied science,





aspiring researchers might turn to other non-scientific careers, depriving society of their potential contributions and undermining potential for all forms of scientific progress (16). Conversely, nations with strong fundamental research programs can attract and hold onto international research leaders and inspire a future generation of scientists (7). Thus, fundamental research is crucial to the training of future scientists and innovators and to maintaining a healthy balance between fundamental, use-inspired, and applied research endeavours (16).

4. Fundamental research satisfies human curiosity. In addition to life-changing products and technologies, fundamental science satisfies the basic human need to understand the universe and humanity's role within it. As Einstein noted, "curiosity has its own reason for existing" (17). Fundamental, or curiosity-driven, research has been called "one of the most ancient and noble of human aspirations" by ecologist Franck Courchamp (18) and "a positive and pure thirst for knowledge" by human geographer Richard Phillips (19). For example, the discovery of radium was motivated purely by curiosity, but also laid the foundation for achieving life-saving therapies that still resonate strongly more than a century later. Two-time Nobel prize winner (physics and chemistry) Marie Curie, who led this discovery, explained that "this is a proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science" (20).



1.3 Report Objectives

Motivated by the foundational role that fundamental research plays in advancing the scientific enterprise and by recent declines in support for fundamental research in Canada, our objectives in this report are to:

- Quantify how research support has changed in Canada over the past decade relative to other G8 nations and OECD member countries, including those that invest the most in research;
- Quantify the extent to which support for fundamental research and for applied research has changed in Canada overall and within each of the three major granting councils that support Canadian academic researchers;
- Provide a voice for Canadian researchers to communicate the impacts of declining fundamental research support on their research programs and the consequences of these changes for research excellence in Canada; and to
- Make clear recommendations based upon our analyses regarding the specific investments needed to reverse the measured erosion of support for fundamental research in Canada.

This report is intended to complement the work of Canada's Advisory Panel on Federal Support for Fundamental Science (21). We explain the value of fundamental research, present analyses and perspectives that reflect the experiences and concerns of active researchers in Canada, and identify priorities for improving the research environment for these researchers. It is our view that these priorities must be accounted for in decisions regarding the future of fundamental research in Canada.

2. International Research Funding: How Does Canada Stack Up?

2.1 Research Funding in Canada Relative to G8 and OECD Comparator Nations

Canada's capacity to compete internationally in any research sector, whether fundamental, use-inspired or applied, relates strongly to its investments in these research activities. While each nation's investment in research and development (R&D) will depend, in part, on the economic conditions within that country (22), investment in R&D may also reflect the extent to which a country values research. By examining the trajectory of Canada's overall investments relative to other nations, we illustrate Canada's diminishing capacity to be a research powerhouse on the world stage and we provide a backdrop for understanding the challenges and opportunities confronting Canadian research and researchers.

At the national scale, research expenditures are measured using GERD, the Gross Domestic Expenditure on Research and Development, which is expressed as a percentage of a nation's gross domestic product (GDP) (22). Comparative international data on research expenditures that distinguishes between fundamental, use-inspired and applied research do not exist, so changes in the relative funding within each of these research sectors cannot be extracted from trends in GERD.

We evaluated Canada's overall research expenditures relative to two groups of comparator nations internationally: the top ten countries according to GERD; and the G8 nations. These analyses are based on OECD 2014 and 2015 data, the most recent measurements available (depending on the country) at the time of publication (Appendix A).

Canada's investments in research and development (GERD) declined substantially over the decade from 2005 to 2014 (the most recent year for which Canadian data are available (Figure 2)). Canada's GERD dropped from approximately 1.98% of GDP to 1.61% over this period (Figure 2), a research expenditure low last seen in 1996. This decline accelerated toward the end of this period (Figure 2). The federal government and business enterprises (industry) together fund around 80% of Canada's R&D activities, with most of the remaining funds coming from higher education, provincial governments, research organizations, and private non-profits (23).

As a result of a declining expenditure in research over the past decade, Canada's GERD dropped from a ranking of fourteenth amongst the 34 OECD member countries in 2006, to a ranking of twentieth by 2014 (Appendix A). Canada's investments in R&D lag significantly behind the OECD average (Figure 2a), the G8 average (Figure 2b), and even the R&D investments of some developing nations, such as Tanzania (GERD: ~2.4%) and Nepal (GERD: ~1.9%) (24).

In contrast to Canada's performance over the past decade, the average GERD amongst OECD countries increased steadily to 2.4% (Figure 2a; note that data for most of these countries with the exception of Canada are available to 2015). Amongst the top R&D investors, Israel has long been a leader, with GERD exceeding 4% for most of the past decade (Figure 2a). However, as a result of its rapid rise in GERD over the past decade, South Korea reached parity with Israel, and these two countries are now the highest proportional spenders in R&D, with GERDs of 4.23% and 4.25%, respectively (Figure 2a). Japan and Germany are currently the only G8 countries amongst the top ten GERD performers globally.

In comparison with the other G8 countries, Canada ranks sixth in terms of GERD, ahead of only Russia and Italy (Figure 2b). Overall, the average GERD of the G8 countries showed a slight increase over the past decade (Figure 2b). Canada is the only G8 country that significantly reduced its

research investments relative to GDP between 2005 and 2014 (Figure 2b). Canada's GERD was near that of the UK for the past decade, but lagged significantly behind France, the United States, Germany and Japan (Figure 2b).

Although the OECD collects data on member nations' expenditures on basic (i.e. fundamental) research—defined as "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view" (25)—these data are irregularly reported and completely lacking for some nations. Notably, Canada is the only G8 nation that does not report basic research expenditures to the OECD. The consequence is uncertainty: We cannot measure the proportion of Canada's GERD that is allocated to fundamental research nor the extent of these investments relative to comparator nations.

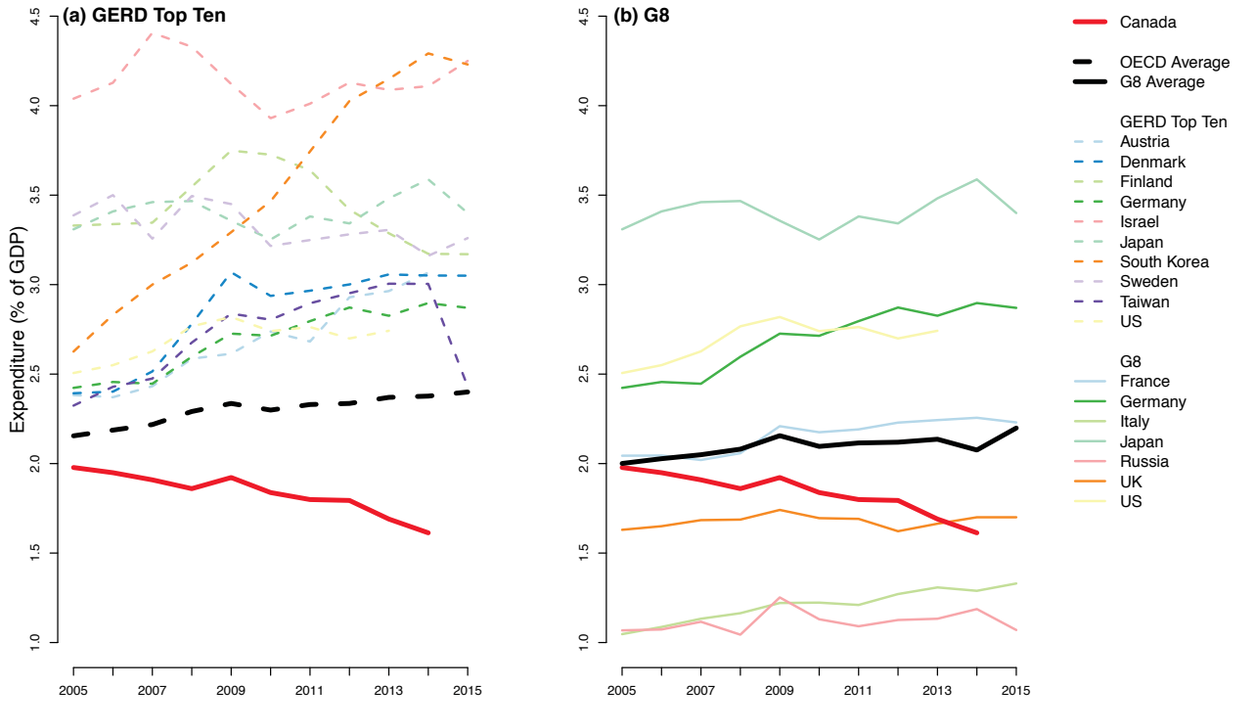


FIGURE 2. Gross Domestic Expenditures on Research and Development (GERD) in Canada (red line) relative to other countries. Comparator nations include (a) the top ten OECD leaders in GERD; and (b) G8 nations. Canada is the only nation to exhibit a declining trend in gross expenditure in research and development with respect to GDP.

2.2 The Bottom Line

1. In contrast to many other countries, Canada's proportional R&D investments declined considerably over the past decade, with the consequence that Canada's GERD dropped from fourteenth to twentieth place amongst the 34 OECD member countries between 2006 and 2014.

2. Canadian R&D expenditures are now below both the OECD and the G8 averages. Canada ranks sixth out of the G8 countries for GERD. Reduced investment in R&D reflects diminishing capacity for discovery and innovation across Canada's research landscape.

3. Analyses of the proportion of Canada's GERD dedicated to fundamental research and comparisons of these investments to other nations could not be undertaken because—unlike every other G8 nation—Canada does not report these data to the OECD.

3. The Erosion of Federal Funding for Fundamental Research

3.1 Introduction

Our focus within this report is on funding for researchers and their research programs within higher education (i.e. academia) because these researchers conduct the majority of fundamental research in Canada. We evaluate trends in funding for fundamental and applied research for each of the tri-council agencies (NSERC, SSHRC, CIHR) involved in research program support. We focus on the primary funding elements that affect whether excellent researchers are able to establish or maintain research programs in Canadian academic institutions: total expenditures, average grant values, numbers of grants awarded, applicant success rates, and the amounts expended on research relative to the numbers of higher-education researchers.

Context: Three major government funding agencies, known collectively as the "tri-council," comprise the primary funding mechanisms for these researchers: the Natural Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and the Canadian Institutes of Health Research (CIHR; see Box 3.1 for more information). Each of the tri-council agencies supports a distinct array of funding programs that accommodate mixtures of fundamental, use-inspired and applied research initiatives. Each agency also offers a variety of granting programs that support a range of defined types of research for particular research projects or for long-term research programs. Researchers can also draw support from the Canadian Foundation for Innovation (CFI; Box 3.1) and provincial counterpart agencies for infrastructure needs, but CFI does not fund research programs. In some cases, academic institutions, along with private enterprises and non-governmental organizations, also make research funds available to researchers.

The federal government includes many science-based departments and agencies (SBDAs) that are involved in fundamental, use-inspired, and applied research sectors. SBDAs most commonly pursue research constrained by their particular mandates (e.g., health-related research at Health Canada) rather than purely curiosity-driven work. Although detailed quantitative analysis of research funding for SBDAs is beyond the scope of this report, we note that where agencies have strong fundamental research traditions, there is clear evidence of a shift toward applied work within them (see Box 3.2: Timeline). Prominent amongst these changes are those within the National Research Council of Canada (NRC), the nation's largest scientific and technology organization. While the NRC has traditionally led renowned fundamental research programs in many fields, it shifted its emphasis decisively over the past decade toward work in support of industry needs (see Box 3.2: Timeline, and Appendix B). Rapid shifts in the NRC's mandate toward becoming an industrial "concierge service" (see References 62-66 in Appendix B) reflect the government's recent emphasis on applied over basic research.

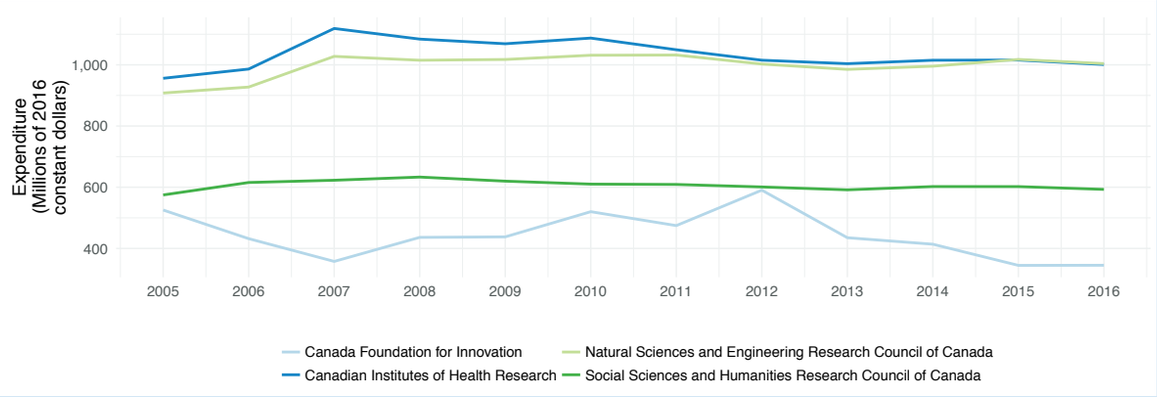
Methods: We extracted funding data from the *NSERC Award Database*, the *SSHRC Award Database, the CIHR website*, the *Canadian Research Information System* hosted by CIHR, and the *Canadian socioeconomic database from Statistics Canada (CANSIM)*. NSERC, SSHRC and CIHR each operate complex and lengthy arrays of granting programs that are broadly classified as supporting fundamental or applied research (Appendix A). Although there is not a distinct set of granting programs for use-inspired research in any of the tri-council agencies, this research sector is supported by various programs in both of the other sectors. Data on expenditure and number of grants awarded are reported by fiscal year, in which case multi-year grants are documented by the total amounts expended for each of the years that funding was provided. Success rates are reported by competition year and measure the ratio of successful to unsuccessful grant applications submitted in that year's competition. All measurements of research expenditures included in every analysis in this report have been adjusted for inflation to 2016 constant dollars using the *Bank of Canada Inflation Calculator*.

Box 3.1 Core agencies supporting research programs, projects and infrastructure in Canada

Natural Sciences and Engineering Research Council (NSERC): NSERC funds non-medical research in the natural sciences and engineering (NSE). NSERC's mandate is "to make Canada a country of discoverers and innovators for the benefit of all Canadians." The agency supports students through scholarships from undergraduate through to postdoctoral career stages, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in post-secondary research projects (26).

Social Sciences and Humanities Research Council (SSHRC): SSHRC promotes and supports post-secondary-based research and research training in the humanities and social sciences that "enhances our understanding of modern social, cultural, technological, environmental, economic and wellness issues" (27).

Canadian Institutes of Health Research (CIHR): CIHR supports discoveries and innovations that improve Canadians' health and strengthen the Canadian health-care system. CIHR is independent but accountable to the Minister of Health. CIHR is divided into 13 institutes that focus on distinctive areas of health research (28). The CIHR Act declares that "the objective of CIHR is to excel, according to internationally-accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians, more effective health services and products, and a strengthened Canadian health-care system" (29).



Total annual expenditures in millions of inflation-adjusted 2016 constant dollars for each of the tri-council funding agencies, which support most of the research programs and projects in Canada, and the Canadian Foundation for Innovation, which supports research infrastructure.

Tri-council Granting Criteria

The main academic fields that the tri-council agencies focus on relate to traditional divisions in the academic community: applicants to NSERC are most commonly from Faculties of Science, applicants to SSHRC are usually from Faculties of Arts and Social Sciences, and researchers from medical schools or fields with health applications form the largest pool of applicants to CIHR. Nevertheless, researchers can apply to any granting council funding programs for which their proposed research meets program requirements. Granting councils organize committees with both national and international experts to evaluate applications for their scholarship and granting programs on a range of factors specific to each granting program. These evaluation criteria are particular to each granting program, but often include assessments of researcher excellence, merit of the proposal, and quality of training of early career scientists expected if the proposal is funded. Additional criteria in some programs are potential for practical benefits, technology transfer, and likelihood of commercialization of research products. Each granting program weighs criteria distinctly. Excellence, based on national and international peer review, is intended to be the common basis for grant application success.

Canadian Foundation for Innovation (CFI): CFI was created by the Government of Canada in 1997 as an independent, non-profit corporation to fund scientific research infrastructure (30), including buildings, laboratories, scientific equipment, databases, and communications. CFI funds up to 40% of a project's research infrastructure costs, with matching funds from provincial counterparts and industry partners. CFI does not fund research programs, unlike the tri-council agencies, and its endowment is renewed intermittently, leading to greater fluctuations in CFI funding than for tri-council funding.

Next, using CANSIM data, we examine how the size of Canada's natural sciences and engineering (NSE) and social sciences and humanities (SSH) research communities have changed over time. Longitudinal data on numbers of researchers were consistently available until 2013 for both of these research sectors, and for each we examine trends in the number of higher education and federal government researchers. Data on the number of researchers working primarily in areas related to human health, who would be amongst the potential applicants to CIHR, are not measured in the CANSIM database.

We then assess trends in a critical, but rarely measured metric: availability of research funding per higher education researcher. Combining granting agency funding data with the CANSIM data described above, we assess these trends for NSE and SSH researchers, explicitly considering total research funding (i.e. fundamental and applied research funding combined) availability per researcher, fundamental research funding availability per researcher, and applied research funding availability per researcher. We estimate these trends up until 2015 by assuming, conservatively, that numbers of researchers in these sectors remained constant in 2014 and 2015. Given the lack of data on numbers of researchers, we could not assess changes in the availability of research funding per researcher in health-related fields.

Drawing on analyses conducted here, we summarize and discuss the evidence for shifting federal support for fundamental research in Canada through time, addressing separately the trends that could be measured in NSE, SSH and human health.

Finally, to complement the quantitative analyses here, we present a timeline of key events and public commentary in high-profile media sources (supported by quotes from national research leaders) from over the past six years that focuses on shifts in support for fundamental research in Canada (see Timeline; Appendix B).

3.2 The Natural Sciences and Engineering Research Council

Background: NSERC has been the primary granting council for scientists and engineers conducting research in the natural sciences and engineering (NSE) since its inception in 1978. Its grant funding programs and expenditures are grouped into two broad categories: "Discovery: Advancement of Knowledge" and "Innovation: Research Partnerships." A complete listing of the many granting programs that NSERC classifies within each of these categories is provided in Appendix A. Note that these programs are distinct from NSERC's direct support for scholarships to students and postdoctoral researchers.

Researchers seeking funding to support fundamental research or use-inspired research typically apply to granting programs within the Discovery stream, the mandate for which is to "invest in scientific discovery and people for the benefit of Canada—[supporting] science and engineering at the frontier of knowledge" (31). Discovery programs at NSERC seek to fund excellent research that allows researchers significant latitude to define their research objectives, which can include the pursuit of fundamental, use-inspired or applied questions. Researchers seeking support for applied research connected with industry generally apply for Innovation grants. These are meant to "use discoveries to accelerate R&D [and] provide feedback loops from industry to academia to optimize technologies and inform [the] future discovery of research" (31).

We compared trends in total expenditures, average award value and number of grants awarded across all Discovery and Innovation grant programs to evaluate how the amount of support for fundamental and applied NSE research within academia in Canada has changed over time.

Findings: Trends in research investments differ between applied and fundamental research sectors. Applied and partnered research programs under NSERC's Innovation umbrella have grown sharply, reaching a peak in 2013 of $369 million, a 51% increase from 2005 (Figure 3.1a). Over the same period, combined funding for all Discovery research programs has declined rela-

tively steadily (Fig 3.1a). Investments in these fundamental research activities peaked in 2007 at $503 million, and declined by 16% thereafter to $420 million in 2015, the most recent year for which data are available (Figure 3.1a).

Average grant sizes awarded through Discovery programs at NSERC have eroded significantly since 2005, declining by 15% from $45,279 to $39,275 in 2015 (Figure 3.1b), whereas the number of grants changed very little over this period (Figure 3.1c). The average value of Innovation grants was more volatile over the past decade but, overall, declined considerably (Figure 3.1b). There is notable growth in the number of Innovation grants awarded, which has more than doubled between 2005 (when 3,022 were awarded) and 2015 (when 6,161 were awarded) (Figure 3.1c). Success rates for grant applications in the Discovery program have declined from 75% in 2005 to 65% in 2015 (Figure 3.1d).

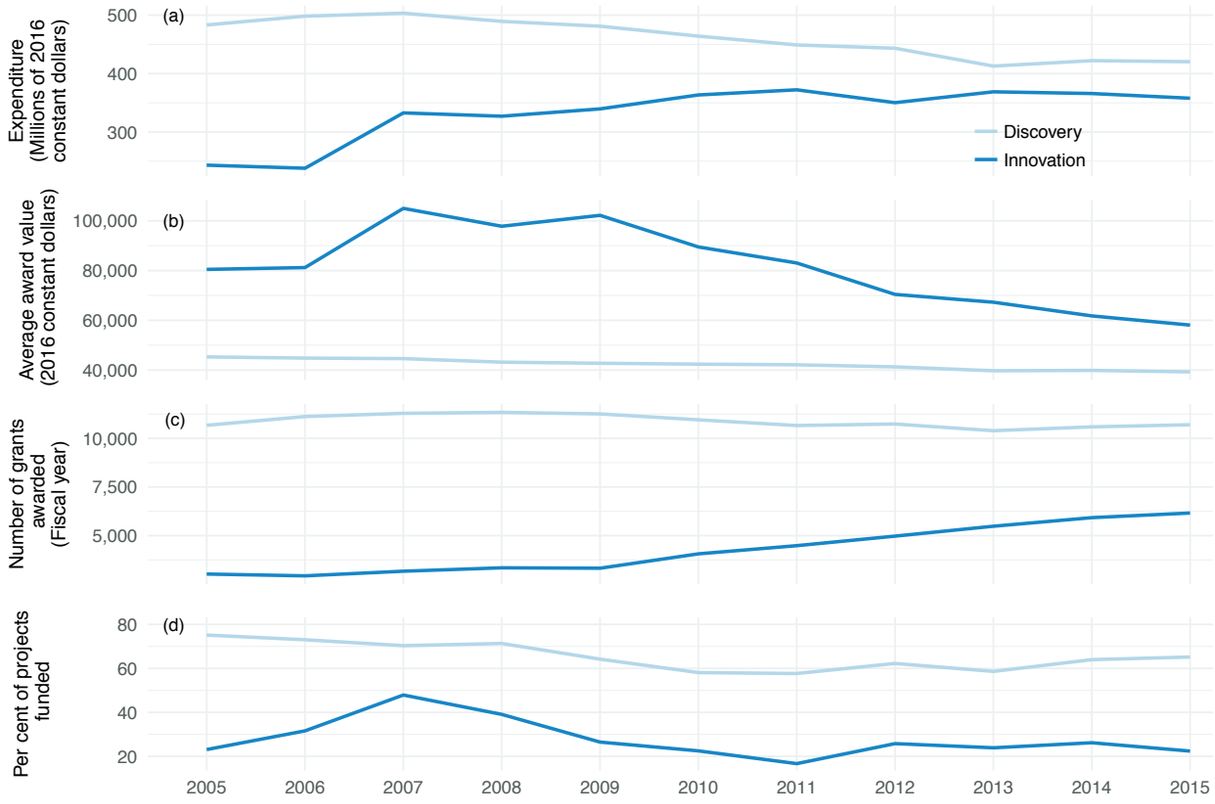


FIGURE 3.1. NSERC expenditure, average award value, number of grants awarded for Discovery and Innovation programs in millions of 2016 (inflation-adjusted) constant dollars, and per cent of projects funded. Overall expenditure on Discovery program grants decreased toward 2015 while expenditures in the Innovation program rose (a). Average award values declined for both the Innovation and Discovery programs (b). The number of grants awarded within the Discovery program decreased slightly, but increased sharply in the Innovation program (c). Success rates for applicants to Discovery programs have declined over the same period, while success rates for grant applications to Innovation programs have been volatile but show no overall trend (d). Data shown in this figure are included in Appendix A.

3.3 The Social Sciences and Humanities Research Council

Background: Since 1977, SSHRC has funded research in the social sciences and humanities that "enhances our understanding of modern social, cultural, technological, environmental, economic and wellness issues" (27). Its granting programs were reorganized between 2010 and 2012 to establish two categories for research grant support: "Insight" and "Connection" (32). As with NSERC, SSHRC maintains a distinct, third funding area for scholarship support.

The Insight grant family is the major source of funding for fundamental research projects in SSH, with the overarching goal to "build knowledge and understanding about people, societies and the world" (33). The Connection granting stream funds applied research programs and the communication of research, with the goal to "realize the potential of social sciences and humanities research for intellectual; cultural; social; and economic influence, benefit and impact on and beyond the campus" (34). A detailed list of individual granting programs included in the Insight and Connection analysis can be found in Appendix A.

Findings: Investments in the Insight grant program eroded between 2005 and 2011, declining from $160 to $136 million, but have since recovered to levels similar to those in 2005 (Figure 3.2a). Expenditures on Connection grants have traditionally been lower and less consistent, peaking at $71 million in 2006 but decreasing to $32 million in 2015 (Figure 3.2a).

The average award value for Insight grants has varied between $37,000 and $55,000 over the past decade, but Connection grant sizes have fluctuated much more, between $63,000 and $156,000 (Figure 3.2b). In the past few years, average grant values for each of the Insight and Connection programs have converged, and are now both near $60,000 (Figure 3.2b). The number of grants available in Connection programs has remained small in comparison with Insight programs (Figure 3.2c).

Demand for research grants in the SSH remains very high and grant application success rates in the Insight programs have declined significantly, from 40% in 2005 for the predecessor program for Insight grants (most Standard Research Grants became part of the Insight granting stream after 2012) to about 23% in 2015. Success rates also dropped for Connections grants, declining from about 80% in 2012, when these grants were instituted, to 55% in 2015 (Figure 3.2d).

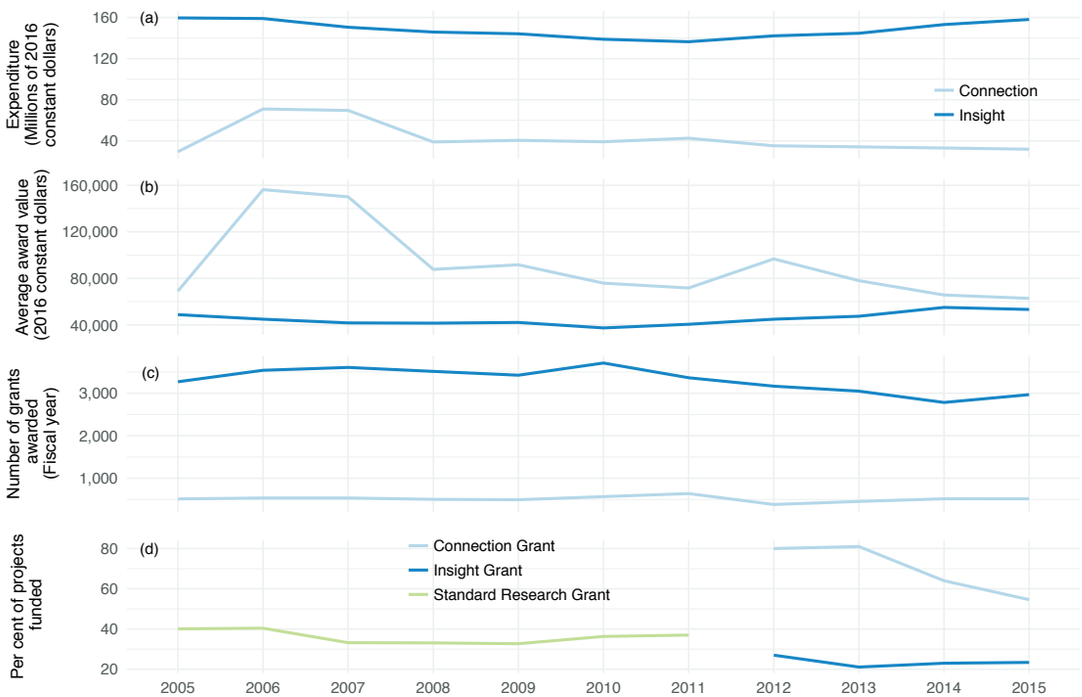


FIGURE 3.2. SSHRC expenditure, average award value, number of grants awarded by fiscal year for Insight and Connection programs in millions of 2016 (inflation-adjusted) constant dollars, and per cent of projects funded. Overall expenditure on Insight program grants has fluctuated, while expenditures in the Connection program have decreased in recent years (a). Average award values in 2015 are similar to values from ten years ago for both the Insight and Connection programs (b). The total number of grants awarded within the Insight program has decreased in recent years, while they have remained relatively stable for the Connection program in the same time period (c). Grant application success rates have declined for both Insight and Connection grants over this period; note prior to 2012 the Connection and Insight granting programs did not exist, and were instead represented by the Standard Research Grants (d).

3.4 The Canadian Institutes of Health Research

Background: Health research includes both fundamental and applied streams and is supported in Canada by the Canadian Institutes of Health Research (CIHR). CIHR was formed in 2000 as the successor to the Medical Research Council. Its mandate is to "excel, according to internationally-accepted standards of scientific excellence, in the creation of new knowledge and its translation into improved health for Canadians" (29). CIHR research support is divided among 13 constituent institutes, each of which focuses on particular domains of health-related work. Following the recommendations of an international review panel, CIHR reformed their funding schemes and review processes in 2013 (35).

The grant programs offered by CIHR are grouped into "Investigator-driven" or "Priority-driven" health research (36). Projects that are created by individual researchers and their teams comprise the investigator-driven research projects, and the Core Open Operating Grant Competition is the main grant program that offers researchers this freedom (36). These grants are also known as curiosity-driven grants, or commonly as "Open" grants. Priority-driven research projects reflect government choices about strategic research directions, which can be tightly defined (e.g., grants for mild traumatic brain injury) (36). Funding in this stream is commonly referred to as "Fettered" grants.

Findings: Expenditure on Open and Fettered research grants has varied significantly in the past decade (Figure 3.3a), reflecting volatility during reforms to CIHR granting programs initiated in 2013. Expenditure on research in the Open grant family grew sharply from 2008 to 2009 to over $500 million, but then dropped by nearly 50% between 2013 and 2014 (Figure 3.3a). In contrast, expenditure on Fettered research grants more than doubled in 2014 and 2015 to over $500 million (Figure 3.3a).

Average grant values for CIHR programs are much higher than those for NSERC and SSHRC, and display a similar trend to the overall expenditures in each of the Open and Fettered granting programs (Figure 3.3b). From 2009 to 2013 the average award value for the Open grant program exceeded $700,000, whereas those in the Fettered program grant value averaged $300,000. However, this pattern was dramatically reversed in 2014, when the average Fettered program grant rose sharply to $1,100,000 and the average Open program grant declined in value by nearly 50% to $368,000 (Figure 3.3b). Although in 2015 the average grant size in the Open research programs returned to 2013 levels, Fettered research grants remained large in comparison, averaging approximately $950,000 (Figure 3.3b).

The most striking characteristic of CIHR grant program trends in the past decade is the steep decline in the number of grants awarded (Figure 3.3c) and the associated erosion of grant application success rates (Figure 3.3d) for Open research grants. The number of Open research grants declined steadily between 2005 and 2008, held fairly steady until 2014, and then dropped sharply in 2015 to half the 2014 number (Figure 3.3c). Meanwhile, the number of Fettered grants varied through time but increased in 2015 to almost twice the number of Open grants awarded (Figure 3.3c).

Disconcertingly, only 14% of health researchers applying for Open research grants were funded in 2015, compared to 28% in 2005 (Figure 3.3d). The likelihood that grant applications would be considered worthy of potential funding (their

approval rate, a necessary precursor to funding) declined from 53% in 2005 to 26% in 2015 (Figure 3.3d). Even with this substantial decline in grant approval rates, just over half of applications deemed worthy of funding have received support (Figure 3.3d). Opportunities to receive fundamental research funding at CIHR are increasingly remote for researchers in the Canadian health research community.

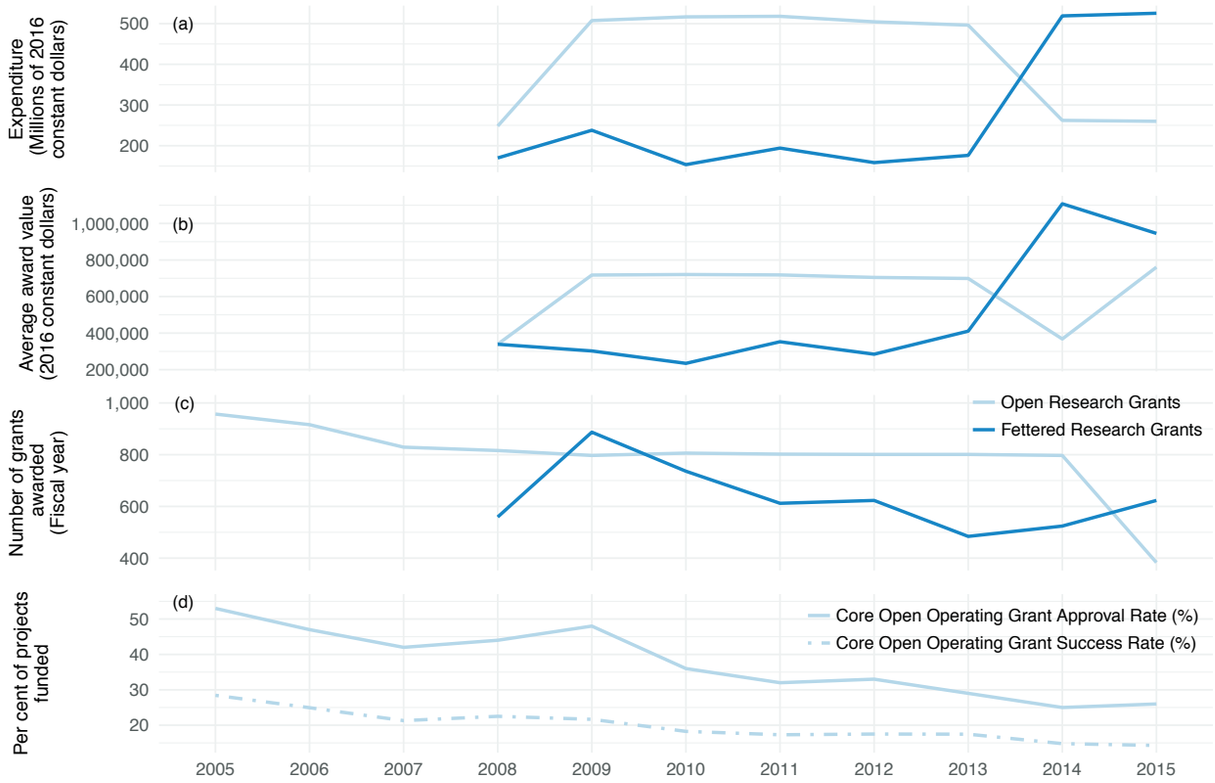


FIGURE 3.3. CIHR grant expenditure, average award value, number of grants awarded, and grant approval and actual funding (success) rates by fiscal year for Open and Fettered research grants in millions of 2016 (inflation-adjusted) constant dollars. Total expenditures on Open research grants declined in recent years, in contrast to Fettered research grants (a). Average award values have varied in both Open and Fettered programs, but the latter has grown sharply (b). Numbers of grants awarded declined gradually in Open programs until 2015, when the number of grants plummeted by >50% (c). The approval and success rates for the Open research programs have decreased dramatically over the past decade (d). Data shown in this figure are included in Appendix A.

Granting programs at CIHR continue to change quickly, leading to uncertainties in the researcher community that relies on those programs for funding health-related discovery and innovation (see Timeline, Appendix B) (35, 37). Among reforms is the replacement of face-to-face peer review of grant applications with a virtual, anonymous review system (Appendix B). CIHR now indicates that 54% of their budget is allocated to investigator-initiated research, 23% to priority-driven research, and the remainder to tri-council programs and operating expenditures (36).

3.5 Growth in Canada's Research Community

Background: A healthy research community is inseparable from Canada's potential for science and technology (S&T) leadership on the international stage, so trends in research funding need to account for the number of researchers within the Canadian research landscape. Statistics Canada recognizes researchers as those that are "engaged in the conception or creation of new knowledge, products, processes, methods and systems" as well as post-graduates, managers and administrators involved in the planning and management of technical and scientific work (38) (Appendix A).

Here, we focus on numbers of researchers in the academic community, which is the main target of tri-council funding, and we provide trends in federal government research workforces for comparison purposes. It should be noted that growth in academic employment depends on hiring priorities within provincial institutions, namely universities and colleges, and is not directly related to federal research funding trends. Hiring decisions within these institutions reflect growing demand for—and prestige associated with—high-impact research, rising undergraduate enrolments, and the need to train a highly-qualified workforce.

Findings: The size of Canada's academic research community has grown significantly since 2005, creating substantial—but rarely measured—pressure on grant budgets for the tri-council agencies.

In NSE, the number of researchers in higher education has increased by 35%, from 23,720 in 2005 to 32,010 in 2013, the last year for which data are available (Figure 3.4a). Statistics Canada reports a sharp decline in researcher numbers in 2009 and complete recovery in 2010, an anomaly that provides no insight into the long-term trend and that we do not interpret here. Numbers of NSE researchers in the federal government show much less variability, but declined by 6% after 2011 (Figure 3.4a).

The academic researcher community in SSH has grown even faster than in the NSE, expanding by 43%, from 19,700 in 2005 to 28,260 in 2013 (Figure 3.4b). Few researchers in the federal government are classified as working within SSH, but this number grew from 380 to 930 over the same period (Figure 3.4b). We do not interpret these latter numbers because SSH includes areas of research, such as socioeconomics, in which many federal agencies specialize (e.g., Statistics Canada), so estimates of changes in the size of the SSH research community size in the federal government may be a weak reflection of numbers of workers actually engaged in fundamental or applied SSH research fields.

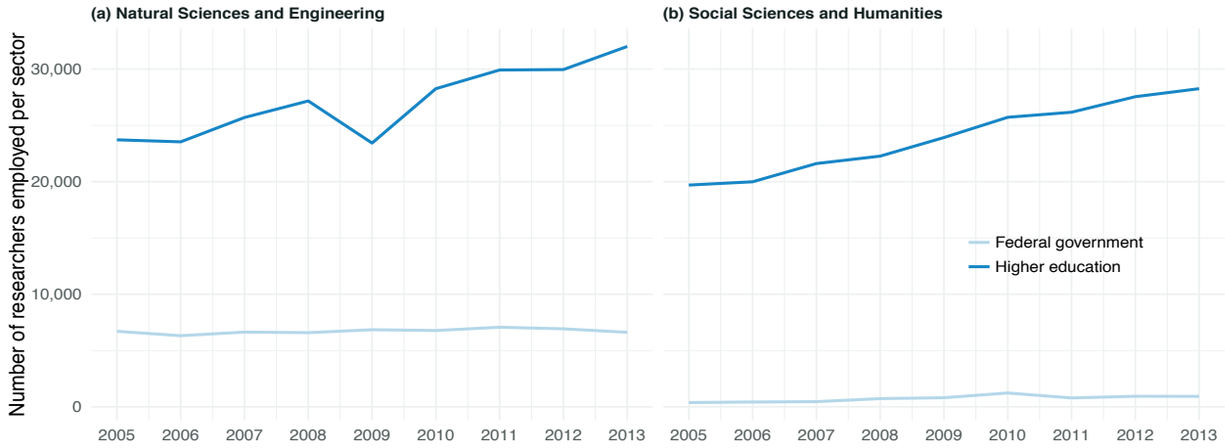


FIGURE 3.4. Number of researchers in Canada by major performing sector. Growth in the academic community has been very strong in both the NSE (a) and SSH (b), driven by demands for new professors in universities. Over this time, the numbers of federal researchers in NSE- and SSH-related fields has remained relatively stable, but federal researcher numbers declined by 6% after 2011 in the NSE and may have grown in the SSH. Data shown in this figure are included in Appendix A.

3.6 Declining Availability of Research Funds Per Researcher, 2005-2015

Trends in research funding are best interpreted after taking into account adjustments for inflation as well as the number of researchers who may need access to those funds.

For researchers in the NSE, fundamental research funding availability per researcher (through NSERC's Discovery research granting programs) declined sharply over the 2005-2015 period, dropping from $20,374 to $13,131, a decline of 35.55% (Figure 3.5a). During the same period, applied research funding (through NSERC's Innovation research granting programs) rose by 9.02%, growing from $10,253 to $11,178 per researcher. The erosion of fundamental research funding was not consistent, and the highest per capita funding availability was in 2006, when funding values reached $21,169 per researcher. Applied research funding availability relative to the number of researchers who potentially sought this support peaked in 2009 at $14,492, and showed much greater volatility through time than funding support for fundamental research.

Declines in funding available to researchers in the SSH (Figure 3.5b) were pronounced and more consistent than for researchers in NSE disciplines. Fundamental research funding availability (through SSHRC's Insight granting support) in comparison with numbers of researchers declined by 30.96% over the 2005-2015 period, dropping from $8,102 to $5,593 per researcher. In contrast with NSERC funding for applied research, the accessibility of applied research funding (measured as SSHRC Connection grant program funding) declined by 24.55% during the same period, from $1,497 per researcher in 2005 to $1,129 in 2015, the lowest funding levels recorded during this period. Applied research funding was volatile, varying from a low of $1,129 in 2015 to a high of $3,553 in 2006.

Total research funding available through research grants to researchers applying to NSERC and to SSHRC have declined significantly over the 2005-2015 period. In the NSE, total research funding dropped by 20.63% (from $30,627 to $24,309) while it declined by 29.96% in the SSH (from $9,958 to $6,722).

Measurements of numbers of researchers in health-related fields are unavailable in CANSIM, making estimates of these trends for CIHR's granting programs impossible.

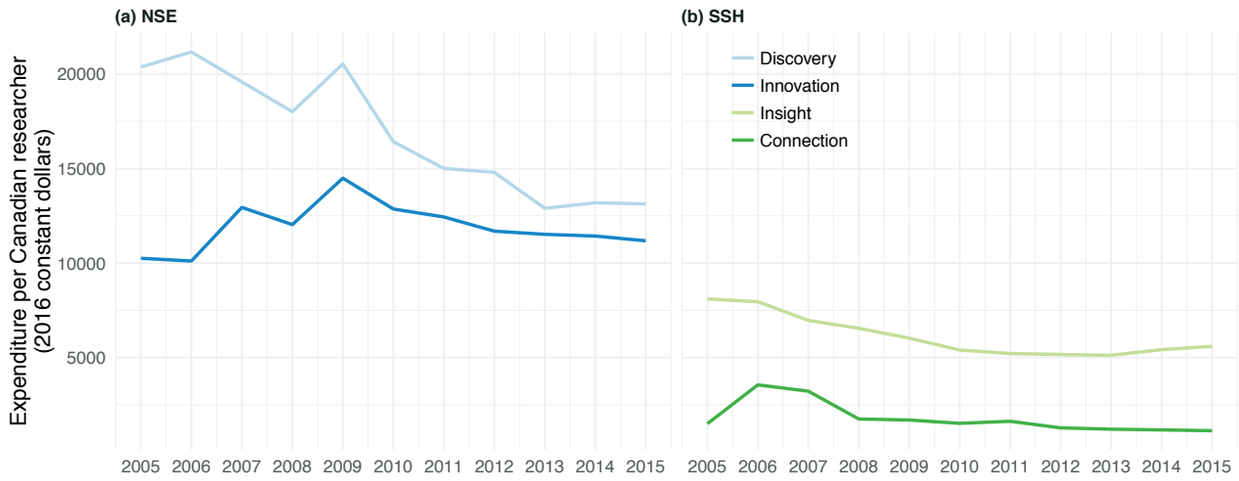


FIGURE 3.5. Expenditure per higher-education researcher on fundamental and applied research in NSE and SSH in thousands of 2016 (inflation-adjusted) constant dollars. Changes to research funding availability per researcher are shown separately for fundamental and applied research programs, divided by the granting council responsible (NSERC for NSE and SSHRC for SSH). Fundamental research funding, relative to numbers of researchers in NSE (a) and SSH (b), has declined sharply over the 2005-2015 period for which these data were available. Funding availability for applied research has been considerably more volatile for both NSE and SSH. Data shown in this figure are included in Appendix A.

3.7 Implications of the Loss of Fundamental Research Support

The implications of growing proportions of underfunded researchers for the excellence of Canadian research institutions should not be underestimated. Scarcity of funding equates to losses of opportunity for—and the reduced likelihood of retention of—highly-trained and mobile researchers (39). For institutions, larger numbers of unfunded or underfunded researchers means reduced access to Indirect Costs of Research funds, which offset institutional costs associated with salaries and infrastructure maintenance in proportion to the number and value of federal research grants awarded to institutions' researchers.

Yet, Canadian researchers continue to have an impact that is large relative to their numbers on the international research scene, and there is a strong foundation of excellence on which to build. Scientific publications by Canadian researchers between 2008 and 2012 were cited about 16% more frequently than the OECD average, and 13.1% of Canadian papers in that period were among the 10% top cited publications, exceeding the OECD average of 11.1% (40). Canada's relatively strong research performance, according to such metrics, will be increasingly difficult to maintain if the grants that support excellent researchers become increasingly difficult to obtain while, at the same time, shrinking in real value.

There is also an opportunity cost to the erosion of research support to Canadian researchers: Canadian researchers perform well, but their leadership and consequent benefits to Canada might have been much greater had funding not eroded over the period studied here. While researchers at Canadian institutions outperform OECD comparators, there are signs at the institutional level that Canada's research performance faces risks. For instance, Canada's research-intensive universities have fallen farther behind their international comparators in terms of excellence (41), which may partially reflect declines in relative support to these institutions through Indirect Costs of Research funds, the increasing number of researchers who do not receive federal granting council support, or a combination of both of these factors.

3.8 The Accumulated Funding Gap for Canadian Researchers

The accumulated funding gap for Canadian researchers in the NSE and the SSH can be calculated as the amount of money that would need to be added and made accessible to NSERC and SSHRC researchers to increase the availability of research support per researcher to previously-observed levels. The peak funding levels vary depending on whether the researcher was working in NSE or SSH, whether the program was fundamental or applied, and the year chosen for comparison with funding levels observed in 2015.

For fundamental research, the combined funding increase required to fill the accumulated funding gap in NSE since 2005 is $231,836,327, which would need to flow to Discovery Programs at NSERC. The comparable calculation for SSHRC's Insight programs, which emphasize fundamental work, is $70,888,270. Both of these figures were calculated in 2016 dollar terms. These estimates rely on two assumptions, namely that the number of researchers measured by Statistics Canada in the SSH and NSE are eligible to apply for research funding from either SSHRC or NSERC, and that the number of researchers in SSH and NSE disciplines have remained constant since 2013, the last year in which CANSIM measured these numbers. These estimates are conservative and the funding gap is likely to be somewhat larger than stated here. Data supporting these conclusions are included in Appendix A.

Improvements to the fundamental research budgets of the tri-council agencies made in 2016 were large by recent historical standards, and alleviate some of this erosion (42). These funding increases amounted to $76 million for the tri-council agencies in 2016, and these funds continue to be added to granting competitions adjudicated in 2017 and later (42).

These budget increases were divided among NSERC ($30 million), SSHRC ($16 million), and CIHR ($30 million), and were directed to fundamental research. Budget 2016, in other words, filled in as much as 12.9% of the $231.836 million required to restore per-researcher funding levels to 2005 values in inflation-adjusted terms. For SSHRC, the budget increase restored as much as 22.6% of the $70.888 million required for Insight programs if per researcher funding availability was to be restored to 2005 levels in inflation-adjusted terms. These were large single-year increases for fundamental research, but they could not compensate for the measured erosion that accumulated over the previous decade. Budget 2017 did not increase funding to granting councils' fundamental research budgets above levels achieved in 2016, favouring increases in intramural governmental science spending and targeted extramural investments instead (43).

The extent of the benefits derived from recent or future increases to tri-council research funding should account for differences in the size of the research community, necessitating ongoing and timely estimates of the numbers of researchers who are left out of the research landscape by remaining unfunded. Measurements of researcher numbers in Canada should be extended to include those working in health-related fields.

3.9 The Bottom Line

1. Fundamental research support faded strongly in the Canadian research ecosystem between 2005 and 2015, while support for applied research grew. Success rates for grant applications to fundamental research programs at both SSHRC and CIHR have declined sharply. The decline at SSHRC was from 40% success rates in 2005 to 23% success rates in 2015, while CIHR has dropped by half, from 28% in 2005 to 14% in 2015. Success rates also declined at NSERC, albeit to a much smaller degree. Real expenditures on fundamental research at NSERC declined significantly over this period.

2. Shifts toward applied research are readily detectable in the sharply-increased expenditures on Innovation programs at NSERC (rising to a peak of $369 million in 2013, 51% higher than levels from 2005) and numbers of applied research grants offered (which more than doubled, to 6,161, over the 2005-2015 period). This trend is not evident at SSHRC. However, health-related researchers have been confronted with a volatile funding landscape, with sharp increases in grant funding toward Fettered Research and declining expenditures and numbers of Open Research Grants.

3. The erosion of Canada's three major research councils' capacity to support excellent fundamental research between 2005 and 2015 is most striking once the sharp growth in numbers of researchers needing access to research funding is taken into account. The extent of these declines is not evident in standard reporting metrics. In the NSE, this decline was 35.55%, reflecting the erosion of funding in NSERC's Discovery programs relative to inflation and the growth of Canada's NSE research community. The trend for researchers in SSH is similar, as funding available through SSHRC's fundamental research programs (now known as Insight grants) has declined by 30.96% over the 2005-2015 period. The trends in health-related fields cannot be tracked as precisely because numbers of researchers in these areas are not tracked by CANSIM databases. However, there is no reason to suggest that trends for CIHR-related programs differ from those found for NSERC and SSHRC.

4. The accumulated funding gap for Canadian researchers conducting fundamental research in NSE is about $231.836 million in 2016 dollars and relative to strong growth in the number of researchers who need access to those funds. These funds would need to flow to NSERC's Discovery programs (and predominantly Discovery Grants) to restore average funding availability per researcher to levels observed in 2005. The comparable funding gap in SSH in Canada for SSHRC Insight programs, which support fundamental research, is $70.888 million. This figure cannot be calculated for fundamental research programs for CIHR because we did not have access to changes in numbers of researchers in health-related fields.

5. Funding increases to the granting councils in 2016 were large relative to historical changes, but did not compensate for a decade of funding erosion after accounting for increasing demand and the effects of inflation. There were no comparable increases in granting councils' fundamental research budgets in 2017.

6. Steep declines in funding availability, in conjunction with stagnation in numbers of research grants available, demonstrates that increasing numbers of Canadian researchers are unfunded. While Canadian researchers achieve more than average across the OECD, Canada's advantage in this area is at risk, and research-intensive institutions are slipping in international ranking exercises.

Box 3.2 Chronicling the Erosion of Fundamental Research in Canada

A number of government decisions in recent years have contributed to the erosion of Canada's fundamental research support system. New policy directions have emerged, leading to changes in the tone and substance of discussions about research support and, in many cases, shifting support toward applied research. Major policy shifts and the reactions of scientists and the general public are highlighted in the timeline below and in a compendium of news articles from national agencies including *CBC*, *Macleans*, and *The Globe and Mail,* as well as from international outlets such as *Nature*, *Science* and *The New York Times* found in Appendix B. The extent of coverage on this topic illustrates that the press and Canada's research community have been keenly aware that support for fundamental research has been deteriorating for some time.

2011

On March 2, 2011, the National Research Council receives a memo outlining an end goal of centralizing 80% of their $1 billion budget, leaving just 20% to fund "curiosity and exploratory activities."
– *Nature News*, April 19, 2011

I hope it doesn't come at the expense of the significant capability they have in basic research. Without basic science, there's no science to apply.

– Henry van Driel, President of the Canadian Association of Physicists and a University of Toronto Professor, *Ottawa Citizen*, March 20, 2011

The shift away from basic science "weakens" the NRC's labs, because they "are required to bridge two cultures – the basic and applied," says John Polanyi, a Nobel laureate and a chemist at the University of Toronto.

– *Nature News*, April 19, 2011

2012

On March 29, 2012, the first budget after the 2011 election announces cuts to "open" research programs supporting investigator-driven research projects. Grant funding within Canada's major funding agencies is reallocated to industrial and strategically defined programs.

"This is disastrous," says James Turk, executive director of the Canadian Association of University Teachers in Ottawa, Ontario. "The government has no understanding of how scientific advancement is made. No appreciation of blue-sky research."

– *Nature News*, March 30, 2012

2013

On March 21, 2013, Finance Minister Jim Flaherty releases the 2013 budget outlining benefits for mostly applied research. He refers to the budget as "a plan for jobs, growth and long-term prosperity."

...the government's relentless focus on business innovation does not represent a coherent science strategy.

– Paul Dufour, Director of Paulicy Works, a science and technology consultancy, as quoted in *Nature News*, March 22, 2013

"Science powers commerce," Mr. Harper has said... But many worry that the budget's emphasis on applied research and commercial outcomes is weakening the country's scientific capability in the long term.

– *The Globe and Mail*, March 25, 2013

We need to remember that the distinction between fundamental and applied research is misleading. As Nobel laureate Sir George Porter famously pointed out, there is applied research and yet-to-be-applied research....what for me is the most important asset of all...I am referring, of course, to young talent. The resources that matter the most aren't in the ground or offshore. The resources that will win the day for Canada are the inquiring, agile and creative minds of the next generation.

– David Naylor, *The Globe and Mail*, March 27, 2013

Countries around the world are picking winners and investing heavily in them, so they are coming up the ranks while Canada is slipping.

– Phil Baty, editor of Times Higher Education World University Rankings, in reference to the decline in ranking of top Canadian universities, as reported in *The Globe and Mail*, March 27, 2013

"It's like literally standing there and having somebody punch you in the head many, many times over," Jeffrey Hutchings, a biology professor at Dalhousie University in Halifax, said about the federal cuts. "You can sometimes deal with one punch, or a second, but it was like being pounded. I think that's really how scientists felt in this country and still feel that today."

– *Huffington Post*, March 30, 2013

2013

On May 7, 2013, the new NRC plan was formally unveiled to include: a shift away from quasi-independent research institutes with wide-ranging research efforts that emphasize discovery research and towards collaborative R&D projects with private industry; a focus on five areas of research: health costs, the manufacturing supply chain, community infrastructure, security, plus natural resources and the environment; and closing of some support facilities in Winnipeg, Calgary and Halifax.

The 97-year-old NRC will focus on a clutch of large-scale, business-driven research projects at the expense of the basic science that was once at its core.

– *The Globe and Mail*, May 7, 2013

Mr. Goodyear insisted the government isn't abandoning basic science, just shifting its focus to commercializing discoveries. "The day is past when a researcher could hit a home run simply by publishing a paper on some new discovery," he said.

– *The Globe and Mail*, May 7, 2013

Any government is well advised to encourage and fund some blue-skies research, as the return on investment can be enormous: one fundamental discovery today can inform a hundred research programs tomorrow.

– *Atoms and Numbers*, May 8, 2013

The shift away from basic research has already been accompanied by a precipitous 73% fall in published research by NRC scientists in just two years.

– *Chemistry World*, May 14, 2013

If we want to succeed in science and technology, we need to always strive to answer the biggest, highest-impact questions. If we don't take the lead on answering the big questions, then we will be the ones buying technology, not selling it.

– Cathleen Crudden, president of the Canadian Society for Chemistry, *Chemistry World*, May 14, 2013

July 2013 – Significant cuts to Canada's major funding agencies begin to take form. NSERC's Major Resources Support program, which awards grants to cover the costs of specialized research facilities, equipment and staff, is on hold and no longer accepts applications "as part of the Government of Canada's efforts to return to balanced budgets." Bamfield Marine Sciences Centre and the Dalhousie University Aquatron lab are two notable victims of these cuts.

The government, which has been cutting programs in all areas, insists that any science-related cuts are part of the broader belt-tightening needed to get Canada's books in the black.

- *Huffington Post*, July 5, 2013

The experts... were saying we were doing an amazing job and we deserved more money. And a year afterwards, it's just yanked. With nothing.

– Brad Anholt, director of Bamfield Marine Sciences Centre, *Huffington Post*, July 5, 2013

The granting agencies are still making grants, but... they're not granting in areas that are not considered business-led and industry relevant.

– Green Party of Canada Leader Elizabeth May as reported by the *Huffington Post*, July 5, 2013

The ability of Canadian scientists to dream and make the kind of truly innovative discoveries that lead to awards is increasingly compromised by the declining levels of funding based primarily on excellence and vision, and the rise of support for so-called translational and targeted research, which is too frequently of questionable value.

– Tony Pawson, First Canadian to win the Kyoto Prize for Science, excerpt from a *Globe and Mail* Op-Ed included in *Macleans*, August 10, 2013

Shifting even more university research funding toward industry partnership programs is a myopic view of how science works – and is likely to backfire.

– Josh Neufeld, *iPolitics*, October 21, 2013

2014

June 2014 – Results of a survey conducted by Environics Canada include responses from over 4,000 federal scientists, researchers and engineers. They show:

- 91% think cuts to federal science budgets will have a detrimental impact on the federal government's ability to serve the public
- 51% think the impact will be "very detrimental"
- 80% of 268 respondents from the National Research Council think Canada has done a worse job over the past five years of advancing our international standing in technology and innovation

– Data from CBC article, June 2, 2014

The current policy appears to be trying to "push" technology from universities to industry, but what is needed to increase the level of innovation is for industry to get better at investing in new ideas and well-qualified researchers.

– Arthur Carty, a former science adviser to the Prime Minister and a former head of the National Research Council, as quoted in *The New York Times*, February 16, 2014

September 2014 – An international survey of higher education and research unions shows that scientists are concerned about the drop in government support of basic science in favour of applied research.

– Survey conducted by French National Trade Union of Scientific Researchers in 12 countries (including Canada)

Funding trends vary by country, but in all cases research institutions are being reformed to strengthen governments' grip on science... Canadian scientists, in particular, face a unique set of challenges as the government puts a squeeze not only on their funding, but also on their freedom of expression.

- Patrick Monfort, Secretary General of the French National Trade Union of Scientific Researchers, *Nature News*, September 3, 2014

Basic science is an investment in the long-term future, which current governments seem to be less interested in....Basic science is one of our last tools to seek the truth...To unlock those mysteries, to truly understand our role, and to truly expand our thinking, we need to keep those scientific eyes open.

– Bob McDonald, CBC News blog, September 5, 2014

I definitely would not be coming to Canada now to pursue research. And if things do not get better in two years, I am out of here.

– Dr. Stagljar, professor at the University of Toronto and a world-renowned scientist who developed a powerful method to discover new cancer genes, *The Globe and Mail*, December 16, 2014

2015

In April 2015 an election year budget is announced that focuses on investments in research infrastructure and partnerships with industry but flatlines funding for basic science

– *Globe and Mail*, April 27, 2015

Rather than reenergizing the research sector... the federal budget maintains the status quo at a time when other countries are staking more on science as a long-term strategic investment.

– *The Globe and Mail*, April 27, 2015

"You run the risk of having these wonderful labs with no people in them," said Deborah Gordon-El-Bihbety, president of Research Canada, an alliance of stakeholders in Canadian health research. "They've not solved the problem of how they make sure they get the right balance."

– *The Globe and Mail*, April 27, 2015

Much of the promised funding for research is destined for industrial partnerships. This is in keeping with other Conservative policies, some of which have strained relationships between the government and scientists.

– *Nature News*, April 30, 2015

The upcoming Canadian election later this month will provide a welcome opportunity to reboot the federal government's controversial approach to science policy and research.

– James L. Turk, editorial in *Science*, October 9, 2015

2015

April 2015 and onwards – Revamping of the Canadian Institutes of Health Research (CIHR) includes a number of changes to the funding structure and the evaluation process. Funding for CIHR's 13 institutes will be cut in half, with the savings going to a common fund only accessible to researchers aligned with cross-disciplinary initiatives that have extra support from a funding partner.
– *Nature*, April 16, 2015

Stephen Ferguson, professor in the Faculty of Medicine at the University of Ottawa, has "actively pushed [his] own children away from science" due to changes to science funding through CIHR reforms.

– *Ottawa Citizen*, November 25, 2015

Michael Rudnicki, a leading Canadian stem cell researcher says "there is less money for basic research" and that "morale among scientists has bottomed out and many are struggling to hang on."

– *Ottawa Citizen*, November 25, 2015

I have seen colleagues who I look up to and respect as being better than me who didn't make it through the last round of funding, and that just puts the fear of God into me. When you've got people who are world-class scientists who don't get funded.

- Stephen Ferguson, *Ottawa Citizen*, November 25, 2015

"As a result of the reforms, early career scientists have seen a huge, immediate decline in opportunities and funding success," [said Michael Hendricks]. Scientists have told the *Citizen* that morale is low and that some might have to close their labs because they have little prospect of getting grants to continue their work.

– *Ottawa Citizen*, December 14, 2015

October 6, 2015, Canadian Dr. Arthur McDonald is awarded the Nobel Prize in Physics for his work on neutrinos.

This type of basic research is important, because grasping the forces that power the sun and run the universe on a large scale could become relevant here on the ground in the future. Efforts are already under way to harness the same type of energy produced in the centre of the sun in nuclear fusion reactors that could provide clean energy in the future.

– Bob McDonald, CBC News blog, October 9, 2015

October 19, 2015, Canada elects a new government that promises to hire a chief science officer, create a central place where the public can access the results of government science, and allow government scientists to speak freely about their work.

...the extreme ideologies that characterized the Harper government led to pervasive suppression of federal science and scientists for nearly a decade... The new government can act decisively and rapidly to begin repairing this damage.

– Jeremy Kerr, Professor at the University of Ottawa, *The Star*, October 25, 2015

Many scientists are hoping newly-appointed Minister of Science Kirsty Duncan, a medical geographer, will put an emphasis on basic science and help boost funding for such research.

– American Chemistry Society, November 23, 2015

The members of Prime Minister Justin Trudeau's cabinet are being told to bring "scientific considerations" into all aspects of their decision-making...Based on her mandate letter, Ms. Duncan's job also includes strengthening basic research.

– *The Globe and Mail*, November 30, 2015

2016

March 2016 – A new federal budget is released that emphasizes basic research and increases funding for the tri-council agencies (NSERC, SSHRC, CIHR), which funnel federal dollars to university researchers across the country in the areas of natural sciences and engineering, social sciences and humanities, and health.

To me, it says all the right things and it's money on the table.

– Kristin Baetz, a researcher at the University of Ottawa and president of the Canadian Society for Molecular Biosciences, as reported in *The Globe and Mail*, March 23, 2016

...the budget signalled a shift to basic science away from the applied science focus of recent years and launched a review of the entire complex Canadian research funding ecosystem.

– *Ottawa Citizen*, March 23, 2016

June 2016 – A nine-member panel led by David Naylor is announced to review federal funding for fundamental scientific research.

At present, it is very hard to get money for discovery research, and this concerns me because the one lesson we have learned through all the years is that we don't know enough. We need new information – information that comes from discovery research – because our chances of translating successfully are diminished if we don't have a constant new supply of information.

– Philip Branton, recipient of McGill Medal, *McGill Reporter*, June 9, 2016

Asked what she most wanted the panel to address, Ms. Duncan cited, as an example, the plight of younger researchers who, in many cases, must wait until they are in their 40s to get federal support.

– *The Globe and Mail*, June 13, 2016

The minister has given us a very broad scope and a lot of independence to take a look at the whole ecosystem.

– David Naylor, *The Globe and Mail*, June 13, 2016

I think we have to get clear about what our expectations are and to ask ourselves whether we want each and every agency to be all things to all people. ... If the mandate is that expansive, then the budgets will tend to be expansive as well, and if the budgets aren't expansive, then there will be problems of resource allocation. All that says: Let's align missions, mandates, and budgets in an intelligent and strategic way and then figure out where we go from there.

– David Naylor, *Science*, June 13, 2016

Universities also must develop and maintain meaningful programs in a diversity of fundamental sciences. These must be equally accessible to both genders and all races, including our own indigenous people, and they must be untainted by interference from government or big business.

– David Schindler, *Edmonton Journal*, June 20, 2016

2016

July 2016 – CIHR announces it will revise its controversial system of reviewing grant proposals in response to an open letter signed by more than 200 scientists to Health Minister Jane Philpott.

Canada's health scientists are furious. Many have joined together in a virtual scream of frustration, as they watch the system they depend on for science funding crack under the pressure of a series of reforms.

– CBC, June 28, 2016

"There're just a thousand and one horror stories," said Jim Woodgett, director of research at Lunenfeld Tanenbaum Research Institute at Toronto's Mount Sinai Hospital. As a consequence of the switch, he said, "there will be a lot of extremely good science that should be funded which will not be funded, and that's going to close labs."

– *The Globe and Mail*, July 5, 2016

"We heard the concerns of the community," [CIHR President] Beaudet said. "This can only work with the community on board."

– *Ottawa Citizen*, July 13, 2016

Leonard Maler is an internationally-recognized leader in brain research... for the first time in 40 years, the lab has been turned down for funding by Canada's biomedical research agency, the Canadian Institutes of Health Research. The funding decision is seen as a blow to support for basic science in Canada. One of the reviewers who turned down Maler's funding application said simply that his brain research was "too basic."

– *Ottawa Citizen*, August 19, 2016

We believe it is important that all funding agencies recognize the nature of basic research as a critical foundation for effective clinical outcomes.

– David Park, director of the University of Ottawa's Brain and Mind Research Institute, *Ottawa Citizen*, August 19, 2016

September 2016 – $900 million in research grants is handed out from the Canada First Research Excellence Fund established by the Harper Conservatives in the 2014 budget.

We need to think about how fundamental research can be funded in the best Canadian way possible.

– Martha Crago, VP Research at Dalhousie University, *University Affairs*, September 2, 2016

"Support for science is an essential pillar in our strategy to create sustainable economic growth and support and grow the middle class," Prime Minister Justin Trudeau told his Science Minister Kirsty Duncan in the mandate letter he provided her last fall.

– *National Post*, September 6, 2016

CFREF [Canada First Research Excellence Fund] was created to allow big science in Canada to bulk up so it could compete against world-leading research institutions abroad. But it comes along at a moment when everyday science – the day-to-day efforts of researchers in labs across the country – has been struggling. The Harper government held the line on most operating grants to researchers, so fewer and fewer research applications have been receiving funding. The Canadian Institutes for Health Research, the main federal government vehicle for funding medical research, has seen its "success rate" fall to 13%, and it will probably fall further.

– *The Star*, September 7, 2016

...we need [the Fundamental Science Review] to adjust government priorities so that Fundamental Science is accorded its proper share of the resources devoted to science and innovation. But to achieve this we need to make it clear that the two activities differ, and so have differing needs for success. The fundamental scientist's job is to seek patterns in nature, the innovator's to shape knowledge so that it fills societal needs.

– John Polanyi, Nobel laureate at the University of Toronto, *The Globe and Mail*, September 29, 2016

While Trudeau's report card on Canadian science issues looks good so far, there's still a lot of heavy lifting ahead.

– *Desmog Canada*, December 27, 2016

2017

March 22, 2017 – The 2017-18 federal budget is released with no increase in funding for any of the tri-council granting councils.

Canada is not nearly as appealing a place to begin a science career as it was a decade ago.

– *The Star*, March 7, 2017

Innovation is built on fundamental science, so I'm looking to see if the government is willing to support, in a big way, fundamental science in the country.

– Alan Bernstein, President of CIFAR, CBC News, March 21, 2017

The budget also promises a forthcoming fundamental science review "in the coming months," a new science infrastructure strategy, and a promised review this year at the National Research Council on the government's innovation and skills plan.

– *iPolitics*, March 22, 2017

Overall, Morneau's budget proposes an $11.3 billion spending increase to $247.7 billion. But at best, academic researchers can hope to tap modest monies either allocated or reprofiled for a bevy of national programs generally aimed at promoting "innovation," particularly through partnerships between industry and universities, or from several smaller, boutique initiatives, such as one to develop a national action plan to respond to health risks posed by climate change.

– *Science*, March 22, 2017

Nevertheless, this week's budget offers no relief for individual researchers struggling with diminishing resources and tight competition for scarce federal dollars. Last year's budget increased the funding for the three federal granting councils that support scientists across Canada. Ms. Duncan noted that those increases would continue into the future and that a report on the federal research funding system, expected in the coming weeks, would help point the way to further improvements.

– *The Globe and Mail*, March 23, 2017

... the budget included no new funding for the three major research granting councils – the Natural Sciences and Engineering Research Council, the Social Sciences and Humanities Research Council and the Canadian Institutes of Health Research – dismaying many in the research community.

– *University Affairs*, March 23, 2017

While the Canadian budget plan, released by Prime Minister Justin Trudeau's government this week (March 22), promises to devote more than C$1 billion to establish "Innovation Canada," an initiative promoting partnerships between industry and academia, the budgets of three critical science councils – tasked with funding basic research on natural, heath, and social sciences – remain flat.

– *The Scientist*, March 26, 2017

Last year's new federal money to fund unfettered, curiosity-driven research – the widely proclaimed end to the so-called war on science – and to finance badly-needed upgrades to the research infrastructure on our campuses is also paving the way for future breakthroughs. These investments in turn will make our offer to talented newcomers around the world even more compelling.

– *Ottawa Citizen*, March 27, 2017

The budget that Canadian Prime Minister Justin Trudeau's government released on 22 March...presents scientists with a depressing, and unexpected, freeze on the main funding streams for basic research.

– *Nature*, March 30, 2017

2017

April 10, 2017 – The Naylor Report the federal government commissioned, "Fundamental Science Review," is released, suggesting that the federal government should increase base-level spending on core research funding agencies from $3.5 billion to $4.8 billion a year, including a $485 million increase for curiosity-driven research over a four-year period.

Governments cannot short-change basic research and expect innovation to flourish.

- David Naylor, *Macleans*, April 10, 2017

"Everything is ultimately going to come down to knowledge and research in the decades ahead," Dr. Naylor said. "Either we keep up or we lose ground."

- *The Globe and Mail*, April 10, 2017

[Younger researchers] are really finding it difficult in the present system.

– Art McDonald, Naylor Report panel member and Nobel-prize winning physicist, who added that limited funding and low success rates on grant applications were taking a toll on an entire cohort of early career researchers, *The Globe and Mail*, April 10, 2017

"A crucial shortcoming in the system is the level of support for independent investigator-initiated research," said David Naylor, a former president of the University of Toronto, who led the nine-person review panel, told *ScienceInsider*. "That support has been squeezed for about a decade... Restoring the balance [between curiosity-driven research and applied research] is central to reinvigorating Canadian scholarship and science."

– *Science*, April 10, 2017

4. What Canadian Researchers Say About the State of Fundamental Research

4.1 Querying the Canadian Research Community

Motivated by the need to understand the impacts of changes in available funding for fundamental research on researchers and their research programs, we conducted an on-line survey entitled "Perceptions of Funding for Fundamental Research" between May and October 2016. This survey measured Canadian researchers' personal perceptions of research funding trends in Canada and their outlook on the research funding landscape for fundamental and applied research in this country.

The survey gathered detailed information to address questions in six major areas:

- **Research Focus:** *Has the type of research (fundamental, use-inspired, applied) that Canadian researchers conduct changed over the past decade? If so, why, and what are researchers' views on these changes?*
- **Grant Success Rates:** *Have perceived success rates for fundamental, use-inspired or applied research grants changed over the past decade*?
- **Practical Applications and External Partnerships:** *What is the perceived value of suggesting practical applications and including external partnerships to grant success? Has the level of external partnerships changed for Canadian researchers over the past decade? If so, why, and what are researchers' views on these changes?*
- **Government Priorities:** *How important do Canadian researchers believe fundamental research is to the federal government, and do they believe any type of research has become a higher priority in the past decade?*
- **Implications of Funding Changes on the Next Generation of Scientists:** *What impact will funding changes have on the likelihood of the next generation to pursue careers in research?*
- **Future Research Funding:** *Do Canadian researchers believe that available funding for fundamental, use-inspired or applied research will change in the next five years?*

The survey was open to researchers from all disciplines and career stages with the proviso that participants had to have some experience applying for research funding (i.e. be at least at the postdoctoral stage of their career). The full survey, additional methodological details, and supplementary figures and analyses are provided in Appendix C.

In total, 1,303 Canadian researchers completed the survey, suggesting that there is considerable concern in the research community about recent changes to support for fundamental research. We synthesize these survey results, inferring that the pool of respondents is an accurate representation of the Canadian research community, and hence, referring to them as such throughout the following sections. We complement the formal survey responses with quotes from individual researchers, which serve to further illustrate the concerns of the research community.

Researchers from many different disciplines were represented in the survey: Almost 60% of responses came from either the natural or physical sciences, with the remaining responses spread amongst the medical and life sciences (20%), engineering (13%), interdisciplinary research (5%), and social sciences and humanities (3%) (Appendix C, Figure C1).

Almost all of the survey respondents (94%) were either senior academics (65%), defined as those researchers with more than ten years' experience applying for research grants since completion

of their PhD, or early career academics (29%) (Appendix C, Figure C1). The remainder of responses came from post-doctoral researchers (4%), non-academic researchers (2%), or those who did not indicate their career stage (0.4%).

Almost three quarters of the respondents were male (74%) and one quarter was female (25%); a very small proportion either did not input their gender or selected other.

4.2 Researchers' Perspectives on Fundamental and Applied Research

Fundamental research is enormously important to the Canadian research community: Three quarters of respondents reported that between 2006 and 2010 their research programs were dominated (i.e. half or more of their program) by fundamental research (Figure 4.1).

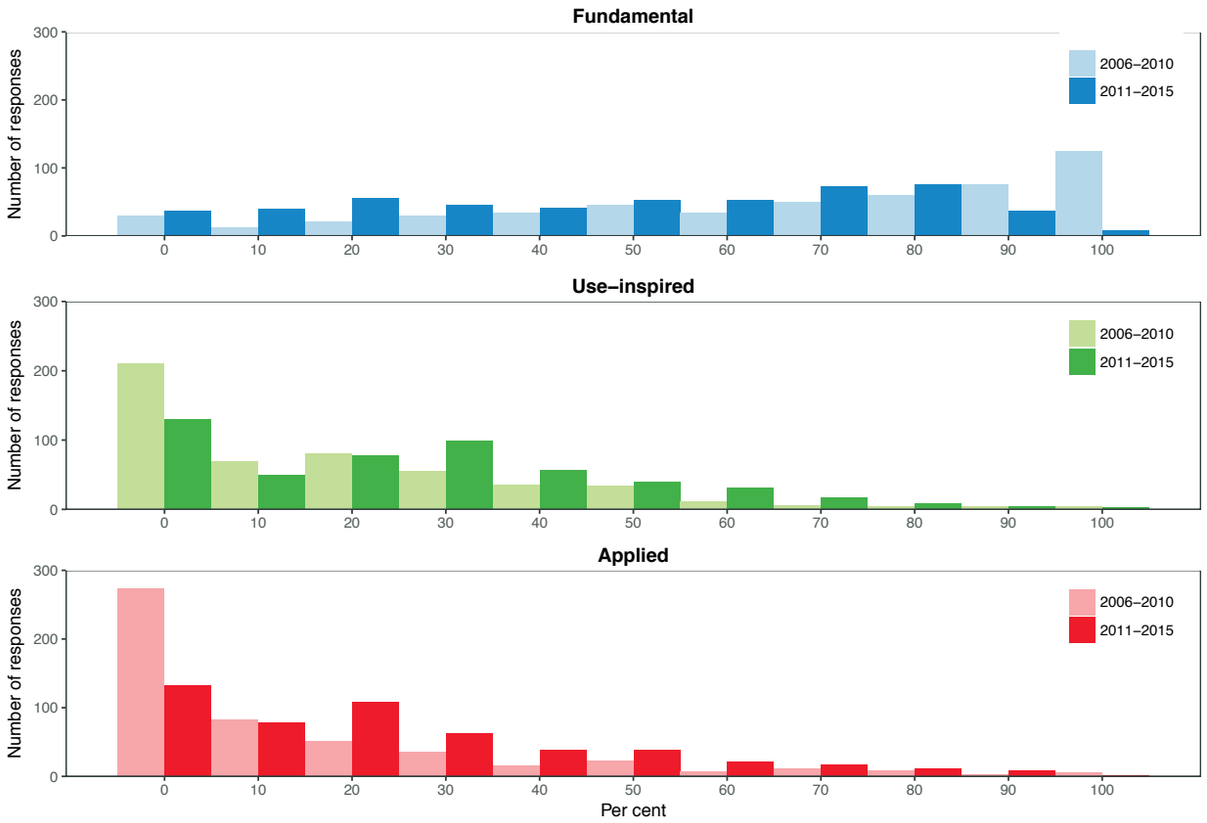


FIGURE 4.1. Per cent of survey respondents' research programs that focused on fundamental, use-inspired and applied research in the period 2006-2010 and in the period 2011-2015. Vertical bars are centered around per cent values to indicate changing emphases in research programs (e.g., nearly 300 respondents used to have 0% of their research programs focused on applied research, but now only about 100 respondents have no applied research component in their research program).

Canadian researchers also believe that fundamental research is of great importance to our society, with many providing compelling examples of the links between fundamental and applied research:

> *"Fundamental research provides a springboard from which applications can be realized. Cutting off one for the other doesn't work because they are a part of the same pipeline."*
>
> – Early career female academic, physical sciences

> *"Biomedical science is a pyramid. At the base or foundation is basic/fundamental research, in the middle might be a gradation of translational research that expands on the fundamental research. This can be anything from translating studies in invertebrate model organisms to vertebrate or human cells, to using basic knowledge to identify drug targets, to developing biomarkers for disease. At the top are cures, which are very rare, make great news headlines, and are absolutely dependent on the fundamental research at the base. Without fundamental research, there is no knowledge base to support translational studies and the development of cures and medical treatments. It is easy for the government and lay people to be shortsighted and not recognize the value of the fundamental research and focus attention on curing diseases. This is the direction research funding in Canada is going. With reforms to the CIHR, I fear that there is now even more emphasis on health outcomes and less on understanding the fundamentals of biology."*
>
> – Senior male academic, medicine/life sciences

> *"My field (neuroscience) is so new that even though there are many real applications, there is also so much potential for basic research to understand the human brain in ways that will provide the foundations for future applications. Science is full of so many examples of curiosity-driven research that eventually led to powerful applications. If only the politicians better understood this."*
>
> – Senior female academic, medicine/life sciences

> *"The history of major 20th century discoveries that have radically altered industry and technology have almost all come from fundamental research. The recognition of this simple truth seems to utterly escape the current…generation of political and industry leaders who influence government policies that affect science and education."*
>
> – Senior male academic, physical sciences

Most Canadian researchers also reported that their research program encompasses a mix of fundamental, use-inspired and applied research (Figure 4.1), indicating that these different types of research can be closely connected even within single labs. Some researchers also commented on the fluidity between these research "boundaries," and a few believed that because of this fluidity, these categories should no longer even be used.

> *"Although I perform applied research in plant biotechnology, it is underpinned by a strong basic research program. Sometimes, the line between basic and applied is somewhat blurred and should be thought of as more of a continuum."*
>
> – Senior male academic, natural sciences

> *"I believe in fundamental research in part because we cannot know where research will lead us in the future and what may (or may not) be beneficial to society. What I have come to realize is that same argument holds for doing applied research. We cannot necessarily predict how applied research might benefit fundamental research in the future. I have found having the two research thrusts to have a synergistic relationship with mutually reinforcing benefits. The key, then, is for future funding opportunities to strike a balance between the two kinds of projects."*
>
> – Early career male academic, natural sciences

4.3 Changing Research Foci

The focus of many (40%) Canadian researchers' research programs has changed substantially over the past five years, with the most commonly-reported change being a shift away from fundamental research and toward use-inspired or applied research (Figure 4.1). Notably, whereas 75% of respondents reported that their research programs were dominated by fundamental research between 2006 and 2010, only 58% of respondents reported this to be the case between 2011 and 2015 (Figure 4.1). Both use-inspired and applied research filled this gap: Research programs dominated by use-inspired or applied research rose from 12% and 11% respectively in the period 2006-2010, to 20% and 19% in the period 2011-2015 (Figure 4.1).

Strikingly, between the periods 2006-2010 and 2011-2015, the proportion of researchers who only conducted fundamental research collapsed, declining from 24% to 1.6%, and those who reported conducting no use-inspired or applied research declined from 47% to 25% (Figure 4.1).

> ***"In my opinion, the shift towards more applied research and stronger industrial partnerships threatens cutting off the potential gains in applied research in the next two decades."***
>
> – Early career male academic, physical sciences

Almost half (45%) of respondents cited changes to available research funding as the reason for shifting the focus of their research programs (Figure 4.2a), indicating that federal funding priorities between 2006 and 2015 effectively pushed researchers away from fundamental research in Canada. Twenty-six per cent of researchers cited changing research interests and 15% cited career changes as their reason for shifting research foci (Figure 4.2a).

> ***"Funding is much more plentiful on the applied research side of the fence."***
>
> – Early career male academic, engineering

> ***"There has been a large reorientation in the goals of science funding towards ever more applied research, which makes it difficult to perform any of the basic research upon which long-term advances in the sciences depend."***
>
> – Early career male academic, interdisciplinary science

Overall, researchers' opinions on the impacts of these changes were sharply divided: Almost half (48%) of researchers viewed the shift in their research program emphasis as slightly or very positive, while one quarter of researchers viewed the change as slightly negative (Figure 4.2b). Perhaps surprisingly, only 10% regarded the changes as very negative. It is possible that these positive perspectives reflect researchers' satisfaction with attaining funding more easily for their new research focus or greater satisfaction with their careers through time related to greater seniority.

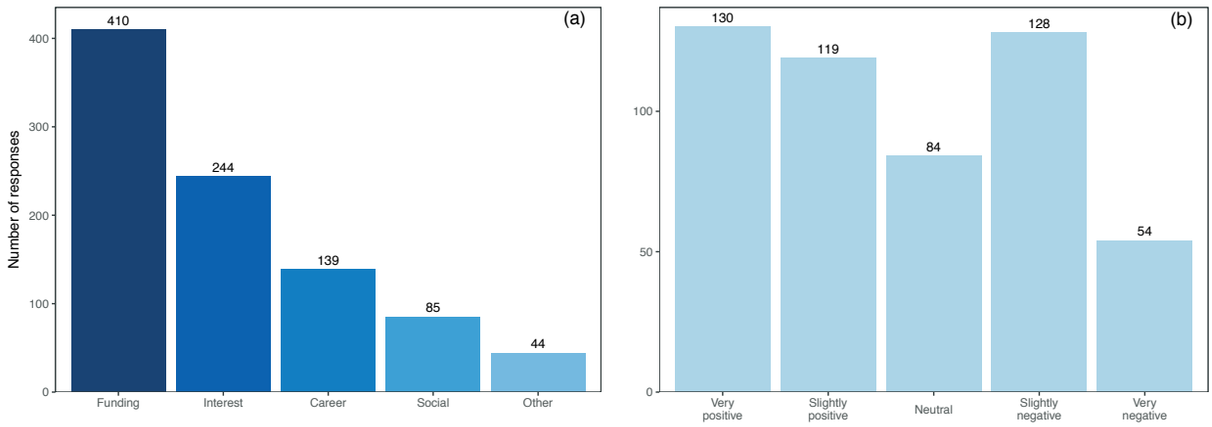


FIGURE 4.2. Researchers' motivations for shifting their research focus (a); Attitudes of researchers toward the shift in emphasis in their research programs (b). Note that the number of respondents in (a) and (b) is limited by the number of researchers who indicated that their research focus had shifted (n=517 respondents; Respondents could chose more than one multiple options).

4.4 Grant Success Rates: Is it Harder to Get Fundamental Research Funded?

Eighty-two per cent of Canadian researchers believe that success rates for fundamental research grant applications have declined, either slightly (42%) or considerably (40%), over the past decade (Figure 4.3). A number of factors, including the decreased availability of overall funding, increased number of researchers, and the new requirements for industry partners documented in Chapter 3, could be contributing to these perceived declines.

In contrast, the majority of researchers (59%) perceived success rates for applied research grant applications to have increased, either slightly (28%) or considerably (31%), over the past decade (Figure 4.3). More researchers believed that the success rates of use-inspired research grant applications had increased (31%) than decreased (20%) (Figure 4.3).

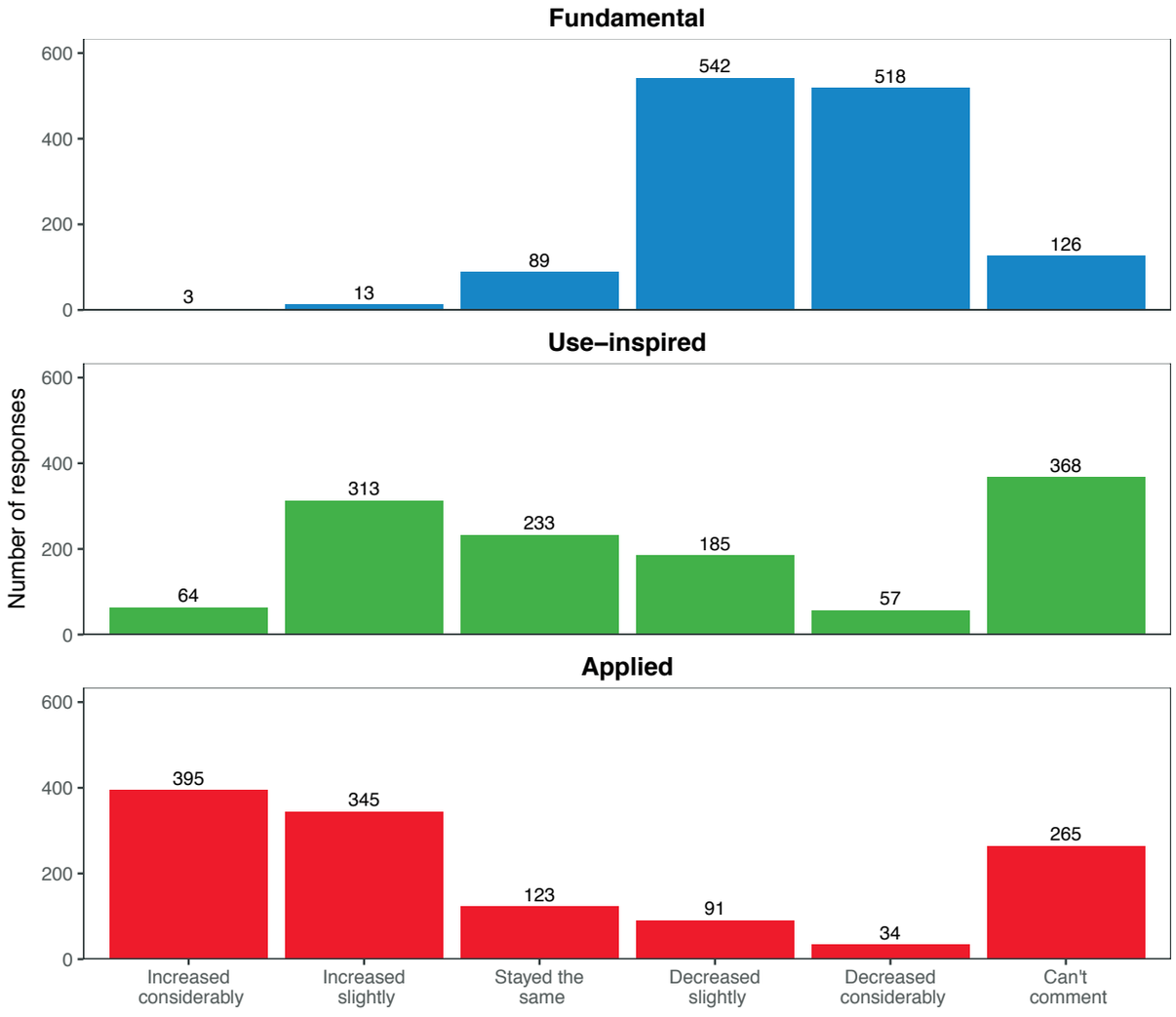


FIGURE 4.3. **Researchers' perceptions of how success rates for fundamental, use-inspired and applied research grants have changed in the past 10 years.**

> ***Every academic can unequivocally tell you that the landscape of funding for basic research in Canada has been changed and damaged beyond recognition over the past decade.***

– Early career female academic, physical sciences

> ***A huge amount of funding goes into use-inspired and applied research in other NSERC and other government programs, with very little effect on our economy or national productivity…In contrast, the world-class fundamental research going on in Canada has an enormous return on the dollar in terms of training and long-term research outcomes. It's a national scandal that few know about this outside the scientific community.***

– Senior male academic, natural sciences

> ***Fundamental research has been starved in Canada, while it's almost as easy as pie to get a grant (or student funding) if you bring on an industrial partner.***

– Senior male academic, natural sciences

> ***Scientists are trained to be researchers, yet I and most of my colleagues can no longer do the job we were trained and hired for since we have such low success rates for funding (approaching single digit % success). We spend most of our time reapplying or chasing new funding and have no time for the exciting part—doing the science…The system is unsustainable as it is.***

– Senior female academic, medicine/life sciences

> ***This [funding trend] is dangerous, since without a good solid fundamental research base, applied research cannot work.***

– Early career academic, medicine/life sciences

Decreased availability of fundamental research funding from the federal government is a serious problem considering that Canadian researchers rely heavily on this source of funding. Over three quarters (78%) of respondents fund 50% or more of their research program with money from the federal government, and a further 14% are funded entirely by the government (Appendix C, Figure C2). As funding for fundamental researchers has diminished, Canadian researchers appear to have diversified their funding sources, as evidenced by the increase in research funding from non-governmental, for-profit (i.e. industry), internal and other funders between the periods 2006-2010 and 2011-2015 (Appendix C, Figure C2). These alternative funding sources do not, however, necessarily make up for the losses in fundamental research funding from the federal government, given that many of them have specific requirements for the research to be applied and/or to have industry partners.

Several researchers also commented that the current funding environment had forced them or their colleagues out of the system:

> ***The general theme of funding (in Canada) is to move toward application driven research rather than curiosity (fundamental) research. This eventually forced me into early retirement.***

– Senior male academic, physical sciences

> ***Government (in my case NSERC and NRCan) has been steadily cutting the amount of funding for fundamental research. It has become so difficult that many of my colleagues have given up, and the paperwork is now so bad that I am thinking of giving up…When I retire, it will be because the work required to obtain funding has become too onerous.***

– Senior male academic, natural sciences

> ***We are having a very difficult funding period…particularly in medically-oriented research. Investigators have to continually apply for grants and 85-90% are being turned away by the federal funding agency (CIHR). Established investigators are having to close their labs and give up research. There is little incentive for new investigators to go into research with this funding situation.***

– Senior female academic, medicine/life sciences

4.5 Are Practical Applications and External Partnerships Required to Obtain Research Funding?

Grant requirements, such as listing practical applications or having external partners, can also indicate use-inspired or applied research. For example, external research partners in industry or non-governmental sectors are now required for many types of grants within the NSERC Innovation and SSHRC Connection grant families, both of which support applied or use-inspired research.

One quarter (24%) of Canadian researchers believe that it is now mandatory to suggest practical applications as an outcome of their research in order to successfully obtain funding, and a further third believe it is very important to do so (Figure 4.4a). In contrast, only 9% of researchers believe that it is not at all important to suggest practical applications of their research (Figure 4.4a).

These viewpoints have changed considerably over time, with Canadian researchers believing that suggesting practical applications of their research is now much more important than it was in the past. For example, in contrast to their views for the period 2011-2015, only 6% and 20% of researchers believed practical applications were mandatory or very important, respectively, for the period 2006-2010 (Figure 4.4a).

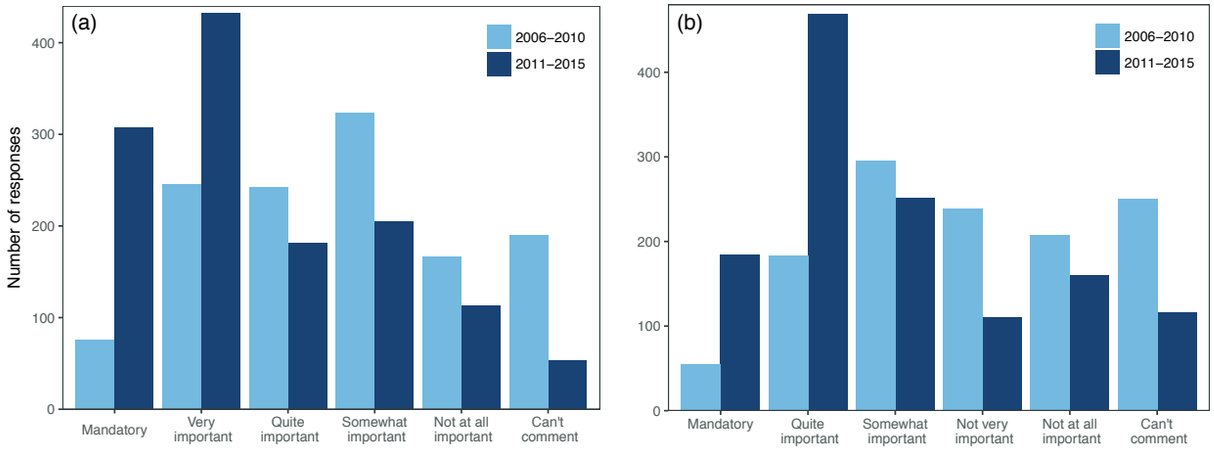


FIGURE 4.4. Researchers' perceptions of: the importance of indicating practical applications of their research to successfully obtain funding in 2006-2010 and in 2011-2015 (a); the importance of including external partners (e.g., from industry or non-governmental sectors) to successfully obtain funding in 2006-2010 and in 2011-2015 (b).

As with practical applications, Canadian researchers believe that it is now much more important to have external research partners than it was in the past. Half of Canadian researchers believe that it is now either mandatory (14%) or quite important (36%) to include external partners in order for a grant to be successful, whereas only 19% (mandatory (4%) and quite important (15%)) believed that this used to be the case (Figure 4.4b).

> ***"Forcing partnership with industry is very misguided. Although I believe that the ultimate goal of research is to enhance society, there needs to be an incubator space where creativity and reflection can occur, and these must be outside of the sphere of influence of profit-driven industry."***
>
> – Senior female academic researcher, interdisciplinary science

Not surprisingly then, almost all respondents (88%) reported that their current research includes external partners to some degree: Fifty-nine per cent reported some partnerships and a further quarter (27%) reported strong partnerships (Figure 4.5a). This is a significant increase from the preceding five years, when 56% reported engaging in some level of external research partnership and only 11% reported strong external partnerships (Figure 4.5a). Over the past decade, there has been a 32% decline in the number of researchers without any external partnerships, with only 12% reporting no partnerships between 2011 and 2015, down from 44% between 2006 and 2010 (Figure 4.5a). Only 1.5% of researchers reported conducting their research exclusively with partners outside of academia, and this has not changed over time.

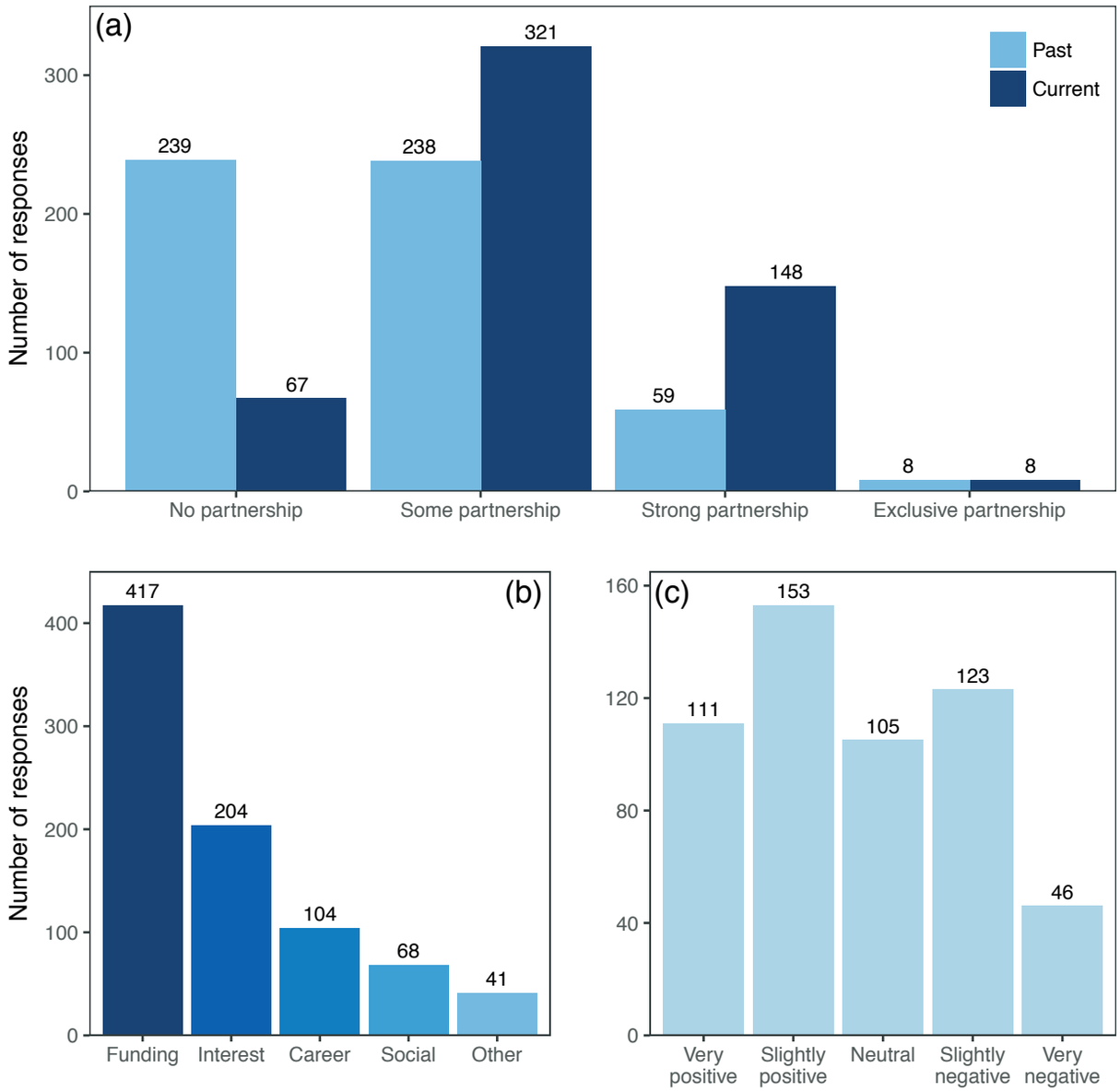


FIGURE 4.5. Current (2011-2015) and past (2006-2010) levels of partnership outside of academia (a); reasons for changes in the level of external research partnerships over the past decade (b); and views on these changes (c).

Funding was the driving force behind the shift towards external partnerships, with half of Canadian respondents reporting that they developed external partnerships to qualify for new funding (Figure 4.5b). The remaining respondents indicated that the motivation for the partnerships was interest-based (24%), career-based (12%), socially motivated (8%), or based on other reasons (5%) (Figure 4.5b).

Attitudes toward these changes were mixed (Figure 4.5c). Interestingly, almost half of respondents (49%) viewed the change in external partnerships as slightly or very positive. Thirty-one per cent of respondents, however, viewed the change as slightly or very negative, and twenty per cent were indifferent to the change (Figure 4.5c).

Several respondents also highlighted the limitations of requiring Canadian industry partners:

> ***"Co-funding requirements have tipped the balance towards applied research, but not all areas of science have companies that perform research in our country."***
>
> – Senior female academic, natural sciences

> ***"The Canadian government has established a clear bias towards applied research. However, the Canadian industry is not very diversified, so for a large number of researchers whose interests are not well represented in the industry, life has become very difficult."***
>
> – Senior male academic, interdisciplinary science

4.6 Perceived Importance of Fundamental Research to the Canadian Government

Over two-thirds (69%) of Canadian researchers believe that fundamental research is either very important (30%) or somewhat important (39%) to our federal government (Figure 4.6a). Still, a considerable number of Canadian researchers believe that fundamental research is either not very important (25%) or not at all important (4%) to our government (Figure 4.6a).

At the same time, over two-thirds (68%) of respondents said that applied research has become a higher priority for our federal government over the past decade, and one quarter (27%) believed that use-inspired research had become a higher priority (Figure 4.6b). This high level of priority for applied research has most likely led to the disparity in funding among the different types of research.

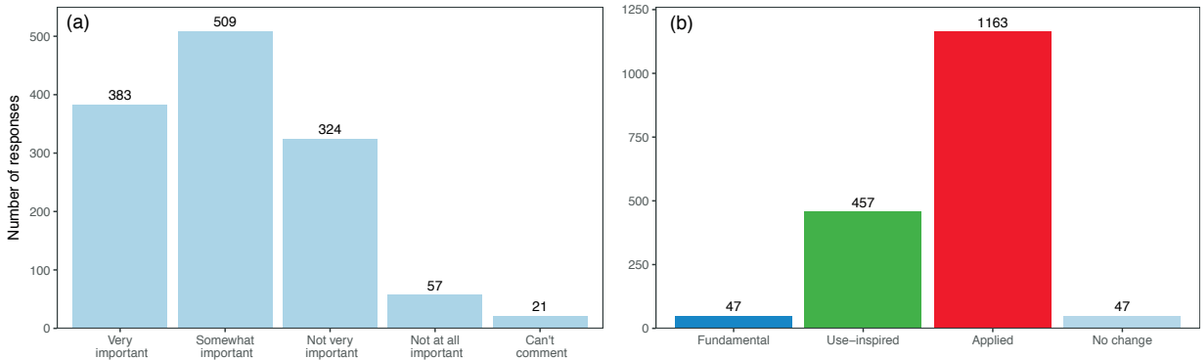


FIGURE 4.6. Perceived importance of fundamental research to the Canadian federal government (a); types of research that are perceived to have become a higher research priority to the Canadian federal government over the past ten years (b).

> *While providing inadequate support for basic research, the government has recently targeted new investments at research appearing to hold the promise of near or immediate commercial value. This, however, is a short-sighted and narrow view of scientific progress that ignores the value of basic investigator-driven research.*
>
> – Senior female academic, natural sciences

> *There has been a strong shift in the definition of what should be researched or "is worth funding." These definitions seem to be set by government officials or economists, and not by scientists.*
>
> – Senior female academic, physical sciences

> *As in many other countries, there has been a shift in Canada toward more emphasis in "priority" areas that are tied with certain technological sectors. Such an approach, if well-intentioned, invariably fails because government agencies and even scientists themselves cannot accurately predict in what area the next technological breakthrough will be. The result is a chase of fads and a waste of funds and efforts in the end. It also encourages groupthink and conformity, and stifles creativity and novelty. This scheme ignores the nature of scientific research, which does not proceed neatly according to a logical plan, but progresses in starts and fits and often in unforeseen directions. A more appropriate model is to fund many small projects based on free exploration by individual researchers, and let science take its course.*
>
> – Senior male academic, physical sciences

4.7 Looking Ahead: Implications of Recent Funding Changes for the Next Generation of Researchers and Canada's Future

Canada's capacity to compete on the world stage as a scientific powerhouse will be greatly diminished if it cannot attract the country's brightest young minds to careers in research. Half of Canadian researchers believe that recent changes in the funding landscape will lead to fewer young Canadians choosing to pursue research careers in the future (Fig 4.7). Almost no researchers (6%) believed that recent changes would inspire considerably more young Canadians to choose a career in research, while 14% believed that they might result in a slight increase (Figure 4.7).

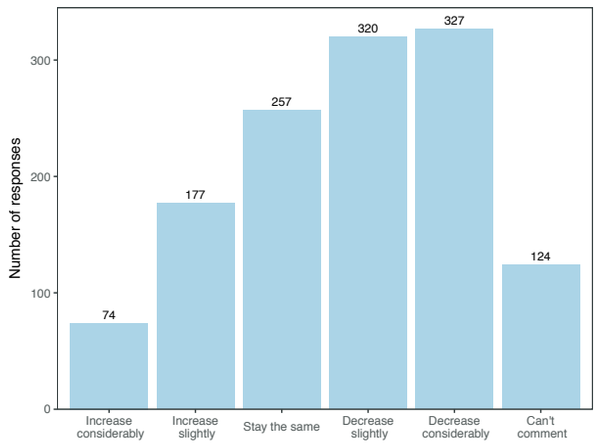


FIGURE 4.7. Effect of changes in research funding on research careers of the next generation in Canada. Researchers were asked if they thought that changes in funding availability would influence the likelihood of the next generation pursuing careers in research.

Today's researchers believe the federal government's recent funding priorities are crippling Canada's future science capacity, and many senior academics commented on the negative impacts the changes have had on their own graduate students and post-doctoral fellows:

> *One of the most significant changes in research funding over the last ten years has been diversion of funding from graduate student scholarships to grants for applied research. Whether or not the next generation pursues careers in research in my country will likely depend on the restoration of direct scholarship funding. Without it, there is no compelling reason for top students to stay here.*
>
> – Senior male academic, engineering

> *I have lost promising graduate students (major award winners, with published papers, etc.) in the past five years who informed me that the primary reason for leaving an academic (or even scientific) career path was because of trends in funding. Essentially, we are losing the top scientists of the next generation.*
>
> – Senior male academic, natural sciences

> *The per capita decrease in support for fundamental research, especially through the federal grant councils, has been most disheartening. I would NOT pursue an academic career today if I could start again, and I can tell you that the best Canadian students are leaving the research path in droves...The system is seriously broken and it is going to cost Canadians significantly in the long run.*
>
> – Senior male academic, natural sciences

> *The damage of the last ten years of government has discouraged at least one generation of scientists from even starting with [and/or remaining in] basic research. I have graduated excellent young people year upon year, and they have largely left the country or accepted reduced opportunity here in Canada. It is a devastating result.*
>
> – Senior male academic, natural sciences

> *[Research in Canada] was fun in the 80s, still reasonable as work through the 90s, but increasingly stark since the millennium with hugely hard work, often requiring 80 hours per week...way too much of it spent fighting the bureaucracy, and in grant applications and useless reports. Before 1995, virtually ALL of my best students went on to effective and successful careers in research (many award winners in my cohort of graduate students). Since the mid-90s NONE of [my] best Canadian students have entered the research arena, and several have told me that this is because they did not want to have to work as hard as I did.*
>
> – Senior male academic, natural sciences

Finally, several researchers noted that if recent funding changes away from fundamental research are not reversed, they will significantly limit Canada's long-term scientific capacity:

> *The Canadian government will have to outsource scientific positions because the type of people they want won't exist in the Canadian population.*
>
> – Senior female academic, interdisciplinary science

> *Research is a long-term investment that should not be driven by political parties but by knowledgeable scientists working outside of a political agenda...[Canada] is losing an entire generation of well-trained scientists because there are no jobs in generating knowledge, and using existing knowledge has a limited and targeted capacity that changes with co-funders and business opportunities; neither offer the stability needed for fertile ground for an early career researcher. Our country needs to fund more fundamental research if it hopes to compete on a global front.*
>
> – Senior female academic, natural sciences

4.8 Looking Ahead: Expectations for Future Research Funding

The majority of Canadian researchers are optimistic that research funding will either be stable or increase in the next five years for all three types of research (Figure 4.8). Optimism about government directions relative to perceptions of growing challenges over recent years almost certainly stems from the election of a Liberal federal government in October 2015.

> ***"We are all hoping that the new government will overturn shocking decisions and reforms made in the past decade to bring Canada back to a level where Canadian researchers can once more stand proud and strong."***
>
> – Senior female academic, interdisciplinary sciences

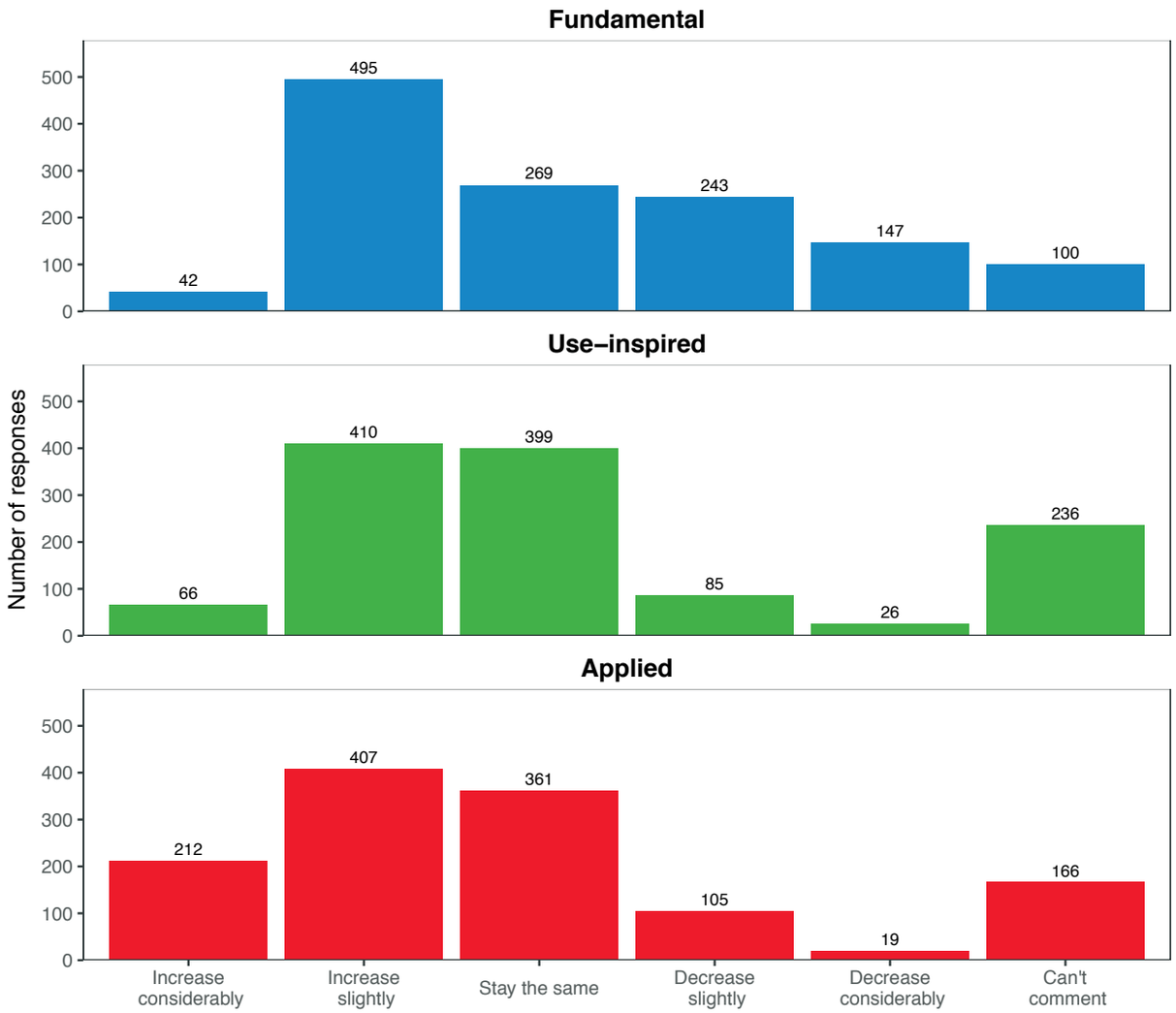


FIGURE 4.8. Researchers' perceptions of how funding for fundamental, use-inspired and applied research will change in the next five years in Canada.

> ***An ideologically-driven agenda that favoured only research that had direct industrial and corporate applications fundamentally starved fundamental research in Canada during the previous government regime. It remains to be seen whether this will be changed under the newly-elected government.***
>
> – Senior male academic, physical sciences

> ***I can only hope that the Canadian government will realize the importance and impact fundamental, "curiosity-driven" research has had in Canada and the world over the last 50+ years. As we look to the next 100 years, curiosity will be a critical driving force for innovation and discovery. You cannot advance science by only looking at a specific application.***
>
> – Early career academic, physical sciences

Despite general optimism, including the belief of 38% of respondents that fundamental research funding will increase slightly in the next five years, almost no Canadian researchers (3%) believe that fundamental research funding will increase considerably (Figure 4.8). The on-line survey was conducted following the fall 2015 federal election and the release of the 2016 federal budget in March 2016 (42). $90 million in new research funds were directed toward fundamental research in the new government's budget in 2016 (42). Respondents apparently viewed further increases following that announcement as unlikely. Moreover, 30% of respondents believed that support for fundamental research would continue to decrease under the new government (Figure 4.8).

Optimism remains the most pronounced for applied funding, with almost half of respondents expecting this funding to increase either slightly (32%) or considerably (17%) (Figure 4.8).

4.9 The Bottom Line

1. Over 1,300 Canadian researchers responded to our on-line survey, most of whom were senior (65%) or early-career (29%) academics from the natural, physical, medical or life sciences, or engineering. Most researchers noted that their programs encompass a mix of fundamental, use-inspired and applied research, illustrating the connections across these research sectors. Over two-thirds of Canadian researchers believe that while fundamental research is still important to our federal government, applied research became a higher priority over the past decade.

2. Strikingly, between 2006-2010 and 2011-2015, the proportion of Canadian researchers who only conducted fundamental research collapsed from 24% to 1.6%, and the number of researchers who reported that their research programs were dominated by fundamental research declined from 75% to 58%. Changes to available research funding was the most commonly reported reason for shifting research program foci, suggesting that federal funding priorities between 2006 and 2015 effectively pushed Canadian researchers away from fundamental research. Interestingly, however, researchers' opinions about these changes were mixed.

3. Eighty-two per cent of researchers believe that success rates for fundamental research grant applications have declined over the past decade, while at the same time a majority believes success rates for applied research grant applications have increased. In response, researchers have diversified their funding portfolios, but this often comes at the expense of being able to conduct fundamental research. Several researchers noted that these changes had forced them or their colleagues out of the system.

4. Approximately half of researchers believe that it is now either mandatory or very important to suggest practical applications as an outcome of their research and to include external Canadian partners in order to successfully obtain funding; far fewer thought this was the case a decade ago. Not surprisingly, almost all respondents (88%) reported that their current research now includes some external partners, with funding being the driving factor in the formation of these partnerships. A potential outcome of these changes is that research directions are more influenced by partnerships and availability of government funding than by the scientific priorities identified by researchers themselves.

5. Canada's capacity to compete as a scientific powerhouse on the world stage will be greatly diminished if it cannot attract the country's brightest young minds to careers in research. Half of researchers believe that recent changes in the funding landscape will lead to fewer young Canadians choosing to pursue research careers in the future, and several commented that if recent funding changes away from fundamental research are not reversed, they will cripple Canada's future capacity for scientific excellence.

6. The majority of Canadian researchers are optimistic that research funding will either remain stable or will increase in the next five years for all three types of research, most likely because of the election of a Liberal federal government in October 2015. Yet, virtually no researchers believe that fundamental research funding will increase considerably—a change that would be needed to bridge the accumulated funding gap.

5. Conclusion and Recommendations for Strengthening Canada's Capacity for Fundamental Research

5.1 Synthesis

Fundamental research offers many benefits to society, including serving as the foundation for innovation and the catalyst for practical scientific applications. Fundamental research also satisfies the basic and widely-shared human need for exploration and understanding. Despite habitual absence from any quantitative metric of the importance of fundamental science, the role of fundamental research as a source of inspiration to new generations of young Canadians is vital.

If Canada's best research resource is the excellence of its people (26), then inspiring the next generation to become scientists is a critical requirement for renewing this resource and ensuring future Canadian scientific excellence. For many talented young Canadians, contact and engagement with science and scientists provides the inspiration necessary to imagine that a career in science might be both possible and worthwhile. Extraordinary discoveries in fundamental science—from Banting and Best's discovery of insulin for the treatment of diabetes, to Schindler's demonstration of the ecosystem impacts of acid rain and phosphate pollution, to McDonald's discovery that the subatomic particles neutrinos have mass—have inspired Canadians for decades. Failure to restore fundamental research funding in Canada will have cascading effects far beyond diminished potential for world-class discoveries in fundamental science, since young Canadians are unlikely to make the decision to join the scientific research community if they rarely recognize scientific discovery or encounter a scientist.

Canada's support for research and development declined substantially relative to total economic activity over the decade from 2005-2014 as shown in Chapter 2. This trend, which diverges substantially from other developed countries, plunged Canada from fourteenth to twentieth place amongst the 34 OECD member countries in GERD rankings, and Canada now lags significantly behind both the overall OECD average and the G8 average in terms of its investment in R&D. The consequences of deprioritizing investments in R&D are readily apparent in Canada's declining research performance internationally.

The erosion of research funding has been particularly pronounced among fundamental research programs, where funding declined in real terms despite strong growth in numbers of researchers. Between 2005 and 2015, funding availability dropped by over 35% for researchers in the natural sciences and engineering (NSE) and by nearly 31% for those in the social sciences and humanities (SSH) after accounting for the increased numbers of researchers in Canada in these fields. Data on numbers of researchers in health-related fields were not available for this report, but there is no reason to suspect that trends in per capita funding availability declined more slowly in these areas. These numbers will be provided in the future by the recently re-established University and Colleges Academic Staff System at Statistics Canada.

As research support declined at each of the tri-councils, so too did grant success rates for fundamental research programs. This loss was most prominent at SSHRC and CIHR, where researchers applying for fundamental research support had, at best, only slightly better than half the

chance of success in 2015 relative to the same grant application in 2005. At CIHR, this loss was accompanied by a significant move toward applied research and highly-volatile funding levels.

Declining success rates for grant applications have strong implications for Canadian researchers. At minimum, researchers must spend increasing amounts of time writing grant proposals rather than performing the research that will drive Canada's economy, catalyze new practical applications, and inspire Canadians.

Potentially compounding these problems is the move in Canada towards investments in "star" research programs, including the Canada Excellence Research Chairs and Canada First Research Excellence Fund. Research productivity (measured as publications per research dollar awarded) amongst Canadian researchers, at least in the NSE, increases dramatically with small amounts of research funding, but declines with larger grant sizes (44). In other words, Canada's relatively strong research performance in the NSE has reflected the tendency to support larger numbers of researchers at moderate funding levels, rather than concentrating resources in a few research groups. These data are a warning against overinvestment in "star research" programs if such programs are associated with erosion of fundamental research support.

As federal research priorities moved toward applied research, Canadian researchers clearly indicated that their research programs followed suit. Between 2006-2010 and 2011-2015, 40% of researchers substantially changed their research foci, with most shifting emphasis away from fundamental research and towards applied. Most telling is the virtual loss (from 24% to 1.6%) of researchers with programs focused solely on fundamental research. Almost half of respondents cited changes to available research funding as the reason for this change, indicating that federal funding priorities effectively pushed Canadian researchers away from fundamental research.

If inspiring the next generation to choose careers in science is one of the most important benefits derived from a healthy science ecosystem in Canada, then eroding funding for fundamental work is likely undermining this benefit. The Canadian research community expressed strong concerns about this problem, with half of the survey respondents convinced that, as a consequence of recent funding changes, fewer young Canadians will choose to pursue research careers. Additionally, researchers noted the negative impacts that changes to the funding landscape have had on their research programs, their students and their colleagues. Several also worried that if recent funding changes away from fundamental research are not reversed, they will cripple Canada's future capacity for scientific excellence.

Despite the many negative impacts of dismantling the federal government's support for fundamental research, the Canadian research community remains cautiously optimistic about the future. Most likely because of the election of a new government in late 2015, the majority of respondents believe that research funding will either remain stable or will increase in the next five years for all three types of research. Yet, virtually no researchers believe that fundamental research funding will increase considerably—a change that would be needed to bridge the accumulated funding gap.

5.2 Recommendations

Fundamental research funding at each granting council should be linked with numbers of researchers in Canada working in NSE, SSH, and health-related areas. This simple recommendation addresses a number of key challenges that currently limit the Canadian research community.

Linking federal research budgets to numbers of active researchers in Canada implies a particular per capita funding rate that can account for the needs of each of the communities served by the tri-councils. Ultimately, identifying that funding rate is a task for decision-makers. However, the accumulated funding gap that accrued over the 2005-2015 period has had sufficient negative impacts to date that a clear case exists for it to be reversed. To do this will require investments (in constant 2016 dollars) for NSERC of ~$232 million, a figure that we also recommend for fundamental research at CIHR, and ~$71 million for SSHRC, for a total of $535 million to the tri-councils. Because the federal budget in 2016 direc-

ted $76 million to the fundamental research programs at the granting councils (43), an additional $459 million for research is justified and needed.

The research ecosystem in Canada includes a growing number of researchers without research funding. The suggested infusion of research support would largely be consumed by extending federal research grant support to researchers who currently lack it through investigator-led operating grants that enable curiosity-driven work.

Linking fundamental research funding at the tri-councils to numbers of researchers will also both increase and stabilize grant application success rates. Volatility and general declines in success rates create an uneven playing field between researchers who entered the system years ago and those attempting to enter it today. Improving success rates for grant applications will also serve to increase the proportion of time that excellent researchers perform research, instead of preparing, submitting and often resubmitting grant applications to funding programs.

Extending potential federal research support to the growing numbers of unfunded researchers in Canada is likely to sharply increase Canada's research impact, a critical benefit of the primary recommendation from this report. This does not imply that costly research should receive less funding, but that de-emphasis of fundamental research programs has caused—or forced—many Canadian researchers to reduce their focus on curiosity-driven research and to focus instead on applied research.

Discovery is in Canada's interests. For Canada's excellent research community to serve those interests more effectively, support for fundamental research needs to be commensurate with numbers of researchers contributing to discovery. It is their creativity and curiosity, unleashed and encouraged again, that will inspire the next generation of Canadians to choose science as a career.

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APPENDIX A:
Data Sources and Funding Programs

Chapter 2

Data were extracted from the Organization for Economic Cooperation and Development (OECD) database (http://stats.oecd.org/index.aspx?DatasetCode=MSTI_PUB) associated with the Main Science and Technology Indicators report (MSTI 2016-2 / Release date: 02 February 2017) on April 9, 2017. OECD data include final or provisional results as well as forecasts established by government authorities. In some cases, data may not be available or has not been reported. Data represent the general expenditure on R&D as a proportion of Gross Domestic Product (GDP).

Data Table for Figure 2.1a

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Austria	2.38	2.37	2.43	2.59	2.61	2.74	2.68	2.93	2.96	3.07	
Canada	1.98	1.95	1.91	1.86	1.92	1.84	1.80	1.79	1.69	1.61	
Denmark	2.39	2.41	2.52	2.78	3.07	2.94	2.97	3.00	3.06	3.05	3.05
Finland	3.33	3.34	3.35	3.55	3.75	3.73	3.64	3.42	3.29	3.17	3.17
Germany	2.42	2.46	2.45	2.60	2.73	2.71	2.80	2.87	2.83	2.90	2.87
Israel	4.04	4.13	4.41	4.33	4.12	3.93	4.01	4.13	4.09	4.11	4.25
Japan	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.34	3.48	3.59	3.40
Korea	2.63	2.83	3.00	3.12	3.29	3.47	3.74	4.03	4.15	4.29	4.23
Sweden	3.39	3.50	3.26	3.50	3.45	3.22	3.25	3.28	3.31	3.16	3.26
Taiwan (Chinese Taipei)	2.32	2.43	2.48	2.67	2.84	2.80	2.90	2.95	3.00	3.00	2.43
US	2.51	2.55	2.63	2.77	2.82	2.74	2.76	2.70	2.74	2.76	2.79
OECD Average	2.16	2.19	2.22	2.29	2.34	2.30	2.33	2.34	2.37	2.38	2.40

Data Table for Figure 2.1b

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Canada	1.98	1.95	1.91	1.86	1.92	1.84	1.80	1.79	1.69	1.61	
France	2.04	2.05	2.02	2.06	2.21	2.18	2.19	2.23	2.24	2.26	2.23
Germany	2.42	2.46	2.45	2.60	2.73	2.71	2.80	2.87	2.83	2.90	2.87
Italy	1.05	1.09	1.13	1.16	1.22	1.22	1.21	1.27	1.31	1.29	1.33
Japan	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.34	3.48	3.59	3.40
Russia	1.07	1.07	1.12	1.04	1.25	1.13	1.09	1.13	1.13	1.19	1.07
UK	1.63	1.65	1.68	1.69	1.74	1.70	1.69	1.62	1.66	1.70	1.70
US	2.51	2.55	2.63	2.77	2.82	2.74	2.76	2.70	2.74	2.76	2.79
G8 Average	2.00	2.03	2.05	2.08	2.16	2.10	2.12	2.12	2.14	2.08	2.19

Chapter 3

NSERC Data Analysis

Annual expenditures and average award values for both the Discovery and Innovation Award programs were extracted from the NSERC Award Database (http://www.nserc-crsng.gc.ca/ase-oro/Results-Resultats_eng.asp) and analyzed by fiscal year. Values for 2005-2006 are reported as 2005 and so on for each representative year in the analysis. All granting programs classified under the grant headings of Discovery and Innovation by NSERC were included in the analysis and are listed in the table below. A small number of funding programs were cancelled or created between 2005 and 2015, but large programs (e.g., Discovery Grants) were offered consistently. Here, we take the combined NSERC funding to all Discovery programs as equivalent to fundamental research grant support, and the combined funding to Innovation programs as equivalent to applied research grant support. Success rates represent the proportion of applicants that were successful in receiving funding for their proposed research for that competition year. Application success rates in Discovery programs were retrieved from the compendium of historical statistics in the NSERC Facts and Figures Report 2010-2011 for 2005-2011 period. More recent statistics on application success were retrieved from the NSERC Competition Statistics Reports for 2012-2015. Innovation program values for success rates were provided by NSERC upon request.

All measurements of research investments have been adjusted for inflation to 2016 constant dollars using the Bank of Canada Inflation Calculator (http://www.bankofcanada.ca/rates/related/inflation-calculator/) on April 9, 2017. The source data for Figure 3.1 can be found in the tables below.

Granting Programs Included in NSERC Analyses for Figure 3.1

Discovery	Innovation
Belmont Forum Arctic Observing and Research	Agriculture and Agri-Food Canada Research Partnership
Climate Change and Atmospheric Research	Alternative Radiopharmaceuticals for Medical Imaging
Collaborative Project Grants (H)	Applied Research and Development Grants (Level 1)
Collaborative Research Opportunities Grants	Applied Research and Development Grants (Level 2)
Collaborative Special Project Grants	Applied Research and Development Grants (Level 3)
Conference Grants (H)	Applied Research Tools and Instruments Grants
Discovery Development Grant	Attachés de recherche (H)
Discovery Frontiers: Advancing Big Data Science in Genomics Research	Automotive Partnership Canada Project
Discovery Frontiers: Digging into Data	Business-led Networks of Centres of Excellence: Group
Discovery Frontiers: New Materials for Clean Energy and Energy Efficiency	Business-led Networks of Centres of Excellence: Letters of Intent
Discovery Frontiers: Northern Earth System Research	Canadian Forest Service Research Partnership
Discovery Grants Program: Accelerator Grant	Canadian Microelectronics Corporation
Discovery Grants Program: Accelerator Supplements	Canadian Space Agency Research Partnership
Discovery Grants Program: Group	Canadian Wildlife Service Research Partnership
Discovery Grants Program: Individual	CARNET
Discovery Grants Program: Institutes and Initiatives	Centres of Excellence for Commercialization and Research: Group
Discovery Grants Program: Leadership Support	Chairs in Design Engineering: Research
Discovery Grants Program: Multidisciplinary Network Groups	Chairs in the Management of Technological Change
Discovery Grants Program: Northern Research Supplement	Collaborative Health Research Projects
Discovery Grants Program: Project	Collaborative Research and Development Grants
Discovery Grants Program: Ship Time	Collaborative Research and Development Grants: Government (H)
EWR Steacie Fellowships: Supplement	College: University Idea to Innovation Grants

Discovery	Innovation
Foreign Researcher Awards (H)	College and Community Innovation Pilot Program
G8 Initiative Research Councils on Multilateral Research Funding	College and Community Innovation Program
General Research Grants (H)	College and Community Innovation Program: Entry Level
Government of Canada's Program for International Polar Year	College Special Initiatives
Infrastructure Grants (H)	College Synergy Awards
International: Workshops	Cooperative Activities
International Collaborative Research Grant	Department of National Defence / NSERC Research Partnership
International Opportunity Fund	Engage Grants Program
International: Foreign Researcher (H)	Engage Plus Grants Program
Major Facilities Access Grants	Fellowship Innovation Platform
Major Resources Support Program: Infrastructure	Fuel Cell Technology Program
Miscellaneous	Fuel Cell Technology Program: Chair Project
Miscellaneous Grants	Genomics Projects
Miscellaneous Grants: Dissemination	Idea to Innovation
New Research Idea Grants (H)	Industrial Postgraduate Scholarships
Northern Research Chair Program	Industrial R&D Fellowships (IRDF)
Northern Research Chairs Program: Grant	Industrial R&D Internships
Parental Leave: Research Grants	Industrial Research Chairs
Perimeter Institute	Industrial Research Chairs for Colleges Grants
Presidential Fund	Industrial Research Fellowships
Research Capacity Development in Small Universities	Industrial Scholarship in Partnership with the FQRNT (Master's)
Research Tools and Instruments	Industrial Scholarship in Partnership with the FQRNT (Doctoral)
Research Tools and Instruments: Category 1 (<$150,000)	Industrial Undergraduate Student Research Awards
Research Tools and Instruments: Category 2 ($150,000-$325,000)	Industrial Undergraduate Student Research Awards Program
Research Tools and Instruments: Category 3 (>$325,000)	Industrially Oriented Research Grants
Scientific Publication Grants (H)	Intellectual Property Mobilization: Infrastructure
Special Research Opportunities: Canada-Israel Program	Interaction Grants Program
Special Research Opportunity Program: Inter-American Collaboration in Materials Research	Joint Infrastructure Interdependencies Research Program
Special Research Opportunity Program: Northern Research	Micronet Research Partnership
Special Research Opportunity Program: Pre-research	NanoIP: Project
Special Research Opportunity Program: Project	National Research Council/NSERC Research Partnership
Subatomic Physics Envelope: Group	Networks of Centres of Excellence
Subatomic Physics Envelope: Collaborative Special Projects	Networks of Centres of Excellence: Letters of Intent
Subatomic Physics Envelope: Conference (H)	New Faculty Support Grants
Subatomic Physics Envelope: Individual	New Media Initiatives
Subatomic Physics Envelope: Major Facilities Access	NRC-NSERC-BDC Nanotechnology Initiative
Subatomic Physics Envelope: Major Resources Support Program	NRCan-Earth Sciences Sector/NSERC Research Partnership: Project
Subatomic Physics Envelope: Project	NSERC: EMPOWR Microelectronics HQP Training
Subatomic Physics Envelope: Research Tools and Instruments	NSERC/Energy Sector, Natural Resources Canada
Thematic Resources Support in Mathematics and Statistics	NSERC/NRCan/AECL Generation IV Energy Technologies Program
Unique Initiatives Fund	Other Government Chairs (H)
Women's Faculty Awards (H)	Partnership Workshops Grants: Colleges
Women's Faculty Awards: Salary (H)	Partnerships Innovation Platform

Discovery	Innovation
	Quantum Works Innovation Platform
	Regional Office Discretionary Funds
	Regional Office Discretionary Funds (Atlantic)
	Regional Office Discretionary Funds (British Columbia)
	Regional Office Discretionary Funds (Prairie)
	Regional Opportunities Fund (Ontario)
	Regional Opportunities Fund (Quebec)
	Request for Applications Program (H)
	Research Incentive Grants (H)
	Research Management Funds: Group
	Research Networks
	Research Reorientation Associateships (H)
	Senior Industrial Fellowships (H)
	Shared Equipment and Facilities Grants (H)
	Special Microelectronics Fund (H)
	Special Postgraduate Scholarships for Employed Scientists and Engineers (H)
	Strategic Grants: Conference (H)
	Strategic Grants: Equipment (H)
	Strategic Grants: Individual (H)
	Strategic Projects: Group
	Strategic Projects BIOCAP
	Strategic Projects Supplemental Competition
	Strategic Research Networks Program Letters of Intent
	Strategic Workshops Program
	Technology Access Centre
	Technology Access Centre: Letters of Intent
	Technology Partnerships Program
	Tri-Council Workshop/Networking Program
	Undergraduate Student Research Awards Program: Colleges
	University-Industry Affiliations (H)
	Visiting Industrial Fellowships (H)
	Workshops and Seminars (H)

NSERC Total Expenditures (Figure 3.1a)

Millions of 2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Discovery Program Award Expenditures	483.26	498.32	503.38	489.43	481.11	464.13	449.05	443.37	412.85	422.13	420.32
Total Innovation Program Award Expenditures	243.21	237.92	332.68	327.03	339.56	363.44	372.24	350.21	368.79	365.88	357.82

NSERC Average Amount Awarded (Figure 3.1b)

2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Discovery Programs	45,279	44,796	44,590	43,168	42,727	42,364	42,116	41,282	39,716	39,850	39,275
Innovation Programs	80,480	81,202	10,5011	97,824	10,2215	89,496	83,051	70,422	67,273	61,772	58,078

NSERC Number of Grants Awarded (Figure 3.1c)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Discovery Programs	10,673	11,124	11,289	11,338	11,260	10,956	10,662	10,740	10,395	10,593	10,702
Innovation Programs	3,022	2,930	3,168	3,343	3,322	4,061	4,482	4,973	5,482	5,923	6,161

NSERC Success Rates (Figure 3.1d)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Discovery Programs (%)	75.2	73.0	70.3	71.4	64.2	58.1	57.7	62.2	58.6	64.0	65.2
Innovation Programs (%)	23.1	31.6	47.9	39.1	26.5	22.5	16.7	25.8	23.9	26.2	22.4

NSERC Additional Data on Number of Grants Awarded by Competition Year and Per Cent of Requested Budget Awarded to Successful Applicants

Statistics on the number of grants awarded by competition year and per cent of requested budget awarded to successful applicants were extracted from the *NSERC Award Database* (http://www.nserc-crsng.gc.ca/ase-oro/Results-Resultats_eng.asp) and analyzed by competition year (Figure A1). Number of grants awarded measures new grants for that competition year only. Applications for multi-year grants are counted for the year in which they were successful in the application process. For example, a Discovery Grant application submitted in 2010 would be adjudicated early in 2011. Its success or failure in that year's competition would be measured only in 2011, but the grant's funding period would extend over five subsequent years. The per cent of the requested budget awarded for successful (i.e. funded) grant applications measures the actual grant funding as a proportion of the funding that was requested. Data were retrieved from the *NSERC Facts and Figures Report 2010-2011* for the period of 2005-2011 and the *NSERC Competition Statistics Reports* for the 2012-2015 period, respectively. Comparable data for Innovation programs were provided directly by NSERC staff.

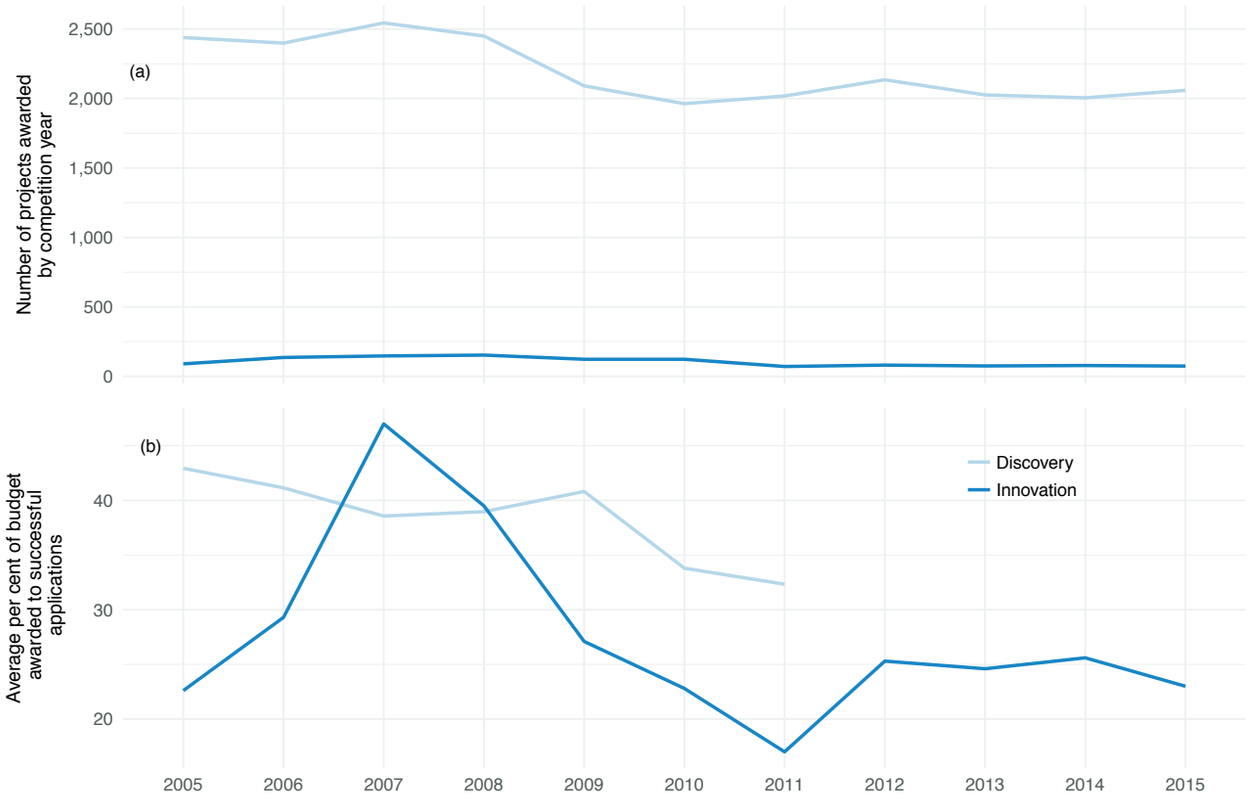

FIGURE A1. NSERC Number of grants awarded by competition year (a) and per cent of requested budget awarded to successful applicants (b).

NSERC Number of Grants Awarded by Competition Year (Figure A1)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Grants in Discovery Programs	2,439	2,399	2,544	2,450	2,091	1,963	2,018	2,135	2,026	2,005	2,059
Grants in Innovation Programs	90	136	147	153	123	123	71	81	75	78	74

NSERC Per Cent of Requested Budget Awarded to Successful Applicants by Competition Year (Figure A1b)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Discovery Programs (%)	42.9	41.2	38.6	39.0	40.8	33.8	32.3	N/A	N/A	N/A	N/A
Innovation Grants (%)	22.6	29.3	47.0	39.5	27.1	22.8	17.0	25.3	24.6	25.6	23.0

SSHRC Data Analysis

Annual expenditures, number of awards and average award values were extracted from the SSHRC Award Database (http://www.outil.ost.uqam.ca/CRSH/RechProj.aspx?vVersion=Avancee&vLangue=Anglais) and are analyzed by fiscal year. Values for 2005-2006 are reported as 2005 and so on for each year

in the analysis. Granting programs classified by SSHRC within Insight and Connection were included in the analysis and are listed in the table below. Insight programs represent fundamental research in this report, while Connection programs represent applied research. Some funding programs were cancelled or created between 2005 and 2015. Many others persisted throughout the 2005-2015 study period and were classified into SSHRC's Insight or Connection programs when these were established in 2011. Success rates represent the proportion of applicants that were successful in receiving funding for their grant applications in that competition year. Success rate data were retrieved from the SSHRC Competition Statistics website (http://www.sshrc-crsh.gc.ca/results-resultats/stats-statistiques/index-eng.aspx).

All measurements of research investments have been adjusted for inflation to 2016 constant dollars using the Bank of Canada Inflation Calculator (http://www.bankofcanada.ca/rates/related/inflation-calculator/) on April 9, 2017. The source data for Figure 3.2 can be found in the tables below.

Granting Programs Inclusive of SSHRC Analysis for Figure 3.2

Insight	Connection
INSIGHT: Individual, Team and Partnerships Research Grants	**CONNECTION: Individual, Team and Partnerships Knowledge Mobilization Grants**
Aboriginal Research	Aid and Attendance Grants to Scholarly Associations
Applied Ethics	Aid to Open-Access Research Journals
Automotive Partnership Canada	Aid to Research and Transfer Journals
BOREAS	Aid to Research Workshops and Conferences in Canada
Canada in the World Research Grants	Aid to Scholarly Journals
Canadian Election Study Data Set	Aid to Scholarly Publications Program
Canadian Health Services Research Foundation	Connection Grants
Canadian Initiative on Social Statistics (CISS) Data Training Schools	Hydrogen Economy Initiative
Canadian Tobacco Control Research Initiative (CTCRI)	Intellectual Property Mobilization Program
CESC-SSHRC Education Research Initiative	Knowledge Impact in Society
Chairs in the Management of Technological Change	Management, Business and Finance: National Forum
Challenges and Opportunities of a Knowledge-based Economy	Public Outreach Grant Open Category
College and Community Innovation Program	Public Outreach Grants: Aboriginal Research
Community-University Research Alliances (CURA)	Public Outreach Grants: Canadian Environmental Issues
Crossing Boundaries Research Initiative	Public Outreach Grants: Digital Economy
Digging into Data Challenge	Public Outreach Grants: Management, Business and Finance
Essential Skills	Public Outreach Grants: Northern Communities–Towards Social and Economic Prosperity
Exploring Social Cohesion in a Globalizing Era	Strategic Knowledge Clusters
Federalism and Federations	Students Promoting Awareness of Research Knowledge (SPARK)
Forest Research Partnerships Program: CFS/NSERC/SSHRC	Tri-Agency-Partnership on Knowledge Syntheses on the Environment
Health Institutes Design Grants	**CONNECTION: Networks of Centres of Excellence**
Homelessness and Diversity Issues in Canada	Advanced Foods and Materials Network (AFMNet)
Image, Text, Sounds and Technology	AquaNet: Network in Aquaculture
Immigration and the Metropolis	ArcticNet
Industrial Research Chairs for Colleges (IRCC) Grants	Business-Led Networks of Centres of Excellence (BL-NCE)
INE: The Canada Project	Canadian Design Research Network (CDRN)
INE Collaborative Research Initiative Grants	Canadian Obesity Network (CON)

Insight	Connection
INE Data and Statistics Seminars	Canadian Stroke Network (CSN)
INE Development Grants	Canadian Water Network (CWN)
INE Research Alliances	Carbon Management Canada (CMC)
INE Research Grants	Centres of Excellence for Commercialization and Research (CECR)
INE Skills Research Initiative	Emerging Dynamic Global Economies (EDGE Network)
Innovation Systems Research Network	Graphics, Animation and New Media Canada (GRAND)
Insight Development Grants	Health Evidence Application and Linkage Network (HEALNet)
Insight Grants	National Initiative for the Care of the Elderly (NICE)
Inter-Council Grant/Consortiums	NCE-Knowledge Mobilization (NCE-KM)
International Community-University Research Alliances (CURA): SSHRC/IDRC	Networks of Centres of Excellence
International Joint Venture Project	NeuroDevNet
International Opportunities Fund	PrioNet Canada
International Research Initiative on Adaptation to Climate Change	Promoting Relationships and Eliminating Violence Network: PREVNet
Major Collaborative Research Initiatives Program	Stem Cell Network (SCN)
Managing for Global Competitiveness	Sustainable Forest Management Network (SFM)
Multiculturalism Issues in Canada	TeleLearning Network of Centres of Excellence (TL-NCE)
National Research Network on the Human Dimensions of Biosphere Greenhouse Gas Management	The Automobile of the 21st Century Network (AUTO21)
NORFACE Transnational Program	The Canadian Arthritis Network (CAN)
Northern Research Development Program	The Canadian Language and Literacy Research Network (CLLRnet)
Ocean Management National Research Network Initiative	The Geomatics for Informed Decisions Network (GEOIDE)
Official Languages Research and Dissemination Program	**CONNECTION: Research-Based Knowledge Culture**
Partnership Development Grants (Insight)	Bora Laskin National Fellowship in Human Rights
Partnership Grants (Insight)	CHSRF/SSHRC Doctoral Fellowship
Project on Trends	CHSRF/SSHRC Postdoctoral Fellowship
Reducing the Health Disparities of Vulnerable Populations	CIHR/SSHRC/NHRDP Health Career Awards
Relationships in Transition	Connection Award
Research Development Initiatives	Connections (Canadian Federation for the Humanities and Social Sciences)
Research Grants: Canadian Environmental Issues	Insight Award
Research Grants: Management, Business and Finance	International Space University Fellowship
Research Grants: Northern Communities: Towards Social and Economic Prosperity	John G. Diefenbaker Award
Research/Creation Grants in Fine Arts	Jules and Gabrielle Léger Fellowship
Rethinking Productivity	Master's Scholarships in Science Policy
Society, Culture and the Health of Canadians	Parliamentary Internship Programme
Society, Culture and the Health of Canadians II	Partnership Award
Sport Participation Research Initiative	Presidential Fund for Innovation and Development
Standard Research Grants*	Queen's Fellowship: SSHRC Fund
Strategic Research Networks in Education and Training	SSHRC Aurora Prize
The Non-Profit Sector in Canada (Kahanoff Foundation)	SSHRC Gold Medal for Achievement in Research
The Social Economy Suite	SSHRC Postdoctoral Prize

Insight	Connection
Tri-Council Workshop/Networking Program	Talent Award
Valuing Literacy in Canada	The Japan Society for the Promotion of Science (JSPS) Fellowships
Virtual Scholar in Residence Program (LCC)	William E. Taylor Fellowship
Women and Change	
INSIGHT: Institutional Research Capacity Grants	
Aid to Small Universities	
Inter-Agency Advisory Panel and Secretariat on Research Ethics and TCPS	
SSHRC Institutional Grants	

SSHRC Total Expenditures (Figure 3.2a)

Millions of 2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total Connection Program Award Expenditures	29.48	71.02	69.61	38.95	40.54	39.13	42.59	35.23	34.19	33.09	31.91
Total Insight Program Award Expenditures	159.60	159.01	150.53	145.86	144.16	138.83	136.43	142.17	144.66	153.15	158.07

SSHRC Average Award Amount (Figure 3.2b)

2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Connection Programs	69,106	156,238	150,061	87,728.	91,652	75,880	71,736	96,703	78,017	65,687	62,804
Insight Programs	48,809	44,917	41,732	41,507	42,103	37,410	40,556	44,905	47,445	55,029	53,275

SSHRC Number of Grants Awarded by Fiscal Year (Figure 3.2c)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Connection Programs	513	535	535	503	494	567	639	382	454	516	515
Insight Programs	3,270	3,540	3,607	3,514	3,424	3,711	3,364	3,166	3,049	2,783	2,967

SSHRC Success Rate by Competition Year (Figure 3.2d)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Standard Research (%)	40.1	40.4	33.2	33.1	32.7	36.3	37				
Insight Programs (%)								27	21.1	23	23.4
Connection Programs (%)								80	81	64	54.6

SSHRC Additional Data on Number of Grants Awarded by Competition Year and Per Cent of Requested Budget Awarded to Successful Applicants

COPY: Statistics on numbers of grants awarded by competition year and per cent of requested budget awarded to successful applicants in SSHRC programs were extracted from the *SSHRC Competition Statistics* website (http://www.sshrc-crsh.gc.ca/results-resultats/stats-statistiques/index-eng.aspx) (Figure A2) and analyzed by competition year. Number of grants awarded measures new grants for that competition year only. Application success for multi-year grants was counted in the year the grant was evaluated by SSHRC. The per cent of the requested budget awarded for successful (i.e. funded) grant applications measures the actual grant funding as a proportion of the funding that was requested. The division between Connection and Insight programs reflects a reform instituted in 2011. Prior to this time, the Standard Research grant was the large competition-based grant program for individual researchers or small groups.

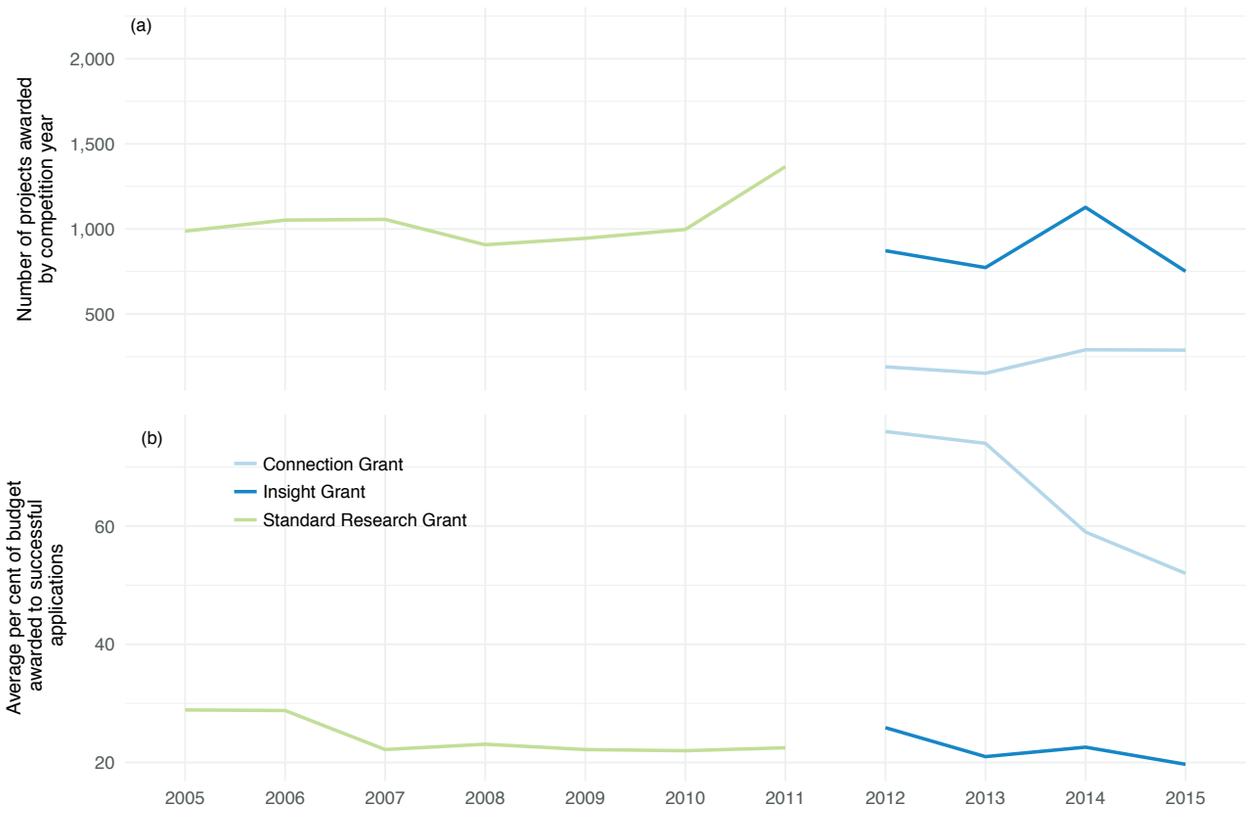

FIGURE A2. SSHRC Number of grants awarded by competition year (a) and per cent of requested budget awarded to successful applicants (b).

SSHRC Number of Projects Awarded by Competition Year (Figure A2a)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Standard Research Grants (n)	987	1,052	1,056	907	945	997	1,366				
Insight Grants Awarded (n)								872	773	1127	751
Connection Grants (n)								190	152	290	288

SSHRC Per Cent of Requested Budget Awarded to Successful Applicants by Competition Year (Figure A2b)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Standard Research Grant Funding Rate (%)	28.9	28.8	22.2	23.1	22.2	22	22.5				
Connection Grant Funding Rate (%)								76	74	59	52
Insight Grant Funding Rate (%)								25.9	21	22.6	19.7

CIHR Data Analysis

Annual expenditures and average award values for both the Core Operating Grant and so-called "Fettered" Operating Grant programs were extracted from the Canadian Research Information System hosted by CIHR (http://webapps.cihr-irsc.gc.ca/funding/Search?p_language=E&p_version=CIHR). Data on the success rates and approval rates for applicants to CIHR's "Open" research grant programs by competition year were extracted from the CIHR website (http://www.cihr-irsc.gc.ca/e/47961.html#fig1). Competition year values include only those new awards that were successful for the calendar year when the grant was evaluated by CIHR.

Granting Programs Included in CIHR Analysis (Figure 3.3). Core operating grants allow investigator-led research and correspond with fundamental research. All grants listed in this table are in fettered, applied research programs

Operating Grant in Fettered Programs
Advancing Technology Innovation Through Discovery
Advancing Technology Innovation through Discovery: Institute of Cancer Research
Alternative Radiopharmaceuticals for Medical Imaging
Alzheimer's Disease Neuroimaging Initiative (ADNI)
Autism Genome Project
Betty Havens Prize
Built Environment: Population Health Intervention Research
CANADA-HOPE Scholarship Program: Operating Grant
Canada-Japan CEEHRC Teams in Epigenetics of Stem Cells
Canada-UK Joint Health Research Program on Antibiotic Resistance
Canada-UK Partnership on Antibiotic Resistance
Canada-UK Partnership on Antibiotic Resistance (LOI)
Canadian Microbiome Initiative(LOI)
Canadian Research Initiative in Substance Misuse: Nodes
Canadian Stroke Network: CIHR Inst of Aging Vascular Cognitive Impairment Dev.
Cancer Stem Cells (CSCC-CIRM Collaborative Partner Program)
Catalyst Grant: CEEHRC Epigenetics, Environment & Health

Operating Grant in Fettered Programs
Catalyst Grant: HIV/AIDS and Aboriginal Health
Catalyst Grant: Mild Traumatic Brain Injury
Catalyst Grant: Mild Traumatic Brain Injury - Blast-Induced
Catalyst Grant: Mild Traumatic Brain Injury - Hotchkiss Brain Institute
Catalyst Grant: Mild Traumatic Brain Injury - Ontario
Catalyst Grant: Maternal Health: From Pre-Conception to the Empty Nest
Catalyst Grant: Advancing the Science to Reduce Tobacco Use & Nicotine Addiction
Catalyst Grant: Bioinformatics Approaches to Cancer Research
Catalyst Grant: Biomedical & Clinical Approaches to Improving Quality of Life
Catalyst Grant: Bone Health
Catalyst Grant: COEN Initiative
Catalyst Grant: eHealth Innovations
Catalyst Grant: eHealth Innovations (Aging)
Catalyst Grant: Environments, Genes and Chronic Disease
Catalyst Grant: Environments, Genes and Chronic Disease (Diabesity)
Catalyst Grant: Ethics
Catalyst Grant: Health Equity
Catalyst Grant: HIV/AIDS and Co-morbidities (Biomedical/Clinical)
Catalyst Grant: HIV/AIDS and Co-morbidities (Health Services/Population Health
Catalyst Grant: HIV/AIDS CBR Program (General Stream)
Catalyst Grant: HIV/AIDS Community Based Research Program (Aboriginal Stream)
Catalyst Grant: HIV/AIDS Vaccine Discovery Research (Can HIV Vaccine Initiative)
Catalyst Grant: Human Microbiome
Catalyst Grant: Infection & Immunity–HIV/AIDS (Health Services/Population Health)
Catalyst Grant: Infection & Immunity–HIV/AIDS (Res - Biomedical/Clinical Stream)
Catalyst Grant: Infection & Immunity–PHAC/CAID/Hep C (Res-Psycho/Behav/Epid)
Catalyst Grant: Infection and Immunity–New Investigator Catalyst Grant
Catalyst Grant: Innovation in HIV Vaccine and HIV Cure Research
Catalyst Grant: Invention and High-Risk, High-Benefit Research
Catalyst Grant: Maternal and Child Health
Catalyst Grant: Methods and Measures for Gender, Sex and Health
Catalyst Grant: Musculoskeletal Rehab and ME/CFS Network Grant (MR)
Catalyst Grant: Official Language Minority Communities
Catalyst Grant: Pandemic Outbreak Research Response
Catalyst Grant: Pandemic Outbreak Team Leader
Catalyst Grant: Pandemic Preparedness
Catalyst Grant: Pilot Projects in Aging
Catalyst Grant: Pilot Projects in Aging (Biological & Clinical Aspects of Aging)
Catalyst Grant: Pilot Projects in Aging (Social Dimensions of Aging)
Catalyst Grant: Planning & Development in Mental Health & Addiction in the Workplace
Catalyst Grant: Population and Public Health
Catalyst Grant: Post Market Drug Safety and Effectiveness
Catalyst Grant: Post Market DSE-DMARD in patients with ankylosing spondylitis
Catalyst Grant: Prevention and Treatment of Illicit Substance Use

Operating Grant in Fettered Programs
Catalyst Grant: Primary and Community-Based Health Care
Catalyst Grant: Psychosocial Issues Associated with Assisted Human Reproduction
Catalyst Grant: Safe Food and Water in Northern Communities
Catalyst Grant: Secondary Analysis of Neuroimaging Databases
Catalyst Grant: Sex as a Variable in Biomedical or Translational Research
Catalyst Grant: Skin Diseases and Conditions
Catalyst Grant: Systems Biology Approaches to Immunotherapy
Catalyst Grant: Infection & Immunity-PHAC-CAID/Hep C Res Init/Biomed/clin stream
Catalyst Grant: Clinical Interventions for Cardiovasc Disease–Enhancing effect...
Catalyst: Methods Post Market DSE–Registry-randomized trials
Catalyst: Methods Post-Market DSE–Bayesian methods and statistical models
Catalyst: Methods Post-Market DSE–Direct patient reporting post-market outcomes
Catyalyst Grant: Health Services and Systems for an Aging Population
CEEHRC Epigenomics Platform: Epigenomic Data Coordination Centre (EDCC)
CEEHRC Epigenomics Platform: Epigenomic Mapping Centres (EMC)
Centres for HIV/AIDS Research
Centres for Research Development in Gender, Mental Health and Addictions (FA)
Centres of Excellence for Commercialization and Research (CECR)
Chair: GlaxoSmithKline Partnered (Operating Component)
China-Canada Joint Health Research Initiative
CICH Profile On-line
CIHR MD/PhD Program Grants
CIHR/Regional Partnership Program/Operating Grants
CIHR/RxD: Biology of Pain– Young Investigators Grant
Collab Health Res Project: INMD-Sodium Reduction in the Food Supply and Health
Collaborative Centres of HIV/AIDS Community-Based Research: Aboriginal Stream
Collaborative Centres of HIV/AIDS Community-Based Research: General Stream
Collaborative Health Research Projects (NSERC partnered)
Core Clinical Centers for the Cardiothoracic Surgical Trials Network (CTSN)
DSEN Training Grant
Emerging Team Grant: Maternal Health–From Pre-conception to the Empty Nest
Emerging Team Grant: Alliances in Mobility in Aging (Launch 2)
Emerging Team Grant: Alliances in Mobility in Aging (Full Application)
Emerging Team Grant: Alliances in Mobility in Aging (LOI)
Emerging Team Grant: Canadian Microbiome Initiative (Full Application)
Emerging Team Grant: Children with Disabilities (Bright Futures for Kids with...)
Emerging Team Grant: Co-morb of brain disorders & other health problems (Full)
Emerging Team Grant: Co-morbidity of brain disorders & other health problems (LOI)
Emerging Team Grant: From Genes to Proteins, Cells, Tissues and Patients
Emerging Team Grant: From Genes to Proteins, Cells, Tissues and Patients (LOI)
Emerging Team Grant: HIV/AIDS Vaccine Discovery & Social Research
Emerging Team Grant: HIV/AIDS Vaccine Discovery & Social Research (LOI)
Emerging Team Grant: Rare Diseases (Basic/Clinical)
Emerging Team Grant: Rare Diseases (Health Services/GELS)

Operating Grant in Fettered Programs
Emerging Team Grant: Rare Diseases (INMD Basic/Clinical)
Emerging Team Grant: Regenerative Medicine and Nanomedicine
Emerging Team Grant: Regenerative Medicine and Nanomedicine (LOI)
Environments, Genes and Chronic Disease
Environments, Genes and Chronic Disease: Chronic Immunologically-mediated
Environments, Genes and Chronic Disease: Chronic Metabolic Diseases
Environments, Genes and Chronic Disease: Environment-Microbiome-Gene
Environments, Genes and Chronic Disease (LOI)
Environments, Genes and Chronic Disease: Reproduction, Fetal and/or ECD
Evidence on Tap: Expedited Knowledge Synthesis
Evidence on Tap: Expedited Knowledge Synthesis (EIHR)
Expedited Knowledge Synthesis: Suicide Prevention
Foundation Grant
Genomics and Personalized Health
Healthy and Productive Work: PDG
History of Medicine
HIV/AIDS CBR Program: Aboriginal (CBR Facilitators)
HIV/AIDS CBR Program: General (CBR Facilitators)
HIV/AIDS Population Health and Health Services
ICRH Community Development Program Grants
ICRH Community Development Program Grants: Critical Care Clinical Trials
ICRH Community Development Program Grants: Resuscitation Clinical Research
ICRH Community Development Program Grants: Stroke Clinical Trials
ICRH Emerging Network Grants: Full Application
ICRH Emerging Network Grants (LOI)
III: Pandemic Preparedness Strategic Research Initiative
Improving Health Care with Knowledge Translation
India-Canada Collaborative Teams in Childhood Obesity Research (LOI)
Industrial Research Chairs for Colleges
Influenza Research Network: Full Application
International COEN Initiative in Neurodegeneration
Intl Collaborative Indigenous Health Res Partnership Chronic Dis: Full Application
Joanna Briggs Collaboration
Joint Canada-Israel Health Research Program
Knowledge Synthesis and Exchange
Knowledge Synthesis Grant
Knowledge Synthesis Grant: PA–Aboriginal Health
Knowledge Synthesis Grant: PA–Age-Supportive Built Environment
Knowledge Synthesis Grant: PA–Arthritis
Knowledge Synthesis Grant: PA–Drug Safety and Effectiveness Network
Knowledge Synthesis Grant: PA–Evidence Informed Healthcare Renewal
Knowledge Synthesis Grant: PA–Financing, Sustainability and Governance
Knowledge Synthesis Grant: PA–Hepatitis C
Knowledge Synthesis Grant: PA–Improve Health and Health Equity

Operating Grant in Fettered Programs
Knowledge Synthesis Grant: PA–Musculoskeletal Health, Skin & Oral Health
Knowledge Synthesis Grant: PA–Phys. Act., sedentary behaviours and health
Knowledge Synthesis Grant: PA–Reproductive and Child Health
Knowledge Synthesis Grant: PA–Tri-Agency Partnership on the Environment
Knowledge Synthesis Grant: PA (HIV/AIDS)
Knowledge Synthesis Grant: PA (Knowledge Translation)
Knowledge Synthesis Grant: Prescription Drug Abuse
Knowledge Synthesis Grant: Prevention and Treatment of Illicit Substance Use
Knowledge Synthesis Grant: PA–Access to Mental Hlth Svs (Children & Youth–IHDCYH)
Knowledge to Action: Maternal Health–From Pre-conception to the Empty Nest
Knowledge Translation Prize
Knowledge Translation Prize: Musculoskeletal Health and Arthritis
Maud Menten New Principal Investigator Prize (Biomedical)
Maud Menten New Principal Investigator Prize (Clinical)
Maud Menten New Principal Investigator Prize (Health Services)
Medical Imaging Clinical Trials Network (LOI)
Mental Health Network: Full Application
Mental Health Network (LOI)
Network Catalyst Grant: Diabetes, Obesity, Digestive and Kidney
Network Catalyst Grant: Infection and Immunity (III)
Network Catalyst Grant: Institute of Cancer Research (ICR)
Network Catalyst Grant: Institute of Musculoskeletal Health and Arthritis (IMHA)
Network Catalyst Grant: Knowledge Translation
Network Catalyst Grant: Practice Guideline
Network Catalyst Grant: Aboriginal Knowledge and Ways of Knowing
Network Catalyst Grant: Adding Life to the Late Years
Network Catalyst Grant: Skeletal Muscle Research
Network Catalyst Grant: Skin Research
New Investigator Research Grants in Child and Youth Health
Nfld and Labrador Centre for Applied Health Res Context. Health Res Synthesis
Operating Grant: Innovative Ebola Research–Transmission, spread, containment, prevent
Operating Grant: eHealth Innov Partnership Program (eHIPP)–Seniors w Complex Care Needs
Operating Grant: PA–Applying the “Two-eyed Seeing” model to Aboriginal Health
Operating Grant: PA–Myotonic Dystrophy (Rachel Fund)
Operating Grant: PA: ALS Canada Research Fund
Operating Grant: Aboriginal Health Intervention (Full Application)
Operating Grant: E-Rare-2 Joint Transnational Call on Rare Diseases
Operating Grant: E-Rare-2 Innovative Therapeutic Approaches
Operating Grant: Health Canada/CIHR Research Initiative on Hepatitis C
Operating Grant: HIV/AIDS CBR Program (Aboriginal)
Operating Grant: HIV/AIDS CBR Program (General)
Operating Grant: Innovative Ebola Research Grants
Operating Grant : JPND Cross-Disease Analysis of Pathways
Operating Grant: PA–Aboriginal Mental Health and/or Addictions Research

Operating Grant in Fettered Programs
Operating Grant: PA–Aboriginal Ways of Knowing and Two-eyed Seeing (Bridge Funding)
Operating Grant: PA–Aging–Optimizing population health and wellness
Operating Grant: PA–Alberta Cancer Foundation–Research (Bridge Funding)
Operating Grant: PA–Bridge Funding–CHVI Vaccine Discovery and Social Research
Operating Grant: PA–Cancer Research (Bridge Funding)
Operating Grant: PA–CHVI Vaccine Discovery and Social Research
Operating Grant: PA–Drug Safety and Effectiveness (Bridge Funding)
Operating Grant: PA–Existing and Emerging Threats & Chronic Disease
Operating Grant: PA–First Nations, Inuit and Metis Health
Operating Grant: PA–Gender, Sex & Health Research Integration and Innovation
Operating Grant: PA–Gender, Sex and Health Research
Operating Grant: PA–Genetics (Bridge Funding: Research Priorities)
Operating Grant: PA–Genetics (Ethics, Law and Society)
Operating Grant: PA–Hepatitis C–Psycho-social/behavioural/epidemiological
Operating Grant: PA–HIV/AIDS–Comorbidity (Biomedical/Clinical Research)
Operating Grant: PA–HIV/AIDS–Comorbidity (Health Services/ Population Health)
Operating Grant: PA–HIV/AIDS Bridge Funding–Biomedical/Clinical Stream
Operating Grant: PA–HIV/AIDS Bridge Funding–Health Services/Pop Hlth Stream
Operating Grant: PA–HIV/AIDS Res Initiative–Hlth Svs/Population Hlth Stream
Operating Grant: PA–HIV/AIDS Research Initiative–Biomedical/Clinical Stream
Operating Grant: PA–Huntington‘s Society of Canada (Prize)
Operating Grant: PA–ICRH–New Investigators (Bridge Funding)
Operating Grant: PA–IMHA–New Investigator (Musculoskeletal Health Bridge Funding)
Operating Grant: PA–IMHA–New Investigator (Oral Health Bridge Funding)
Operating Grant: PA–IMHA–New Investigator (Skin Health Bridge Funding)
Operating Grant: PA–IMHA New Investigators (Bridge Funding)
Operating Grant: PA–INMD Start-up Funds (Clinicians and New Investigators)
Operating Grant: PA–INMHA (Bridge Funding)
Operating Grant: PA–Inst of Nutrition, Metabolism and Diabetes (Bridge Funding)
Operating Grant: PA–Institute of Cancer Research (Bridge Funding)
Operating Grant: PA–Institute of Genetics (Bridge Funding)
Operating Grant: PA–Institute of Health Services and Policy Research
Operating Grant: PA–Musculoskeletal Health, Arthritis, Skin and Oral Health
Operating Grant: PA–Pathways to Health Equity
Operating Grant: PA–Prevention and Treatment of Illicit Drug Use
Operating Grant: PA–Psychosocial Research Parkinson‘s Disease
Operating Grant: PA–Regional Partnership Program (New Brunswick)
Operating Grant: PA–Regional Partnership Program (Newfoundland and Labrador)
Operating Grant: PA–Regional Partnership Program (Nova Scotia)
Operating Grant: PA–Regional Partnership Program (Prince Edward Island)
Operating Grant: PA–Regional Partnership Program (Saskatchewan)
Operating Grant: PA–Regional Partnership Program (Manitoba)
Operating Grant: PA–Reproductive and Child Heath (Start-up grants)
Operating Grant: PA–Schizophrenia (Prize)

Operating Grant in Fettered Programs
Operating Grant: PA–Sodium and Health–Knowledge-to-action
Operating Grant : PA–Transfusion Related Acute Lung Injury (TRALI)
Operating Grant: PA–-–Institute of Human Dev, Child & Youth Health
Operating Grant: PA–Blood Supply Risk
Operating Grant: PA–Gastroenterology
Operating Grant: PA–Hepatitis C (Bridge Funding)
Operating Grant: PA–Aboriginal Ways of Knowing
Operating Grant: PA–Aging (Bridge Funding)
Operating Grant: PA–Bariatric Care (Bridge Funding)
Operating Grant: PA–Blood Utilization and Conservation
Operating Grant: PA–Breast Cancer
Operating Grant: PA–Breast Cancer Research (AVON)
Operating Grant: PA–Canadian HIV Vaccine Initiative
Operating Grant: PA–Epigenetics
Operating Grant: PA–Ethics
Operating Grant: PA–Hepatitis C (Biomedical/Clinical)
Operating Grant: PA–History of Medicine
Operating Grant: PA–Infection and Immunity (Bridge Funding)
Operating Grant: PA–Inflammatory Bowel Disease
Operating Grant: PA–INMD Start Up Funds (Bridge Funding)
Operating Grant: PA–Institute of Gender and Health
Operating Grant: PA–Knowledge Translation
Operating Grant: PA–Neuromuscular Research
Operating Grant: PA–Obesity
Operating Grant: PA–Ovarian Cancer (Bridge Funding)
Operating Grant: PA–Population Health Interventions
Operating Grant: PA–Prospective Active Surveillance
Operating Grant: PA–Spinal Cord Research (Prize)
Operating Grant: Randomized Controlled Trials Mentoring Program
Operating Grant: Resuscitation and Knowledge Transfer and Exchange
Operating Grant: Secondary Analysis of Databases
Operating Grant: Adv Theoretical Meth Innov Hlth Res-Longitudinal Studies Aging
Operating Grant: Bioinformatics and Computational Biology (LAPs)
Operating Grant: PA–Gender, Sex and Health Res. -Work & Hlth & Sexual Hlth
Operating Grant: PA–Inst of Circulatory and Respiratory Health (Bridge Funding)
Operating Grant: PA–Bridge Funding Primary Care
Operating Grant: PA–Mobility in Aging
Operating Grant: Advancing Theoretical & Methodological Innovations in Hlth Res
Operating Grant: Advancing Theoretical Method. Innovations Hlth Res (POP)
Operating Grant: Advancing Theoretical Method. Innovations Hlth Res(HSPR)
Operating Grant: Antimicrobial Resistance (EOI)
Operating Grant: Autism Spectrum Disorders Treatment and Care Research
Operating Grant: Bioinformatics and Computational Biology
Operating Grant: Boys' and Men's Health

Operating Grant in Fettered Programs
Operating Grant: Breast Cancer in Young Women–Research Program
Operating Grant: BSP Technical Adjustment
Operating Grant: CAG Gastroenterology/Nutrition
Operating Grant: CAG Gastroenterology/Nutrition–Endoscopy (Olympus)
Operating Grant: CAG Gastroenterology/Nutrition–IBD (Abbott & Merck)
Operating Grant: CAG Gastroenterology/Nutrition–Upper GI (AstraZeneca)
Operating Grant: Canada-China Human Vaccines (Full Application)
Operating Grant: Canadian DOHaD Cohort Registry
Operating Grant: Canadian Environmental Urban Health Research Consortium
Operating Grant: Cancer Prevention Research Grants
Operating Grant: CEEHRC (Epigenetics)
Operating Grant: CQDM/CIHR Collab Prog in Personalized Medicine (Full Application)
Operating Grant: Demonstration Projects in Mobility in Aging
Operating Grant: Discovery Frontiers
Operating Grant: Discovery Frontiers (LOI)
Operating Grant: Fall 2008 PA (IMHA)
Operating Grant: Genetics (Ethics, Law and Society)
Operating Grant: Health Systems Research on H1N1
Operating Grant: Health, Wellbeing & Extended Working Life
Operating Grant: Industry-partnered Collaborative Research
Operating Grant: Industry-partnered Collaborative Research (Other Partner)
Operating Grant: Industry-partnered Collaborative Research–(Rx&D partner)
Operating Grant: Innovative Ebola Research Grants–Ebola biology
Operating Grant: Innovative Ebola Research Grants–Ebola treatment
Operating Grant: Innovative Ebola Research Grants–Health system impacts
Operating Grant: International Res Initiative on Adapt to Climate Change(LOI)
Operating Grant: JPco-fuND–European research on neurodegenerative diseases
Operating Grant: Knowledge to Action
Operating Grant: KTA PA: Primary and Community-Based Healthcare
Operating Grant: Making progress in women's mental health in the Province of Ontario
Operating Grant: Maternal and Child Health
Operating Grant: Methodological Innovations for Neuroimaging Datasets
Operating Grant: Monitoring and Optimizing CPR
Operating Grant: Pathways Implementation Research Team–Component 1
Operating Grant: Pathways IRT–Component 1: Diabetes/Obesity
Operating Grant: Pathways IRT–Component 1: Oral Health
Operating Grant: Pathways IRT–Component 1: Suicide Prevention
Operating Grant: Pathways IRT–Component 1: Tuberculosis
Operating Grant: Patient/Client Safety in Home Care in Canada
Operating Grant: Population Health Intervention Research
Operating Grant: Population Health Intervention Research (LOI)
Operating Grant: Population Health Intervention Research (Pathways)
Operating Grant: Prevention of Cardiovascular and Respiratory Diseases
Operating Grant: PA–Transfusion Science

Operating Grant in Fettered Programs
Operating Grant: PA (IHSPR)
Operating Grant: PA (IPPH)
Operating Grant: Program. Grants in Food & Hlth -Pop Hlth research...
Operating Grant: Programmatic Grants in Food & Heallth–Basic Biomedical Science
Operating Grant: Programmatic Grants in Food & Health–Human/Clinical Research
Operating Grant: Programmatic Grants in Food and Health (Full Application)
Operating Grant: Programmatic Grants in Food and Health (LOI)
Operating Grant: Programmatic Grants to Tackle Health and Health Equity
Operating Grant: Programmatic Grants to Tackle Health and Health Equity (LOI)
Operating Grant: Quantitative Imaging for Responses to Cancer Therapies
Operating Grant: Sharing Big Data for Health Innovation
Operating Grant: SPOR PIHCI Network–Quick Strikes
Operating Grant: Targeting High Fatality Cancers–Innovation Grant
Operating Grant: Terry Fox New Frontiers Program Project Grant
Operating Grant: Joint Programming Initiative on Antimicrobial Resistance (JPIAMR)
Operating Grant: PA–INMD Start Up Funds–Bridge Funding (Assistant Professors)
Operating Grant: PA–INMD Start Up Funds–Bridge Funding (Clinician Scientists)
Operating Grant: PA–INMD Start Up Funds–Bridge Funding (New Investigators)
Operating Grant: PA–Sodium and Health
Operating Grants: Physiotherapy and Mobility in Aging
Operation: eHealth Innov Partnership Program(eHIPP)-Youth & Adolescent Mental Health
Other: Canada-UK Aging Initiative
Partnership Award
Partnerships for Health System Improvement (PHSI)
Patient Engagement: Collaboration Grants
Personalized Medicine in Inflammation Network (LOI)
Pfizer Operating Grant in Disease Prevention and Management
Preventive Health Care, Evidence Review and Synthesis Centre
Program
Project Grant
Proof of Principle: PA–Cancer Early Detection, Imaging/Trans Therapeutics
Proof of Principle Program (Phase I)
Proof of Principle Program (Phase II)
Proof of Principle Program Phase I: Drug Development
Research Catalyst Network: Rare Diseases
Research Program on Care Practice in Cognitive Impairment in Aging
Science to Business Program
Sleep and Circadian Rhythms: Team (LOI)
Sleep and Circadian Rhythms: Operating Grant
SPOR Network in Primary and Integrated Health Care Innovations (Alberta)
SPOR Network in Primary and Integrated Health Care Innovations (Manitoba)
SPOR Network in Primary and Integrated Health Care Innovations (New Brunswick)
SPOR Network in Primary and Integrated Health Care Innovations (Northwest Territories)
SPOR Network in Primary and Integrated Health Care Innovations (Ontario

Operating Grant in Fettered Programs
SPOR Network in Primary and Integrated Health Care Innovations (Prince Edward Island)
SPOR Network in Primary and Integrated Health Care Innovations (Quebec)
SPOR Network in Primary and Integrated Health Care Innovations (Saskatchewan)
SPOR Network in Primary and Integrated Health Care Innovations (British Columbia)
SPOR Network in Primary and Integrated Health Care Innovations (Nova Scotia)
SPOR Network in Primary and Integrated Health Care Innovations (Newfoundland & Labrador)
SPOR Networks in Chronic Disease
SPOR Networks in Chronic Disease (LOI)
Strategy on Patient Oriented Research (SPOR): PA
Team Grant: Canadian Traumatic Brain Injury Consortium Grant
Team Grant: Clinical Imaging
Team Grant: HIV/AIDS and Comorbidities
Team Grant: HIV/AIDS and Comorbidities (LOI)
Team Grant: India-Canada Collaborative Teams in Childhood Obesity Research
Team Grant: Maternal Health: From Pre-conception to the Empty Nest (LOI)
Team Grant: Environments and Health (LOI)–IWK/TEK/TES
Team Grant: Environments and Health (LOI)–Resource Development
Team Grant: Environments and Health (LOI)–Urban Form
Team Grant: Alzheimer's Disease France-Quebec
Team Grant: Bariatric Care–Comparative hlth svs res to improve mgt of obesity
Team Grant: Bariatric Care–Mechanisms Underlying Bariatric Procedures
Team Grant: Biomarkers in Nutrition and Health (BioNH)
Team Grant: Bone Health
Team Grant: Bone Health (LOI)
Team Grant: Boys' and Men's Health (CIHR/PHAC)
Team Grant: Boys' and Men's Health (General)
Team Grant: Boys' and Men's Health (HIV/AIDS)
Team Grant: Boys' and Men's Health (LOI)
Team Grant: Boys' and Men's Health (OHTN)
Team Grant: Canadian Initiative for HIV Cure Research
Team Grant: CEEHRC (Full Application)
Team Grant: Cerebrovascular Diseases
Team Grant: Childhood Cancer–Late Effects of Treatment
Team Grant: Childhood Cancer–Late Effects of Treatment -LOI
Team Grant: China-Canada Collaborative Teams in Health Research
Team Grant: China-Canada–Alzheimer's Disease and Related Disorders
Team Grant: Chronic Disease Risk and Intervention Strategies
Team Grant: Chronic Disease Risk and Intervention Strategies (LOI)
Team Grant: Circumpolar, Wellness, Resilience and Suicide Prevention
Team Grant: Clinician-Investigator Teams in Obstetrics & Maternal-Fetal Medicine
Team Grant: Community-Based Primary Healthcare (Full Application)
Team Grant: Community-Based Primary Healthcare (HIV Comorbidity Research)
Team Grant: Community-Based Primary Healthcare (IAPH)
Team Grant: Community-Based Primary Healthcare (ICR/CBCI)

Operating Grant in Fettered Programs
Team Grant: Community-Based Primary Healthcare (IGH)
Team Grant: Community-Based Primary Healthcare (IHDCYH)
Team Grant: Community-Based Primary Healthcare (LOI)
Team Grant: Community-Based Primary Healthcare (SPOR)
Team Grant: DOHaD - Implications for Men, Women, Boys and Girls
Team Grant: DOHaD - Implications for Men, Women, Boys and Girls (LOI)
Team Grant: DSEN Collaborating Centre (Network Meta-Analysis)
Team Grant: Early Origins of Addiction in Children and Youth (Canada - Finland)–LOI
Team Grant: Early Origins of Addiction in Children and Youth (Canada - Finland)
Team Grant: Environment and Reproductive Health (Full Application)
Team Grant: Environment and Reproductive Health ((LOI))
Team Grant: Environments and Health–LOI (Agri-food)
Team Grant: Environments and Health–Intersectoral Prevention Research (LOI)
Team Grant: Epigenomics of Complex Diseases
Team Grant: E-Rare-3 Joint Transnational Call
Team Grant: European Research Projects of Neuroscience
Team Grant: Health Challenges in Chronic Inflammation Initiative (Full Application)
Team Grant: Health Challenges in Chronic Inflammation Initiative (LOI)
Team Grant: HIV/AIDS Vaccine Discovery and Social Research
Team Grant: HIV/AIDS Vaccine Discovery and Social Research (LOI)
Team Grant: Implem Res on Hypertension in Low/Middle Income Countries
Team Grant: Intestinal Microbiomics
Team Grant: Late Life Issues
Team Grant: Late Life Issues (LOI)
Team Grant: Mental Disorders
Team Grant: Metabolic Syndrome
Team Grant: Mild Traumatic Brain Injury in Children and Youth (Fonds de rech QC)
Team Grant: Mild Traumatic Brain Injury in Children and Youth (Hotchkiss Brain Ins)
Team Grant: Mild Traumatic Brain Injury in Children and Youth
Team Grant: Mild Traumatic Brain Injury in Children and Youth (Ontario)
Team Grant: Mucosal Immunology for HIV Vaccine Development
Team Grant: National Hepatitis C Collaborative Network
Team Grant: Neurodevelopmental Disorders
Team Grant: Neuroinflammation
Team Grant: Pathways Implementation Research Team–Component 2
Team Grant: Pathways Implementation Research Team–Component 2 (LOI)
Team Grant: Pathways IRT–Component 2 (LOI–Oral Health)
Team Grant: Pathways IRT–Component 2 (LOI–Suicide Prevention)
Team Grant: Pathways IRT–Component 2 (Suicide Prevention)
Team Grant: Pathways IRT–Component 2 (LOI–Obesity/Diabetes)
Team Grant: Pathways IRT–Component 2 (Obesity/Diabetes)
Team Grant: Physical Activity, Mobility and Health (Full Application)
Team Grant: Physical Activity, Mobility and Health (LOI)
Team Grant: Prevention and Treatment of Type 2 Diabetes (Full Application)

Operating Grant in Fettered Programs
Team Grant: Sleep and Circadian Rhythms
Team Grant: Strategic Teams in Applied Injury Research (Full Application)
Team Grant: SU2C Canada Cancer Stem Cell Dream Team Research Funding
Team Grant: Substance Abuse Prevention and Treatment
Team Grant: Terry Fox New Frontiers Program in Cancer
Team Grant: Terry Fox New Frontiers Program in Cancer (LOI)
Team Grant: Violence, Gender and Health
Team Grant: Violence, Gender and Health (LOI)
Team Grant: Vision, Hearing and Communication Disorders
Team Grant: Vision, Hearing and Communication Disorders (LOI)
Team Grant: Joint call for Res Appl (JCRA) Ageing Res-ERA-AGE2
Terry Fox Foundation Training Grant in Cancer Research at CIHR (Full Application)
Therapeutic approaches for H1N1 Complications in the Intensive Care Unit
Tobacco Abuse & Nicotine Addiction (Adv Science to Reduce Tobacco Abuse & Nic...)
Training Grant
Training Grant: Genetic Epidemiology (Full Application)
Training Grant: Genetic Epidemiology (Letter of Intent)
Training Grant: Indigenous Mentorship Network Program (LOI)
Transplantation Research: Full Application
Transplantation Research (LOI)
Vaccines of the 21st Century
Working Groups on Longitudinal Cohorts

CIHR Total Expenditures (Figure 3.3a)

Millions of 2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Open Research Grant Expenditures				248.26	507.52	516.64	517.99	504.46	496.33	262.24	259.95
Fettered Research Grant Expenditures				169.92	237.93	153.51	194.14	158.45	176.24	519.03	525.54

CIHR Average Award Amount (Figure 3.3b)

2016 Constant Dollars	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Open Research Grants				339,232	717,624	720,501	718,184	704,546	698,895	367,871	760,668
Fettered Research Grants				338,946	302,292	234,441	352,734	284,528	410,698	110,7414	945,430

CIHR Grants Awarded (Figure 3.3c)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Open Research Grants	957	916	829	816	797	806	802	801	801	797	383
Fettered Research Grants				559	887	736	612	623	484	524	623

CIHR Grant Success and Approval Rates by Competition Year (Figure 3.3d)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Open Success Rate (%)	28.44	24.95	21.29	22.51	21.66	18.25	17.30	17.50	17.47	14.79	14.28
Open Approval Rate (%)	53	47	42	44	48	36	32	33	29	25	26

Number of Researchers in NSE and SSH

The number of researchers working in higher education and the federal government within SSH and NSE were extracted from *Table 358-0166 Federal personnel engaged in science and technological activities, by major departments and agencies, annual (number)(1,2,4)* from the CANSIM database, available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5193. Data regarding the number of researchers was collected until 2013. Researcher numbers in health-related fields are not tracked explicitly in CANSIM.

Number of Researchers Working in Higher Education and the Federal Government in NSE from 2005-2013 (Figure 3.4a)

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Higher Education	23,720	23,540	25,700	27,170	23,430	28,260	29,920	29,960	32,010
Federal Government	6,710	6,320	6,640	6,590	6,850	6,780	7,070	6,930	6,620

Number of Researchers Working in Higher Education and the Federal Government in SSH from 2005-2013 (Figure 3.4b)

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Higher Education	19,700	19,990	21,610	22,270	23,920	25,720	26,170	27,550	28,260
Federal Government	380	430	460	730	810	1230	790	940	930

Declining Availability of Research Funds Per Researcher, 2005-2015, and Accumulated Funding Gaps. Calculations for Sections 3.6 and 3.8.

Measurement of the research grant funding availability to Canadian researchers requires information on inflation-adjusted granting expenditures by agency and numbers of active researchers through time. Two trends for researchers in NSE and SSH disciplines were estimated, including applied research grant funding per researcher through time, and second, fundamental research grant funding available through time.

Changes through time in support per Canadian researcher were analyzed by calculating funding availability to researchers in SSH and NSE disciplines, respectively, relative to numbers of researchers working in those fields. For NSE, applied research grant funding in NSERC's Innovation granting programs was divided by the number of NSE researchers in higher education in Canada. Comparable calculations were performed for SSH researchers based on their numbers through time and the total funding available through Connection grant programs at SSHRC. This calculation was repeated purely for fundamental research grant support (i.e. Discovery programs at NSERC and Insight programs at SSHRC). The two trends are depicted graphically in Figure 3.5 and as summary calculations in Section 3.6.

Finally, information on changing numbers of researchers relative to inflation-adjusted funding availability was used to measure the "Accumulated Funding Gap for Canadian Researchers" that has grown over the 2005-2015 period for fundamental research programs (summarized in Section 3.8). This calculation addresses the simple question: How much new funding would be necessary to restore the availability of fundamental research funding per researcher to levels observed in 2005?

The data source for the number of Canadian researchers in higher education is identical to that referenced in Figure 3.4 and was extracted from *Table 358-0166 Federal personnel engaged in science and technological activities, by major departments and agencies, annual (number)(1,2,4)* from the CANSIM database, available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5193. Data regarding the number of researchers were collected until 2013. After this time, numbers of researchers in SSH and NSE were assumed to be constant, although it is likely that growth in these communities continued through time.

Data on the total expenditures for NSERC and SSHRC granting programs were sourced as described for the information in Figures 3.1a and 3.2a. All measurements of research investments have been adjusted for inflation to 2016 constant dollars using the Bank of Canada Inflation Calculator (http://www.bankofcanada.ca/rates/related/inflation-calculator/) on April 9, 2017.

Research Grant Expenditure per Higher Education Researcher (2016 Constant Dollars)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NSERC - Researchers in NSE	30,627	31,276	32,532	30,050	35,026	29,284	27,449	26,488	24,419	24,618	24,309
SSHRC - Researchers in SSH	9,598	11,507	10,187	8,299	7,721	6,919	6,841	6,439	6,329	6,590	6,723

Research Grant Expenditure on Fundamental Research per Higher Education Researcher (2016 Constant Dollars)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NSERC - Researchers in NSE	20,374	21,169	19,587	18,014	20,534	16,424	15,008	14,799	12,898	13,188	13,131
SSHRC - Researchers in SSH	8,102	7,954	6,965	6,549	6,027	5,398	5,213	5,160	5,119	5,419	5,593

Research Grant Expenditure on Applied Research per Higher Education Researcher (2016 Constant Dollars)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
NSERC - Researchers in NSE	10,253	10,107	12,945	12,036	14,492	12,861	12,441	11,689	11,521	11,430	11,178
SSHRC - Researchers in SSH	1,497	3,553	3,221	1,749	1,695	1,521	1,628	1,279	1,210	1,171	1,129

APPENDIX B: References for Media Coverage of Shifting Support for Fundamental Research in Canada, 2011-2017

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APPENDIX C: On-line Survey 'Perceptions of Funding for Fundamental Research'

C.1. Additional On-line Survey Methods and Data Analysis

The on-line survey was open to researchers from any country in the world because it conducted as a global survey as a project led by the Global Young Academy's 'Importance of Fundamental Research' Working Group (https://globalyoungacademy.net/activities/importance-of-fundamental-research/). It ran on the Fluid Surveys platform (fluidsurveys.com).

We shared the survey broadly on social media, through the Global Young Academy network, on scientific list serves, and through personal connections. To disseminate the survey specifically to Canadian researchers, we gathered email addresses from Canadian university websites for faculty members and emailed individual researchers directly.

To extract survey responses for Canadian researchers, we selected all respondents who reported 'Canada' as their country of work, as well as those respondents who did not report a country of work (i.e. field was blank) but whose location was within Canada. Not all survey respondents answered every survey question.

C.2. The 'Perceptions of Funding for Fundamental Research' On-line Survey

The on-line survey included the following instructions, consent information and questions:

Instructions:

You are invited to participate in a study entitled 'Perceptions of Funding for Fundamental Research' that is being conducted by Dr. Julia Baum (University of Victoria) and Dr. Oded Hod (Tel-Aviv University). The purpose of this research project is to understand and examine the perceptions of researchers about the importance of fundamental (i.e. curiosity-driven) and applied research to major funding bodies. The type and availability of research funding can impact the careers of young researchers, the next generation of scientific researchers, and society at large. This research is funded by the Global Young Academy (www.globalyoungacademy.net); the survey is hosted by the University of Ottawa.

This survey consists of 5 sections and should only take 10 minutes to complete. This project is directed towards researchers of physical, natural, social, medicine and life, interdisciplinary, and other science disciplines. You are being asked to participate because you have been directly involved in applications for research funding.

Additional Consent Information:

Principal Investigators: Dr. Julia Baum, Assistant Professor, Biology Department, University of Victoria, ***baum@uvic.ca***, +001-250-721-7146; Dr. Oded Hod, Professor, School of Chemistry, Tel-Aviv University, ***odedhod@tau.ac.il***, 972-3-640-5850.

Co-Investigators: Megan Dodd, Postdoctoral Fellow, Department of Chemical Engineering, McMaster University; the Global Young Academy's 'Importance of Fundamental Research' Working Group

Risk/Inconvenience: Participation in this study has no known potential risks or inconveniences to you.

Benefits: Your participation in the survey will benefit the collective state of knowledge on the importance of fundamental and applied research to major funding bodies internationally.

Voluntary Participation: Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time while completing the survey and your data will not be used. Once the survey has been submitted, you can no longer withdraw, as the data is anonymous and cannot be linked back to you.

Anonymity: To protect your anonymity, all data will arrive to us anonymously and be stored this way via the on-line survey format.

Confidentiality: Your confidentiality and the confidentiality of the data will be protected by storage and use in an anonymous format.

Dissemination of Results: It is anticipated that the results of this study will be shared with others in the following ways: report, published articles, presentations at scholarly meetings, on the Internet and possibly via media reports.

Disposal of Data: Electronic data from this study will be stored for future related analyses on a hard drive and in a protected cloud format.

Ethics Review: This research project has been approved by the University of Victoria's Human Research Ethics Board (Protocol Number 16-172). You may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria (+001-250-472-4545 or ***ethics@uvic.ca***).

By completing and submitting the questionnaire, **YOUR FREE AND INFORMED CONSENT IS IMPLIED** and indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researchers.

Part 1. Type of Research Conducted

What percent of your current research falls under the following categories?
Total should equal 100%

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Fundamental Research (definition below)	○	○	○	○	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○	○	○	○	○

Have these proportions changed over the past 10 years?

- ○ Yes
- ○ No
- ○ Can't comment (new researcher)

What percent of your past research program falls into each of these categories?
Total should equal 100%

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Fundamental Research (definition below)	○	○	○	○	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○	○	○	○	○

What is the main reason for the change in category of research you conduct/supervise? Please select all of the following reasons that apply:

- ☐ Interest-related
- ☐ Career-related
- ☐ Funding-related
- ☐ Socially-related
- ☐ Other, please specify... Type here

How do you view this change in the type of research that you conduct/supervise?

- ○ Very positive
- ○ Slightly positive
- ○ Neutral
- ○ Slightly negative
- ○ Very negative

Part 2. External Partnerships

Please indicate the level of partnership that your research currently has outside of academia (e.g. with the for-profit sector or non-governmental sector):

- ○ No partnership
- ○ Some partnership
- ○ Strong partnership
- ○ Exclusive partnership

Has the level of partnership that your research has outside of academia (e.g. with the for-profit sector or non-governmental sector) changed over the past ten years?

- ○ Yes
- ○ No
- ○ Can't comment (new researcher)

Please indicate the level of partnership that your research had with the for-profit or non-governmental sectors before this shift:

- ○ No partnership
- ○ Some partnership
- ○ Strong partnership
- ○ Exclusive partnership

What is the main reason for the change in the level of partnership that your research has with the for-profit or non-governmental sectors? Please select all of the following reasons that apply:

- ☐ Interest-related
- ☐ Career-related
- ☐ Funding-related
- ☐ Socially-related
- ☐ Other, please specify... Type here

How do you view this change in the level of your research's partnerships with the for-profit or non-governmental sectors?

- ○ Very positive
- ○ Slightly positive
- ○ Neutral
- ○ Slightly negative
- ○ Very negative

Part 3. Grant Application History

Please estimate how many external research grant applications, both successful and unsuccessful, you have been involved in. This includes applications to national and international funding bodies, for-profit sector, non-governmental sector, institutes, etc. where you were listed as a principal/chief investigator or equivalent.

2011-2015

	0	1-3	4-6	7-9	10-12	13-15	16+
Fundamental Research (definition below)	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○

2006-2010

	0	1-3	4-6	7-9	10-12	13-15	16+
Fundamental Research (definition below)	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○

Please estimate the percentage of your research grant applications that were successful (received funding):

2011-2015

	No need for applications for this research type	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Fundamental Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○

2006-2010

	No need for applications for this research type	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Fundamental Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○	○	○	○	○	○	○

Given the two time periods below, how important do you think suggesting practical applications of your research was to successfully obtain grant funding?

	Not at all important	Somewhat important	Quite important	Very important	Mandatory	Can't comment
2011-2015	○	○	○	○	○	○
2006-2010	○	○	○	○	○	○

Based on your grant applications, how important do you think it is for grant success to include partners from for-profit or non-governmental sectors in grant applications?

	Not at all important	Somewhat important	Quite important	Very important	Mandatory	Can't comment
2011-2015	○	○	○	○	○	○
2006-2010	○	○	○	○	○	○

Please estimate the distribution of your research funding sources:

Total must add up to 100%

2011-2015

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Internal/Institutional	○	○	○	○	○	○	○	○	○	○	○
Government	○	○	○	○	○	○	○	○	○	○	○
For-profit sector (e.g. Industry)	○	○	○	○	○	○	○	○	○	○	○
Non-governmental sector (e.g. Foundation, NGO, Philanthropist)	○	○	○	○	○	○	○	○	○	○	○
Other (please specify type of source below)	○	○	○	○	○	○	○	○	○	○	○

2006-2010

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Internal/Institutional	○	○	○	○	○	○	○	○	○	○	○
Government	○	○	○	○	○	○	○	○	○	○	○
For-profit sector (e.g. Industry)	○	○	○	○	○	○	○	○	○	○	○
Non-governmental sector (e.g. Foundation, NGO, Philanthropist)	○	○	○	○	○	○	○	○	○	○	○
Other (please specify type of source below)	○	○	○	○	○	○	○	○	○	○	○

Other funding sources type:

Type here

In general, do you think that grant success rates within each category of research have changed over the past ten years?

	Decreased considerably	Decreased	Stayed the same	Increased	Increased considerably	Can't comment
Fundamental Research (definition below)	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○

Part 4. Funding Trends in Your Country of Work

In your opinion, how important is fundamental research to the government in your country of work?

- ○ Not at all important
- ○ Not very important
- ○ Somewhat important
- ○ Very important
- ○ Can't comment

In the past 10 years, have any type(s) of research become a higher priority for the government in your country of work?

Check all that apply.

- ☐ Fundamental Research
- ☐ Use-inspired Research
- ☐ Applied Research
- ☐ No Change Observed

Comments:

Type here

Do you think the availability of research funding will change in your country of work in the next 5 years?

	Will decrease considerably	Will decrease slightly	Will stay the same	Will increase slightly	Will increase considerably	Can't comment
Fundamental Research (definition below)	○	○	○	○	○	○
Use-inspired Research (definition below)	○	○	○	○	○	○
Applied Research (definition below)	○	○	○	○	○	○

Do you think changes in funding availability in your country of work will influence the likelihood of the next generation to pursue careers in research?

Will decrease considerably	Will decrease slightly	Will stay the same	Will increase slightly	Will increase considerably	Can't comment
○	○	○	○	○	○

Comments:

Type here

Part 5. About You

What is your field of research?

- Physical Science (e.g. math, physics, chemistry, computer science)
- Natural Science
- Medicine and Life Science
- Social Science / Humanities
- Engineering
- Interdisciplinary Science
- Other

In what year did you complete your PhD (if applicable)? – applicants choose from a pull down list of years 1950 – 2016 and an option of "I did not complete a PhD"

Select ...

What is your country of work? – applicants choose country from a pull down list

Select ...

What is your gender?

- Male
- Female
- Other

Do you have any final comments?

Comments:

Type here

For the purpose of this survey, the term 'category of research' refers to the following classifications:

- **Fundamental Research** – The pursuit of knowledge and understanding of humanity and the natural world. Executed without specific consideration of an end product.
- **Use-inspired Research** – Systematic study that strives to understand phenomena and processes that are required to address societal challenges.
- **Applied Research** – The systematic use of existing knowledge to develop practical solutions to specific challenges

C.3. Supplementary Survey Results

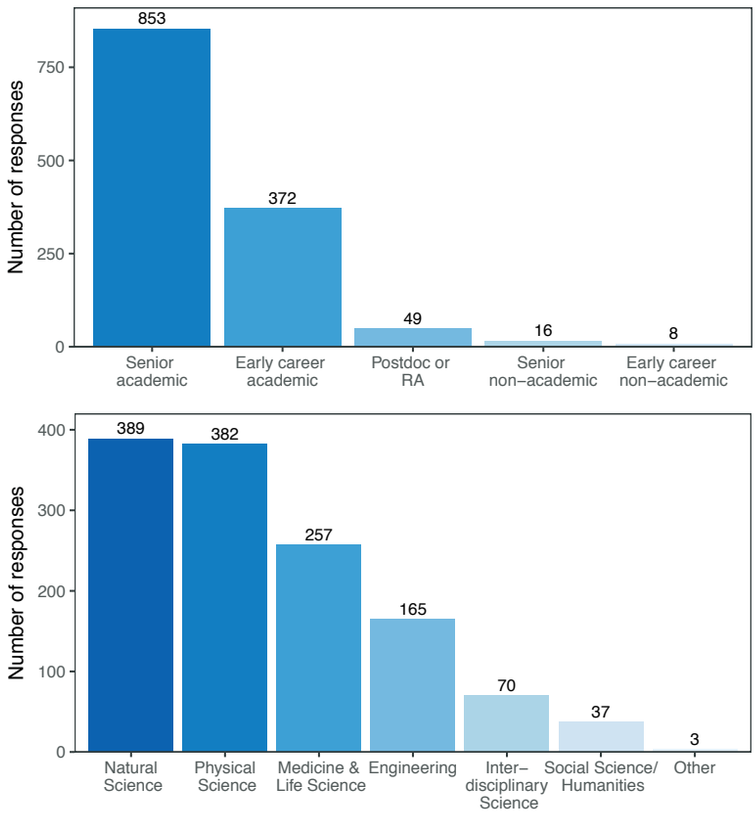

Figure C1. Top) Number of Canadian survey respondents by career stage; Bottom) Field of research of the Canadian survey respondents.

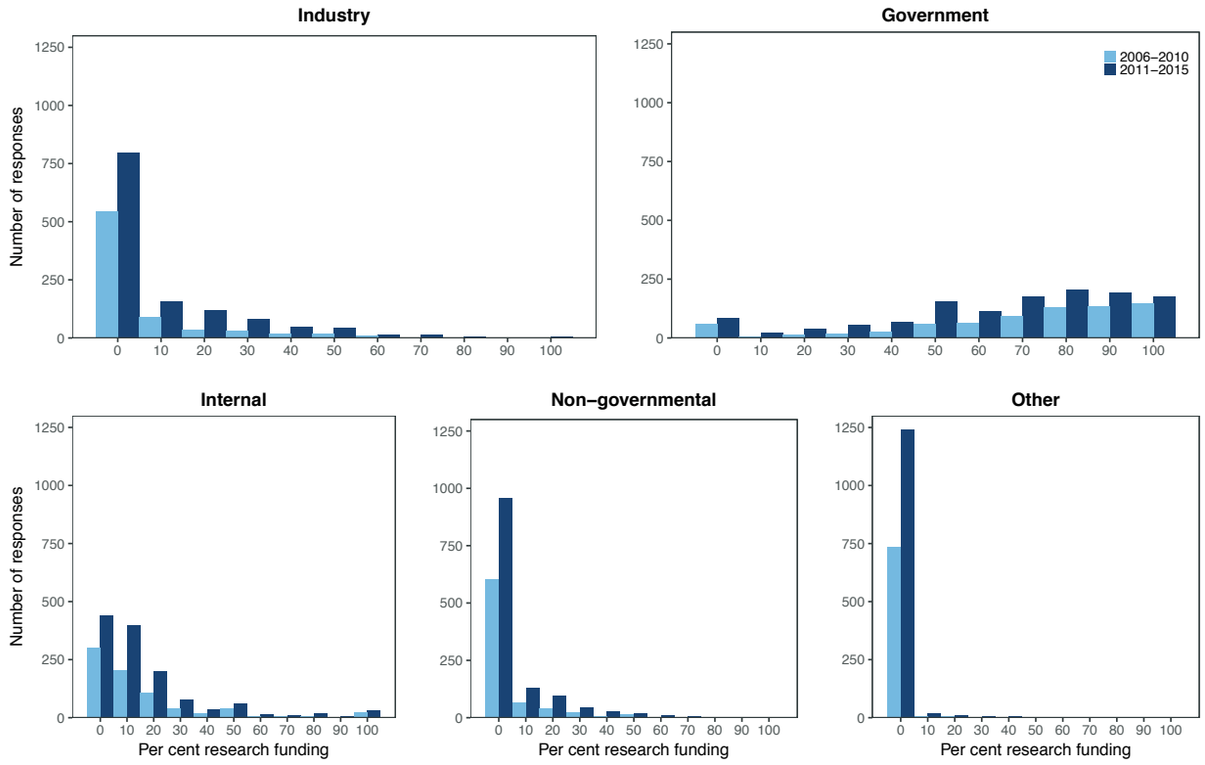

Figure C2. Canadian researchers' estimated per cent of research funding from industry, government, internal, non-governmental or other sources between 2006-2010 and 2011-2015.

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June 2017