



## **DRIVING GROWTH THROUGH RESEARCH:**

### **The importance of research for Canada's future in the world knowledge economy**

Research is crucial for the economic success of Canada and the wellbeing of Canadians. It has received welcome support in the Federal Budget of February 2014. Nevertheless, the Royal Society of Canada is concerned that we are in danger of slipping behind our competitors in our support of research and thereby losing our competitive edge. The RSC believes that we need to be active in expanding funding for research, creating a research culture in Canada, and facilitating the translation of research discoveries into benefits for society.

We believe that research should be central to evidence-based policy development.

We recommend that research funding in Canada should increase at least to the average level in the OECD and G8 countries.

We advise the government to develop a ten-year plan for research, innovation and skill development, in consultation with the academic and business communities.

We urge the government to establish a more extensive and more diverse system for providing expert advice at all levels.

Canada is a fortunate nation with many advantages over our partners and rivals. At the same time, there are many countries that have stronger research cultures and outperform Canada in research by most reasonable measures. The RSC believes that we should be vigilant in nurturing the sources of our success, and in particular our commitment to sustaining a vigorous research community that will drive the innovation we need in order to maintain our place in the world and secure the wellbeing of Canadian society.

## 1. PROSPERITY AND UNDERSTANDING MARCH TOGETHER

Our wellbeing depends on a vast range of services and devices that we often take for granted. We rely on modern technology to operate all of our systems for manufacturing, communication, transport, agriculture and medical treatment. Our prosperity depends on our ability to maintain and improve these systems. All of them are the fruits of research, leading to innovation that benefits us all.

The economic benefits of research have been conclusively demonstrated in many fields, from medicine to mathematics.<sup>1,2</sup> Research is a powerful driver of prosperity because it can open whole new fields of activity. Michael Smith's discoveries at UBC, for example, made a major contribution to the development of biotechnology.

Our wellbeing depends on the wealth that is created by innovation, but it also depends on understanding the world around us and our place in it. Research in the natural sciences enables us to explore the Earth and beyond. Research in the social sciences helps us to understand our own and other cultures. Research in the humanities can lead us toward a more just society. The creative arts provide us with important self-perspectives and challenge us to think deeply about our country's future.

## 2. THE RISK OF LAGGING BEHIND

The world does not stand still, and in fact we live in a time of rapid change. In order to maintain our prosperity we need to keep pace with new advances in understanding and new forces in society. A vigorous research program must be a core component of our national strategy.<sup>3</sup>

The importance of research for economic growth is widely recognized by our competitors.<sup>4</sup> In his State of the Union message for 2013, President Obama declared that "now is the time to reach a level of research and development not seen since the height of the space race".

Canada has an enviable record of research productivity. Canada ranks No. 6 among OCED nations in scientific publications per capita and fifth in quality of publications.<sup>5</sup> Nevertheless, we are not among the leading countries in terms of research investment. Our research intensity (the overall proportion of GDP spent on research and development) is substantially less than the OECD average, and among the G8 countries we spend less than

any country except Italy and Russia.<sup>6</sup> The USA spends about 2.8% of GDP on Research and Development (R&D), and most advanced economies spend more than 2%. Emerging economies are fast catching up: in China, spending grew from less than 1% in 2000 to 1.7% in 2010. Over the same period, spending on R&D in Canada fell steadily from 2.09% to 1.81% of GDP.<sup>7</sup>

To maintain and enhance our competitiveness in the world market it will be necessary to match or exceed the research intensity of our competitors. The federal government announced substantial additional support for research in the 2014 budget, including the Canada First Research Excellence Fund, increased funding for the Tricouncil granting agencies, and support for research institutes such as TRIUMF.<sup>8</sup> This was widely welcomed as an important step forward.<sup>9</sup> We believe that a coherent long-term plan for expanding research investment is an essential factor in securing a prosperous future for Canadians.

## 3. A BROAD BASE FOR RESEARCH

Research is increasingly interdisciplinary. Today's problems and opportunities demand extensive collaboration among specialists in different fields. Topics such as synthetic biology, printer-based manufacturing, adaptation to climate change, the challenges faced by our Aboriginal communities and ageing populations can only be addressed by combining the expertise of many researchers. A broad research base also offers a form of insurance. We cannot predict where the next breakthrough will occur—otherwise we would have made it—and a narrow focus on a few fields runs the risk of missing out completely on the next major development.

Advanced projects are often carried out by teams with a broad range of expertise that includes many different fields and may span the natural and social sciences. Most involve multinational teams of researchers, and likewise the most research-intensive businesses have multinational operations with offices and laboratories throughout the world.<sup>10</sup> These features of modern research have been recognized in the foresight exercises carried out by the Social Sciences and Humanities Research Council and by the International Social Sciences Union.

In order to excel in this changing context of advanced research it is necessary to sustain a research community with a great diversity of different specializations. Canada will only be able to participate in major new industrial

and commercial projects if it has nurtured the range of basic research that is needed to provide the broad base of skills they require.

#### **4. MAINTAINING STEM SKILLS**

Research achievement is fostered by a high quality of education in science, technology, engineering and mathematics (STEM). The ability of Canada to compete internationally in research depends critically on the supply of highly qualified personnel. This in turn depends on the ability of our schools, colleges and universities to educate and motivate young people for a career in research. The maintenance of STEM skills is a serious concern in other countries, which see this as a key to success in modern economies.<sup>11</sup> The equivalent of STEM skills in social sciences and humanities is education that leads to an understanding of core Canadian values such as multiculturalism in a rights-based society. These skills are also needed to produce citizens who can operate effectively in the global economy.

Canada has traditional strengths in science education, but there have recently been troubling signs that we may be slipping down the international rankings. The percentage of students at the high or advanced benchmark for mathematical skills fell between 1995 and 2011 in Quebec and Alberta, although it increased in Ontario.<sup>12</sup> The trends fluctuate over time and our educational system is still highly competitive by international standards. Nevertheless, we should be vigilant and should continue to place a high priority on establishing rigorous standards for STEM education and on developing innovative teaching methods to engage students in research at all levels in the curriculum.

The key to enhancing STEM education is to develop a “research culture” that values and rewards research as a crucial social activity. This will make it easier for us to retain our home-grown talent and to attract the best researchers and educators from the rest of the world. We must act now in order to ensure an adequate supply of professional and technical workers over the next ten years.

#### **5. RETAINING THE REWARD**

It is tempting to believe that we can let other countries specialize in research, while we profit from their successes. This is a dangerous illusion. Without excellence in

research we shall gradually lose our ability to operate advanced technologies and even to maintain STEM skills at a high level. We risk being relegated to a branch plant for countries that have made the necessary investments in research.

Research that is done in Canada benefits the nation in three ways.

- It enables us to support a large cadre of highly qualified workers as the core of an advanced, knowledge-driven economy.
- Advanced research gives Canadian enterprises a competitive edge over our rivals in other parts of the world.
- Research institutes and universities have a dramatic multiplier effect on local economies.

The multiplier effect of investment in research should not be overlooked. An authoritative study concluded that “expenditures for R&D performed by universities are significantly positively related to business enterprise sector expenditures on R&D indicating that public sector R&D and private R&D are complements.”<sup>13</sup>

The benefits of Canadian research are exported to the rest of the world, and we should encourage this by supporting rapid and open publication of research results. The world economy is not a zero-sum game, and we all gain from living in a more skilled, better informed world. Furthermore, there is an intangible but real benefit in being acknowledged as part of the leading group of scientifically advanced nations.

#### **6. THE MUTUAL REINFORCEMENT OF BASIC AND APPLIED RESEARCH**

The economic benefits of research might suggest that our national strategy should prioritize applied research that is targeted for more or less immediate commercialization. This argument should not be unduly emphasized, because basic and applied research are inextricably entangled. Applied research often provides a new point of departure for advancing understanding, for example by the recent development of methods for rapidly sequencing genes. Basic research in turn can create enormous new potential for development, as the invention of the Internet has demonstrated.

Basic research is essential because novel breakthroughs cannot be predicted. An extensive program of basic research

provides a large number of avenues of enquiry, any one of which may turn out to be unexpectedly fruitful. Without such a program, we shall always be playing catch-up to countries which have created the opportunity for taking advantage of unpredictable discoveries.

Novel threats and challenges are also unpredictable, at least in detail. A broad research spectrum gives us the best chance of detecting the early stages of a new danger, such as an emerging disease or invasive species, and provides us with the expertise to deal with it.

The contribution of basic research to commercial and industrial success is often undervalued because it is easy to overlook. A UK report on the service sector concluded that: “the full extent of STEM’s current contribution is hidden from view—it is not easily visible to those outside the process and is consequently under-appreciated by the service sector, policymakers and the academic research community. This blind spot threatens to hinder the development of effective innovation policies and the development of new business models and practices...”<sup>14</sup> We should be correspondingly careful to ensure that our national policy provides the support for research that is essential for the health of Canadian industry.

## 7. BALANCING THE RESEARCH PORTFOLIO

Research is conducted in a variety of institutions, including universities, government laboratories, research institutes and businesses. Each deals with a somewhat different set of issues, often using different approaches and with different priorities. This diversity should be welcomed and respected. Our national research portfolio benefits from a division of labour among its different components.

There is legitimate concern that the results of basic research (typically performed in universities) is not efficiently transformed into projects that bring economic benefits (typically realized in businesses). Despite the high quality of Canadian research, “Canada is not among the leaders in most benchmarks of innovation, ranking 12th in the World Economic Forum’s latest Global Competitiveness Index. In part, this is due to low R&D spending by business, which has declined in inflation-adjusted terms since 2001. Canada’s BERD intensity [spending by business on research and development] is among the lowest of industrialized economies.”<sup>16</sup> According to the State of the Nation report issued by the Science, Technology and Innovation Council in 2010, “economists are

increasingly focusing on a lack of innovation in Canada as a contributor to poor productivity performance.”<sup>15</sup> This issue was the subject of a major report by the Council of Canadian Academies, which concluded that “business will have to embrace innovation-focused business strategies to compete and survive.”<sup>16</sup>

This issue should be addressed, not by prioritizing some kinds of research institutions over others, but rather by encouraging the flow of information between partners. There are many matching-funds programs that are intended to do this, but a more radical approach may be necessary to resolve the problem.

## 8. SUPPORTING YOUNG RESEARCHERS

It is a truism that the future of research in Canada depends on the current cohort of young people in the first few years of their careers. It is important to provide them with the best opportunities for advancing their research programs. There is a very large value-added advantage for ensuring that young researchers, who have been trained at great expense, are given the means for putting their skills to work most effectively.

The foundation of a career in research is the PhD degree, although a further period of postdoctoral study is often required for advanced research in universities. The number of PhDs trained each year in Canada is much lower in proportion to population than in almost all other OECD countries, amounting to about half the rate in the UK and Germany.<sup>17</sup> This may stem from a low demand for advanced skills in the labour market, reflected by the low proportion of businesses that employ PhD graduates.<sup>18</sup> After graduation, the Banting program of postdoctoral fellowships is a welcome new initiative that provides advanced training, but is restricted to 70 awards per year over all three granting agencies. Canada needs to do more to enlarge the entry cohort of researchers.

The crucial transition from graduate student or postdoctoral fellow to employed researcher is facilitated by the creation of research positions that lead to permanent employment. In other countries, research positions specifically tailored for young scientists have been created, such as the Royal Society Fellowships in the UK and the Presidential Fellowships in the USA. The equivalent in Canada is the Canada Research Chairs scheme, founded in 2000. This has been very successful, with about 1,800 chair-holders currently appointed. After over a decade of

operation, it might be timely to review its effectiveness in relation to our international competition.

The recruitment and retention of young researchers is central to our overall research strategy. We need to bulk up our programs in advanced training to ensure that our research capacity matches that of our competitors.

## 9. IN IT FOR THE LONG TERM

Research often requires a long period of incubation before producing palpable results. There are innumerable examples of long-term research programs that have borne fruit only after many years; examples include lasers, genetic transformation and medical imaging. Programs that are continually interrupted by lack of funding are less likely to be successful because of the difficulty of restarting laboratories where expertise and momentum have been lost. Stable funding is necessary to realize the full benefits of past investments.

Moreover, research may be directed towards inherently long-term issues, such as climate change or power generation. The discovery of rising carbon dioxide levels in the atmosphere is a good example of the dramatic impact that long-term research can have. Some of the most important issues for contemporary society can only be addressed through long-term research that requires stable funding.

The importance of long-term, stable funding for research is well recognized by many of our competitors. In the UK, for example, the government has accepted the main recommendation of the Heseltine Review,<sup>4</sup> to provide stable funding for research at a level comparable to peer nations. Stable funding helps to retain internationally mobile research groups in both academic and business

communities. The long-term, sustained approach of the Fraunhofer Institutes in Germany, for example, suggests how stable funding for basic research can be effectively linked to business development.<sup>19</sup>

## 10. HOW THE ACADEMIES CAN HELP

In most advanced countries, the national academy plays a key role in brokering communication between the research community and government.<sup>20</sup> It often provides scientific and technical advice based on a constitutional mandate (such as the National Academy of Science in the USA) or historic prestige (such as the Royal Society in the UK, or the Leopoldina in Germany). In Canada the Academies provide advice to government through the medium of the Canadian Council of Academies, which prepares expert panel reports in response to requests from government departments. The role of the Academies is very limited relative to comparable institutions in other countries, and (in contrast to all other developed countries) they receive no government funding. The Academies are a major national resource that is currently under-utilized.

There is a large unrealized potential in Canada for setting up a more extensive and more systematic framework for linking government at all levels to authoritative sources of scientific and technical advice. In the modern world, economic success and national prestige require evidence-based policies that take full advantage of the expertise represented by the Canadian research community. The Royal Society of Canada embodies a large capacity to mobilize and convene authoritative opinion over the whole range of natural science, social science and the humanities. It stands ready to continue a conversation with Canadians about building a national strategy for research as a chief driver of prosperity.

The Royal Society of Canada (RSC): The Academies of Arts, Humanities and Sciences of Canada was established in 1882 as the senior Canadian collegium of distinguished scholars, artists and scientists. It is Canada's National Academy. The primary objective of the Society is to promote learning and research in the arts, the humanities and the natural and social sciences.

For more information please contact Erika Kujawski: [ekujawski@rsc-src.ca](mailto:ekujawski@rsc-src.ca)

## SOURCES

1. Health Economics Research Group at Brunel University, Office of Health Economics and RAND Europe. 2008. Medical research: what's it worth? [www.acmedsci.ac.uk/index.php?pid=99&puid=137](http://www.acmedsci.ac.uk/index.php?pid=99&puid=137)
2. Deloitte. 2012. Measuring the economic benefits of mathematical science research in the UK. <http://www.epsrc.ac.uk/SiteCollectionDocuments/Publications/reports/DeloitteMeasuringTheEconomicsBenefitsOfMathematicalScienceResearchUKNov2012.pdf>
3. NESTA. 2012. Plan i. The case for innovation-led growth. <http://www.nesta.org.uk/publications/plan-i>
4. HM Treasury. 2013. The Government's response to the Heseltine review. [www.hm-treasury.gov.uk/ukecon\\_heseltinereview\\_index.htm](http://www.hm-treasury.gov.uk/ukecon_heseltinereview_index.htm)
5. OECD. 2010 OECD Science, Technology and Industry Outlook 2010: Country Profiles. <http://www.oecd.org/sti/inno/oecdsciencetechnologyandindustryoutlook2010countryprofiles.htm>
6. OECD. 2012. Main Science and Technology Indicators, p 15. [http://www.oecd-ilibrary.org/science-and-technology/main-science-and-technology-indicators/volume-2012/issue-2\\_msti-v2012-2-en](http://www.oecd-ilibrary.org/science-and-technology/main-science-and-technology-indicators/volume-2012/issue-2_msti-v2012-2-en)
7. National Research Council of the National Academies. 2012. Rising to the Challenge. US Innovation Policy for the Global Economy. National Academies Press, Washington, USA. [For Canadian data see pp 302ff] [http://www.nap.edu/openbook.php?record\\_id=13386](http://www.nap.edu/openbook.php?record_id=13386)
8. Government of Canada, Budget 2014. See: <http://www.budget.gc.ca/2014/docs/plan/ch3-2-eng.html>
9. U15 Group of Canadian Research Universities. Media Release: U15 Group of Canadian Research Universities Applauds the Government of Canada for Investing in Research Excellence. <http://u15.ca/what-we-are-saying/u15-group-canadian-research-universities-applauds-government-canada-investing>
10. Royal Society. 2011. Knowledge, Networks, Nations. Global Scientific Collaboration in the 21st Century. <http://royalsociety.org/policy/projects/knowledge-networks-nations/report/>
11. Australian Industry Group. 2012. Lifting our Science, Technology, Engineering and Mathematics (STEM) Skills. [http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE\\_CONTENT/Publications/Reports/2013/Ai\\_Group\\_Skills\\_Survey\\_2012-STEM\\_FINAL\\_PRINTED.pdf](http://www.aigroup.com.au/portal/binary/com.epicentric.contentmanagement.servlet.ContentDeliveryServlet/LIVE_CONTENT/Publications/Reports/2013/Ai_Group_Skills_Survey_2012-STEM_FINAL_PRINTED.pdf)
12. Trends in International Mathematics and Science Study. 2012. TIMSS International results in Mathematics. [http://timss.bc.edu/timss2011/downloads/T11\\_IR\\_M\\_Chapter2.pdf](http://timss.bc.edu/timss2011/downloads/T11_IR_M_Chapter2.pdf)
13. Falk, M. 2006. What drives business Research and Development (R&D) intensity across Organisation for Economic Co-operation and Development (OECD) countries? Applied Economics, 38: 533-547. <http://www.tandfonline.com/doi/pdf/10.1080/00036840500391187>
14. Royal Society. 2009. Hidden Wealth: the Contribution of Science to Service Sector Innovation. <https://workspace.imperial.ac.uk/innovationstudies/public/Royal%20Society%20Hidden%20Wealth%20Report.pdf>
15. Science, Technology and Innovation Council. 2010. Imagination to Innovation: Building Canadian Paths to Prosperity. [http://www.stic-csti.ca/eic/site/stic-csti.nsf/vwapj/10-059\\_IC\\_SotN\\_Rapport\\_EN\\_WEB\\_INTERACTIVE.pdf/\\$FILE/10-059\\_IC\\_SotN\\_Rapport\\_EN\\_WEB\\_INTERACTIVE.pdf](http://www.stic-csti.ca/eic/site/stic-csti.nsf/vwapj/10-059_IC_SotN_Rapport_EN_WEB_INTERACTIVE.pdf/$FILE/10-059_IC_SotN_Rapport_EN_WEB_INTERACTIVE.pdf)
16. Council of Canadian Academies. 2013. Paradox Lost: Explaining Canada's research Strength and Innovation Weakness". [http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/synthesis/paradoxlost\\_en.pdf](http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/synthesis/paradoxlost_en.pdf)
17. Conference Board of Canada. 2012. How Canada Performs: PhD Graduates. <http://www.conferenceboard.ca/hcp/details/education/phd-graduates.aspx>
18. Cheung, C., Guillemette, Y. and Mobasher-Fard, S. "Tertiary Education: Developing Skills for Innovation and Long-Term Growth in Canada," OECD Economics Department Working Papers, No. 991 (Paris: OECD, 2012).
19. <http://www.fraunhofer.de/en.html>
20. Royal Society. 2013. Fuelling Prosperity: Research and innovation as drivers of UK growth and competitiveness. <http://royalsociety.org/policy/publications/2013/fuelling-prosperity/>