Securing Australia's Future - Project 9
Translating research for economic and social benefit: country comparisons

Canada

Review of Public Research Commercialization Instruments: A Study of Canadian Public Policy and Business Partnership Mechanisms Used for Commercialization of Public R&D

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Executive Summary

TFCI Canada Inc. has been engaged to support the ACOLA in undertaking a global analysis of measures and instruments that can be deployed to strengthen (using Canadian experience as a possible guide to what types of new or adapted measures may be suitable for Australia) the commercialization of public research.

While there are many definitions of public research and commercialization, we have relied upon a broad definition of commercialization; i.e. in addition to product and process innovations which achieve commercial success in the national and/or global marketplace, our definition also encompasses HQP, business consulting, infrastructure development, intellectual property mechanisms and supports for entrepreneurial activities by government. We applied this definition and identified 45 instruments or measures that public authorities have used or can deploy to support commercial development of public research. Typically, instruments or measures employed by public authorities are formulated and described in public parlance as *programs*; or where non-government contributors are involved, as *partnerships. Public programs usually comprise at least three elements:*

- an instrument of eligibility;
- a mechanism for transfer or delivery of benefits (e.g. a grant, loan, licence, etc.);
- a measure of performance or an objective;

For purposes of this study we are including all three of these as measures or instruments – and sometimes referring to programs as the sum of several instruments and measures at once.

ACOLA requested that we select and analyze at least 5 measures or instruments. ACOLA expressed a particular interest in those instruments which have had or could have long-term impacts capable of bridging several regimes of government authorities and funding. We therefore applied 6 criteria (see Section IV) to select the following six groups of measures or instruments:

1. SR&ED Tax Credits
2. Networks of Centres of Excellence, including Commercialization Centres and Business-Led Networks.
3. The "Endowed Foundations"
4. Research Granting Councils Strategic Partnerships
5. The National Research Council and its IRAP and Flagship Programs
6. National Priority Approach (an Integrated Strategic Alignment of Measures for IP Protection, Mentoring, Procurement, Foresight and Finance.

From this list we also identified several success stories as examples of the kinds of commercial success that Canadian public research can inspire.

The knowledge and insights required for this study were acquired over several decades of experience - where most of the 45 measures were applied for at least 5 years, or have been identified as strategically necessary but have yet to be fully developed.

More recently we have relied upon the excellent analysis carried out by the Jenkins panel,

the Canadian Council Academies (The Nicholson Panel) and the published experience of James Balsillie, former CO-CEO of RIM-Blackberry . To augment our perspective on various strategic and operational issues raised by Jenkins, Nicholson and Balsillie, we consulted with and interviewed several current and former stakeholders, a science journalist, and research bureaucrats. We have summarized our findings in the report including directly addressing the recommendations of the Jenkins panel (in the Conclusions Section VII) and describing what we believe will be required to ensure Canada's public R&D portfolio delivers maximum benefits from the billions of dollars[i] allocated to sponsoring Canadian public R&D.

From these analyses we concluded that Canada:

- Is improving its capabilities for commercializing public research by creating new instruments such as the CCIP, Futurpreneurs and the NRC flagship programs:
- Has been investing in the revitalization and renewal of existing instruments such as SR& ED, IRAP, and SADI:
- Needs to improve the collection of performance information from the public investments in R&D; present efforts are inconsistent and insufficient to really determine the relative effectiveness of different instruments. We believe that this situation can be rectified through Executive Action, however the extent of reporting will depend upon the need for and the viability of the data for strategic purposes. Some agencies may question the need for and the cost of acquiring the performance information. However, in a world where measurements determine priorities, the inclusion of performance information should be almost automatic.
- Should encourage a strategic conversation following the issues raised by James Balsillie concerning Canada's poor performance on international technology commercialization.

TFCI believes it is timely to initiate a national foresight effort directed towards identifying what Canada will require in terms of public research and national priority measures-approach to ensure that we are competitive looking to 2050.

The next three decades are projected to be pivotal for the future of western civilization as its confronts enormous challenges such as climate change, global poverty, and the transition to a digital economy and society where machines are intelligent, robots are pervasive and aging and human health are central to our continued existence. A low marginal cost production base and its consequences for the future of work and finance will also create big challenges for public research.

TFCI believes that the issues and instruments-measures explored in this study are equally applicable to Canada and Australia since they both share similar concerns about their ability to realize commercial benefits from their extensive public research portfolios. ACOLA is also interested in the longer term applications of instruments and measures. The Canadian experience seems relevant in this regard because of the endurance of many instruments as well as the sheer diversity of measures and instruments.

This reliance on both a strong set of enduring instruments (E.G. IRAP, SDTC, NCE, SR&ED, NSERC, NRC, etc.) and the diversity of additional more specialized delivery tools has enabled a strategic allocation of budgets to be applied by different administrations (2000-2015) according to their policy preferences and changes in the demand structure. Effectively the same type of measures and instruments were applied over the period 2000-2015 with sometimes minor incremental shifts in emphasis and eligibility.

1. Research Granting Councils Strategic Partnerships
2. The National Research Council and its IRAP and Flagship Programs
3. National Priority Approach (an Integrated Strategic Alignment of Measures for IP Protection, Mentoring, Procurement, Foresight and Finance.

We hope that this study has contributed to the strategic consideration of these issues.

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ACRONYMS

Acronym	Organization/Agency
ACOLA	Australian Council of Learned Academies
BDC	Business Development Bank of Canada
BLCE	Business Led Centres of Excellence
CATA	Canadian Advanced Technology Alliance
CCA	Canadian Council of Academies
CCIP	College and Community Innovation Program
CCRM	Centre for the Commercialization of Regenerative Medicine
CDRD	Centre for Drug Research and Development
CECR	Centres of Excellence for Commercialization and Research
CFI	Canadian Foundation for Innovation
CICP	Canadian Innovation Commercialization Program
CIHR	Canadian Institutes of Health Research
CIPI	Canadian Institute for Photonic Innovations
CRA	Canadian Revenue Agency
CRC	Communications Research Centre
CSA	Canadian Space Agency
DFAIT	Department of Foreign Affairs and International Trade
DFIN	Department of Finance
DND	Department of National Defence
DRDC	Defence Research and Development Canada
GOC	Government of Canada
HQP	Highly Qualified Personnel
IAC	Innovation Advisory Committee
IC	Industry Canada
ICT	Information and Communications Technologies
INMS	Institute for National Measurement Standards
IRAP	Industrial Research Assistance Program
IRC	Institute for Research in Construction
IRIC	Industrial Research and Innovation Council
ITA	Industry Technology Advisors
ITC	Investment Tax Credit
M&E	Machinery and Equipment
NCE	Networks of Centres of Excellence
NRC	National Research Council Canada
NRC-INMS	National Research Council Institute for National Measurement Standards
NSERC	Natural Sciences and Engineering Research Council of Canada
OECD	Organization for Economic Co-operation and Development

PHC	Policy Horizons Canada
PWGSC	Public Works and Government Services Canada
R&D	Research and Development
RIM	Research in Motion
SADI	Strategic Aerospace and Defense Initiative
SDTC	Sustainable Development Technology Canada
SMEs	Small and Medium-sized enterprises
SR&ED	Scientific Research and Experimental Development
SSHRC	Social Sciences and Humanities Research Council
TFCI	Technology Foresight Collaborative Insights (Canada Inc.)
TPC	Technology Partnerships Canada
VC	Venture Capital

Review of Public Research Commercialization Instruments:

A Study of Canadian Public Policy and Business Partnership Mechanisms Used for Commercialization of Public R&D

By TFCI CANADA INC.

Jack E. Smith and Jason Van Dieen

June 15, 2015

I. Background

In May 2015, the Australian Council of Learned Academies (ACOLA) launched a review of instruments and measures being used by public authorities and private partners to commercialize public research. This particular initiative is part of a larger international review to assist Australia to improve the application of outputs from its investment in publicly funded research.

This review provides an overview of Canada's recent experience related to the same issues and challenges. Canada like Australia has a long tradition of government and university supported R&D and has similar concerns regarding the paucity of returns on the public sector investments in R&D which approximately is valued at about $15 B annually[1]

The reasons for the relatively poor commercialization rates of Canadian public sector R&D include: (see ANNEXES B-D for more extensive discussion of this topic)

- Market size
- Lack of comprehensive program instruments
- Venture Capital Gap
- Weak Mentorship, Management
- Risk Aversion – Slow to seize opportunities
- Followership rather than leadership
- Poor coordination of labour with capital, resulting in weak multifactor productivity.

The specific goals of the project are:

1) To examine approaches to commercialization and support for collaboration to ascertain what works well and why;
2) To determine how Canada measures its research impacts in terms of translation and engagement.

[1]http://www.statcan.gc.ca/daily-quotidien/141017/dq141017c-eng.htm

3) To examine common barriers and the potential applicability of international models to the Australian context.

Specifically this report describes and analyses six distinct sets of measures or instruments, and includes a range of measures from financing, to training, formulating national strategy, strengthening performance reporting and renewing the legislative context.

Each measure will be described and analyzed in the Canadian context looking at strengths and weaknesses and where available cite data on their ROI over a five year period depending on their availability. Consistency of data sources is not regarded as critically important to the task; in other words, as long as the data provides an identifiable trend over a multi-year period between 2005-2014, the goals of the study will be realized.

It is logical that returns on investments are more difficult to obtain and measure than the input variables; attribution may be difficult while government and universities track their inputs fairly carefully, outputs occur over several years later are more difficult to identify and attribute. In fact, the federal government only instituted performance reporting by 2000 and initially The National Research Council was the only federal R&D organization responded with estimates and case studies with patents, technical services, technology transfer agreements, revenue sharing with employees from commercial returns. (More on this below)

II. Research Commercialization

Traditionally, R&D commercialization has been associated with the industrial linear process model in which there is a staged flow thru from early stage research ***("R" to "r"; then "d" to "D")*** through to prototype development - and eventually to the "wall" of commercial deployment which must be surmounted /managed by the private sector acting mostly on its own accord. This model seemed to work well until the 1980s when the major innovations of the industrial era began to be supplanted by the new capabilities derived power of software and digital media.

This new model – still emerging and not yet mature – is best characterized by how Microsoft, Apple, Samsung, Google and Facebook, achieve their power from connections, speed and timing, and reliance on low marginal costs once a prototype has been beta tested and "produced". It harnesses information and knowledge to enable ideas to become embodied in valuable capabilities – that can continually be upgraded and that offer agility to users- in contrast to highly engineered, resource- intensive manufactured products like vehicles, airplanes and armaments. It's not that we do not require these engineered products – it is that they increasingly depend upon the outputs of innovation in the digital economy – for their differentiated value proposition. (E.g. Networked intelligence, connectivity, and environmental feedback allow Google to develop driverless cars and adapt production cycles and operations in real time.)

Therefore it is logical that the process of commercialization should also be adapting to the new circumstances. In this report, we shall emphasize measures and commercialization

mechanisms that are aligned with this new model of commercialization. Specifically, in addition to the application of R&D for commercial products we believe- as do the advocates in the new research paradigm in our selected instruments- that the commercialization process also should include the following:

- Contributions by research to the training and deployment of HQP trained in digital media into industry and commercial firms;
- Research knowledge and applications regarding new and emerging technologies;
- Research derived information that helps firms secure new investments;
- Projects that provide technical solutions to obstacles or problems facing companies;
- Infrastructure developments that enhance productive capabilities;
- Research that increases the ability of innovators to prepare for, anticipate and manage change (i.e. foresight and strategy)

Accordingly, in our selection of instruments/measures and in the analysis of each of these we shall be looking for indicators relating to this broader model of research commercialization.

III. The Problem-Challenge for Public R&D

Canada is a country rich in natural resources, and as a result Canadians enjoy a high standard of living. In 2013, Canada's per capita GDP was over 5000 U.S. dollars clear of the OECD average (OECD, 2015). Furthermore, compared to their OECD peers, more Canadians have completed tertiary education, (OECD, 2015) and Canadian research is highly regarded in most fields. (Council of Canadian Academies, 2013)

Canadian R&D spending is heavily concentrated in the education sector with higher education expenditures making up 37% of Canada's R&D spending in 2009; which is considerably higher than the OECD average of 18 percent and the American average of 14 percent. (Ibid) This indicates not only that Canadian funders place a high significance on academic research but also that R&D performed by Canadian businesses is not a strong point. (Ibid)

To further illustrate this point, one can look at Canada's labour productivity statistics, which tell a troubling tale. For example, between the years 2001-2011, Canada's growth of labour productivity rate in the business sector averaged 0.8 percent per year, ranking Canada 15th out of 20 OECD countries (Council of Canadian Academies, 2009). Perhaps even more troubling is Canada's productivity rate in comparison to the United States; peaking at more than 90 percent in the mid 80's it has since dropped to 71 percent as of 2011. (Council of Canadian Academies, 2009).This example complements previous empirical research that suggests business R&D as opposed to Higher Education R&D has the greatest impact on productivity growth (Council of Canadian Academies, 2009).

While the previous paragraph looked at relatively recent figures, it should be noted that Canada's business innovation problem has been a longstanding concern of Canadian governments. As Senator Lamontagne noted (1970): *"Since 1916 … the main objective of Canadian science policy has been to promote technological innovation by industry. Almost every*

decade since the 1920s has witnessed renewed attempts by successive governments to achieve it, but on the whole they have all failed."

So where then, have the past and current Canadian governments gone wrong? Unfortunately, this is not a question that is easily answered, however, past researchers have attempted just that, have reached a variety of conclusions, and in turn provided a plethora of suggestions as to how Canada can improve its innovation track record.

First and foremost evaluative measures need considerable improvement. For the most part, Canada does an ample job of tracking their input into R&D, however their evaluative measures of R&D output leaves much to be desired. With that being said, tracking output is considerably more difficult and contentious than tracking input. Measures for tracking output need to be continually refined and improved in order to improve the reliability and validity of measuring R&D output (Industry Canada, 2011). For example, one of the programs we focus on for this report is the SR&ED tax credit. In 2007, the Department of Finance conducted a thorough cost/benefit analysis of the tax credit and ultimately concluded that the benefit of the program exceeded its overall costs. (Parsons and Phillips, 2007).

However, the Independent Panel on Federal Support to Research and Development that conducted what is widely known as the Jenkins report (2011) noted that the extra R&D performed per dollar of tax credit provided and of the social rate of return on business R&D expenditure is particularly prone to measurement error.

These measurement problems, coupled with the fact that this methodology is difficult to apply to other innovation programs, led the panel to conclude that the calculation of net public benefit is not precise enough at this time to permit a benefit cost/ranking of the government's R&D programs. This however, is not a problem exclusive to Canada as Canada's peer countries of the OECD are also having difficulty measuring their innovation programs and subsequent outputs.

As Canada has an innovation problem, it is not surprising to discover that Canada's commercialization record is also failing in reaching its potential. However, from an optimistic viewpoint what is encouraging about this dilemma is that Canada's lack of commercialization success is not stemming from a shortage of ideas but rather the ability to translate IP into homegrown success. Canada produces an abundance of IP and rather than reap the benefits of these ideas too many of these ideas wind up making others wealthy (Industry Canada, 2011). The Jenkins Report (2011) recommends that the GOC further investigates this issue. Ironically a quote from an individual involved in one of Canada's greatest business success stories provides a real world example of Canada's trouble transitioning from the idea stage to the commercialization stage. Dan Morrison, Chief Operating Officer at Research in Motion (RIM), believes "We became collectively ineffective at moving from the idea stage to the conversion of an idea into a commercial success for anything other than devices." (CB Staff, 2015)

IV. Selecting the Measures / Instruments

Table 1 provides an overview of the over 40 instruments and measures used to examine the strategic issues raised by the study. Canada's transition to a knowledge based economy has been slow and uneven, and despite some key successes the Canadian R&D system has not performed at a high level of commercial success. Until recently, a significant focus of Canadian public sector R&D was associated with domains that traditionally harvest natural resources, or study public ways to deliver public services such as education, health and welfare. A strategic question for this study is:

How does Canada intend to position its public research portfolio to realize the commercial potential that is emerging from the digital economy and its new research paradigm?

Public R&D in Canada - at least since 1916 when the NRC was created to support and develop Canadian industrial R&D capacity - has been the primary way that government has been involved in working with universities, industry, non- governmental organizations and the voluntary sector to effect innovation in Canadian society. Over the intervening years – soon to be a century – Canada has consistently been a leader in the development of new and innovative mechanisms to provide the support, financial and otherwise, necessary to enable the economy to adapt to changing circumstances as well as the public sector to maintain its capacity to provide efficient and cost-effective services and infrastructure.

- For this project, **some 45 distinct measures or instruments** have been identified, encompassing several broadly defined categories as follows: ***Financial*** - Instruments whose main characteristic is the direct provision of funds to a research performing individual, company, NGO, educational institution etc. The Government of Canada (GOC) relies upon grants and contributions as its main instrument of financial assistance to R&D performers. NSERC, NCEs, SSHRC, CIHR, CFI, SDTC, AND IRAP are supported mainly by grants. The GOC also provides loans to firms - sometimes forgivable in whole or in part – to offset risks associated with new technology development and for support in undertaking global competition. Loans are normally provided through industry partnership programs such as the Strategic Aerospace Development Initiative (SADI), or via the Business Development Bank of Canada. Since roughly 2000 the GOC has been supporting several "endowed foundations" (e. g. CFI, Genome Canada, SDTC, CCA and CANARIE). These were created when the Government anticipated an annual surplus and were perceived as creating agility through sector targeting and offering long term stability through the National Government's founding endowment. They have all continued to receive additional funding from subsequent administrations, even when there were no surpluses in government finances.

Other financial instruments include a support for industry associations e.g. CATA, Aerospace and International Collaboration Agreements to foster mutual R&D projects with India and to enable Canadian participation in European Commission Framework Programs. Finally the $1 B NCE Program applies grants and financial transfers in order to attract matching partnership funds from Provinces, universities and firms.

Access to venture capital continues to be a challenge for Canadian SMEs. According to James Balsillie (see Annex B): *Raising capital for technology in Canada is difficult because so many investors are losing money. Venture capital in Canada is one of the worst-performing asset classes. A 2013 study by Thomson Reuters and the Canadian Venture Capital Association reported a staggering divergence in 10-year pooled average returns between U.S. and Canadian VCs. The American VCs' return was 13.5 per cent, while the Canadian VCs' lost 3.4 per cent. A 2014 Cambridge Associates study of early-stage VCs was even more troubling, with U.S. VCs reporting a return of 20.5 per cent and Canadian VCs reporting a loss of 5.6 per cent.*

- ***Tax System*** – measures or instruments that utilize tax credits, refunds, and other incentives such as capital/equipment depreciation rules or reciprocal trade rules to accelerate innovation. The key tax system is the SR&ED Tax Credits aimed at encouraging Canadian business investment in R&D. Costing about $3.5 B a year it represents the largest single expenditure item in our measures list. The tax system also has other means to encourage or discourage various factors related to innovation; i.e. capital equipment depreciation rates, corporate tax rates and the VAT/HST/GST. Although the tax rates are often cited by Governments as being critical for innovation we have little or no evidence of the marginal impact of changes (e.g. corporate tax rate reduction from15% to 11%) to these rates within recent experience. Finally many observers believe that special incentives to encourage angle investors could have very positive impact on innovation investment in Canada, however this has not been recognize as a priority for the tax system.

- ***Procurement*** – public purchase of innovative goods and services, both as confidence measures and also a type of financial-risk reduction support for new and innovative solutions to public challenges. In Canada, despite regular appeals to mobilize public procurement to advance national innovation priorities, the procurement system remains as having only a modest impact on public R&D commercialization. The Jenkins panel identified (Section 7.2-7.5) this challenge as a Procurement Gap. Accordingly they recommended the Canadian Government should:

  "Make business innovation one of the core objectives of procurement, with the supporting initiatives to achieve this objective."

  The Vision of the Panel: The government's procurement and related programming must be used to create opportunity and demand for leading-edge goods, services and technologies from Canadian suppliers, thereby fostering the development of innovative and globally competitive Canadian companies while also stimulating innovation and greater productivity in the delivery of public sector goods and services.

  To begin to realize this vision the GOC has developed a Canadian Innovation Commercialization Program. (CICP)

  The CCIP is designed to help Canadian firms to bridge the pre-commercialization gap by procuring and testing innovations. The program covers the cost of the innovation, delivery, installation and maintenance services, as well as any other direct costs required to test the innovative product. The program's process is fully competitive and consistent with trade agreements.

- ***Mentoring & Nurturing Talent*** - investments in people; skills, technology transfer through educational development, personnel exchanges, internships and specialized initiatives directed toward women, aboriginals, entrepreneurs, youth etc. These investments represent a major portion of the government's commitment to commercialization as indicated in part 2 the research commercialization model has evolved towards capabilities as much as products and services. This means the skills, internships and mentoring of students and innovation system personnel has to be a critical focus of the public research system. Virtually all of the instruments identified in our study provide resources that contributed to commercial potential via the enhancement of technical and related skills. The training and mentorship of managers and financial personnel who are part of the innovation eco system remains a challenge for Canada. Also, training and mentorship of specialized groups e.g. (women, aboriginal, entrepreneurs requires more resources.

  As indicated in Table 1 below, the nurturing of talent is one of the groups of measures which have one of the better performance tracking of benefits.

- ***Infrastructure-*** Public systems that support research commercialization through technical and laboratory capabilities, and digital connections for standards, codes and technical analyses; in the emerging digital economy, a greater proportion of total value will be vested in the infrastructure. Consequently the government research investment in codes and standards development, leading edge national measurement and testing facilities and in fast, high-band with digital networks and mobile communication infrastructure will be critical for innovators and commercialization performance. Canada is currently well positioned in regards to these capabilities but must remain actively competitive and committed to ensure the continued efficacy of Canada's public infrastructure for Canadian innovation. A persistent question in regard to the digital infrastructure is whether or not a national broadband utility may need to be created to serve the strategic objective of affordable seamless digital access for all Canadians.

- ***Intellectual Property*** - public measures that reinforce, extend and enable the public-private patent system and its management regime to function effectively and to protect national interests associated with the outputs of public R&D; Canada has many elements necessary for a coherent IP system but when it comes to global competition for ideas and patent strategies, a different game is being played. This suggests that for IP measures a strategy which combines both the national and global scenes (battlegrounds) will be necessary.

James Balsillie former Executive with RIM and currently a patron of the International Institute of Governance in Waterloo, Ontario, recently made the case for Canada becoming more aware of the dynamics of global IP competition in an influential article published May 8, 2015 in The Toronto Globe and Mail's Report on Business: (attached as Annex B in its entirety)

At a patent conference with some of the world's foremost innovation experts and practitioners, the lead strategist from one of the world's most valuable technology companies announced: We don't sue Canadian companies until they start to matter to us. The money is not worth it when they're small and we don't want to look like a bully. We wait until they get big enough, then we go after them. And we kill them.

Universities have a large stake in the U.S. patent system, so they actively participate in advancing their interests along with (or sometimes in competition with) the private sector. American universities shrewdly lobbied to attain an exceptionally valuable carve-out from the America Invents Act, immunizing university patents from a "prior user" rights defence in infringement suits. This advantage translates into hundreds of millions of dollars in new university revenues. We need a Canadian complement to this innovation lobby, centred on Canadian-domiciled companies selling Canadian ideas globally, to obtain the full commitment of federal politicians and policy-makers to act in ways that support their profitable growth. And we need Canadian universities to actively participate in advancing their own prosperity

Our entrepreneurs graduating from law, business, computer science, or engineering programs need to receive the proper education for commercializing on the global stage. Too many Canadian startups and small or medium enterprises lack IP strategies. Even businesses that do patent rarely have viable strategies for using or enforcing their intellectual property rights. In Silicon Valley, patent-protection strategies are present at all phases of R&D, from the outset.

- ***Marketing and Demonstration*** – not strictly speaking R&D but rather D&R (demonstration and replication) – reflecting the views of many innovators about the importance of marketing for realizing innovation and the need for showcase demonstrations of technologies that have been already technically proven but whose acceptance and appeal become critical for the innovation to be successfully commercialized;

In the digital/innovation economy it has become more important than ever to be able to prove a technology application prior to it being widely adopted. Today innovative technologies need both prototype/technical demonstration and market readiness/acceptance showcase demonstrations.

Canada has lacked a coherent approach to technology demonstration-largely because the public research enterprise does not normally include those functions (demonstration) which are thought to be associated primarily with commercial risk.

This exclusion is not practiced by all of Canada's competitors and consequently it should be revisited in the context of research and technology commercialization as part of a new revitalized national strategy.

- ***Program Design*** – measures built in by design to prompt or facilitate specific program impacts or outcomes while still applying general measures such as grants, mentoring or loans; e.g. including the application of digital tracking and big data predictive analytics to improve innovation prospects; looking ahead to 2025 and beyond these relatively new tools

(i.e. digital age measures) are likely going to change how most innovators approach how innovation occurs and which factors are most determinant. As the elaboration of the key measures below in section 5 indicates, more attention is now being paid to program design, in both the application of new Granting Council research awards, designation and funding of (Commercialization and Business-led) NCEs and in the launching of new initiatives most notably the CICP, Futurepreneurs and the Flagship Programs of the NRC.

- ***National Priority*** – measures and instruments employed by leading national governments for strategic competition and trade purposes; possibly including legislative means such as the Bayh-Dole Act as an instrument for protection of national priority public research in the USA. Canadian measures to protect innovative ideas and to advance commercialization of public research have not achieved legislative prominence although many innovators have suggested that such measures will be required if Canada is to remain competitive in the Global economy. To do so will require a concerted effort by all stakeholders to develop a coordinated integrated innovation eco-system. The training and mentorship of managers and financial personnel who are part of the innovation eco system also remains a challenge for Canada and training and mentorship of specialized groups e.g. (women, aboriginal, entrepreneurs) requires more resources

Table 1 below presents a summary of the 45 measures- instruments employed by governments in Canada to support the broad definition of commercialization of public research.

Table 1. Measures / Instruments for Public Research Commercialization

Measure or Instrument	#	*Organization-Program*	*Approximate Cost*	*Estimated Benefits & Impacts*	*Sources - Comments*
Financial \Transfers					
Grants (Costing about $ 3 B /A)	1.	IRAP, NSERC, SSHRC, CIHR, SADI, NCEs	IRAP- $240 M/A NSERC $ 1.1B/A SSHRC $ 330 M/A CIHR- $718.2 M/A NCEs - $ 150 M/A SADI-200 M/A	IRAP-helps 10 K firms /year NSERC- 11 K professors, 30 K trainees and students supported by over $ 400 M in annual grants SSHRC – 5 K research awards; 9 K projects, 120 strategic partners; CIHR- provides leadership and support to about 14 K/A health researchers, trainees; SADI – 34 projects; range $275 K - $ 300 M	1.) www.actionplan.gc.ca/en; 2.) http://www.nserc-crsng.gc.ca/ 3.) http://www.cihr-irsc.gc.ca/e/documents/cihr_annual_report_2013-14_e.pdf 4.) http://www.budget.gc.ca/2013/doc/plan/chap3-2-eng.html;
Loans (See web site for details)	2.	BDC, TPC – IC being replaced by SADI	BDC-$ 22 Billion in loans financing in 2014. TPC - $ 3.37 B total	BDC- Serving 30,000 entrepreneurs; BDC – $ 434.6 M net income; $ 54.6 M profit paid to GOC; rest into the BDC finance pool TPC – dispersed $ 3.16 B; repaid 1.9	http://www.bdc.ca/EN/Documents/annualreport; BDC_AnnualReport_2014.pdf#
Access to Capital	3.	BDC, IRAP	N/A no data available	N/A no data available	
Interest Subsidies	4.	BDC?	N/A no data available	N/A no data available	
Institutional - Industry Associations	5.	e.g. CATA,	N/A no data available	N/A no data available	www.cata.ca
Endowed Foundations	6.	CFI, GENOME Can, CCA, SDTC, CANARIE	CFI - $; CCA $30 M SDTC- $ 915 M GENOME- $ 915 M as of March 31, 2010 CANARIE $ 21 M/A	STDC-1.1 B revenues , 8200 jobs; CANARIE net broadband access 2K institutions and 1 M users; CCA 33 reports & expert panels;	www.sdtc.ca/en/about-sdtc/funds; www.genomecanada.ca/en/portfolio/; www.innovation.ca; www.scienceadvice.ca;
NCE's	7.	Granting Councils ; NCE Secrt	Active NCEs- $ 664.9 million	Partner contributions $ 449.8 M 1774 partners. Data not available on partner contributions and amount of partners for four NCES, so the estimated benefits is likely higher;	http://www.nce-rce.gc.ca/NetworksCentres-CentresReseaux/Index_eng.asp. .
International Collaboration	8.	e. g. India; European Commission	DFAIT; IC; NRC	EC Framework Programs access	see
Tax System					
SR&ED Tax Credits	9.	CRA	$ 3.5 B/A	Net economic benefit of 11 cents per dollar of tax expenditure.	(Parsons & Philips, 2007) Estimated benefit is highly contentious.
Capitl Equipment Depreciation	10.	CRA, Dept of Finance	Data not available		
Angel Investors	11.	e.g. RIM, Shopify,	Data not available		
Corporate Tax Rate	12.	CRA, Dept of Finance	Data not available	Range from 26/.9 % (in 2012) to 11 % for SMEs	http://www.kpmg.com/ca/en/pages/default.aspx

VAT :HST /GST	13.	CRA	Data not available	GST Rate lowered by 2 % in 2010	
Procurement					
Defense	14.	DND, Industry Can	DND- 2008-09 to 2027- $ 28- 40 Billion dollars.	Increased investment in rebuilding and maintenance of infrastructure of approximately $100M/year	www.forces.gc.ca/en/about/canada-first-defence-strategy.page;
Big Science, Space	15.	CFI, NSERC, NRC, CSA, IC-SADI	e.g. Global Telescopes; NRC $3.2 M to CFHT TRIUMF; NASA projects	Data not available	www.cfht.hawaii.edu;
Health & Medical Facilities	16.	CIHR, CFI, Health Canada	Data not available	Data not available	
Capital Infrastructure	17.	Infrastructure Can ; Economic Action Plan	Econ Action Plan- $ 33 B since 2007 Infrastructure Canada. New Building Canada Plan $ 53 B	Econ Action Plan- 43 000 infrastructure projects across Canada.	http://actionplan.gc.ca/
Goods & Services, Commercialization Vouchers	18.	PWGSC, IC,	CICP- Starting in 2013-$ 14, 95 million over 3 years. 40 million after annually	CICP- As of March 11, 2013, 61 innovators had signed contracts to test their products and services with government departments, for a total of $21,089,991	http://actionplan.gc.ca/en/initiative/canadian-innovation-commercialization-program;
Prototype Demonstration	19.	CANARIE	GOC-105 million 2015-2020	1 million – number of Canadians with access to the CANARIE network. 400+ – Current number of Canadian entrepreneurs and businesses using CANARIE's DAIR cloud service	www.canarie.ca
Infrastructure					
Codes and Standards	20.	IC-CRC-Spectrum NRC- IRC INMS,			
R&D Facilities, Laboratories	21.	CFI, NRC, NSERC, CIHR, SSHRC, CSA, DRDC	CFI- $5,360,405,423 Billion	CFI- 8997 projects	http://www.innovation.ca/en/OurInvestments/ProjectsFunded/SummaryProjectsFunded
Mobile Spectrum Wireless	22.	CRC, CANARIE		Spectrum Auction remits over $ 700 M to GOC	www.crc.gc.ca;
Testing and Certification	23.	IRC, INMS, CRC,	Between 2005-06 and 2011-12, NRC-IRC undertook nearly $45 million of research related work.	For 283 unique clients as part of 453 projects	http://www.nrc-cnrc.gc.ca/eng/about/planning_reporting/evaluation/2013_2014/ecp.html Current data not available
Mentoring – Nurturing Talent					
Tech Transfer	24.		Data not available	Tech transfer happens when people with new knowledge and skills become mobile	
Entrepreneurs	25.	Futurpreneur Canada.	Base funding 10 million+ IC	6,740 entrepreneurs across Canada. 5,475 enterprises supported; More than 26 K new	http://www.futurpreneur.ca/wp-content/uploads/2014/10/Futurpreneur; Annual review 2013-14

		IC BDC		jobs created* An estimated $191 M in tax revenue.	_V.7_INTERACTIVE.pdf
Women	26.	Futurpreneur Canada, IC, BDC	10 million + IC BDC	Approximately 2700 female entrepreneurs	http://www.futurpreneur.ca/wp-content/uploads/2014/10/Futurpreneur_Annual_review_2013-14_V.7_INTERACTIVE.pdf
Aboriginals	27.	SSHRC	SSHRC-120 million between 2007-12	1200 research projects, 1028, researchers, 700 graduate students.	http://www.sshrc-crsh.gc.ca/news_room-salle_de_presse/fact_sheets-fiches_information/PDF/Aboriginal_fact_sheet_e.pdf
Intellectual Property					
Legal	28.		Data not available	Little consistency across the public research enterprise	
IP Rules	29.		Data not available		
IP Management Cost	30.	NRC	Proprietary		
Program Design					
Target and Eligibility	31.				
Industry Partnerships - Leverage	32.	NSERC, NCE, IRAP			
Spinoff Incentives	33.	NRC	Only the NRC has direct incentives in the form of human resources policies and financial supports for employees who want to spin out new firms from the NRC's R&D activity base		
Foresight & Strategy	34.	PHC, CRC, NRC	2-25 PY per agency; <$ 150 K operations per year	• The Future of Asia • MetaScan 3: Emerging Technologies • MetaScan2: Building Resilience in the Transition to a Digital Economy and a Networked Society • The Next Economy • Driving Policy on a Shifting Terrain • MetaScan 2011: Exploring four global forces shaping our future • Well-Being • Environment and Competitiveness • Social Media www.horizons.gc.ca/eng	
Start Ups	35.	Startup Canada	No Data Available except private sector- 25 million dollars mobilized	2014- 85000 engaged 421 partners 20 communities	www.startupcan.ca
Big Data - Predictive Analytics	36.	NRC	a potential initiative under Emerging Technologies		www.nrc-cnrc.gc.ca
Marketing & Demonstration					
Market Studies	37.	No Data Available			
Showcase Demonstration	38.	NRC CRC,			
National Priority					
Patient plus Venture Capital	39.	National Priority – measures and instruments employed by leading national governments for strategic competition and trade purposes; possibly including legislative means such as the Bayh-Dole Act as an instrument for protection of national priority public research in the USA. Canadian measures to protect innovative ideas and to advance commercialization of public research have not achieved legislative prominence although many innovators have suggested that such measures will be required if Canada is to remain competitive in the Global economy. To do so will require a concerted effort by all			
Size of Selective Firms	40.				
National Strategy	41.				
Integrated Non Dogmatic Roles	42.				
Balanced r/ R & d /D Funding	43.				

Innovation Ecosystem Health Cdn Bayh – Dole Act ?	44. 45.	stakeholders to develop a coordinated integrated innovation eco-system. The National Priority measure could be developed by an expert stakeholder group and should include not only the major instruments for innovation but also the newer /smaller measures (e.g. CICP, Futurpreneurs, Flagship) more tailored to the needs and opportunities of global IP competition.

IV.1 Highlighted Measures / Instruments Selection Process

ACOLA aims to evaluate at least five significant instruments or measures that are being utilized by each of the subject countries included in the study. To select the five plus instruments from the larger list of 45 listed above in Table 1 it was necessary to formulate some criteria to guide this selection. Based on our own experience as well as the recent analysis in the Jenkins report and the Nicholson report we have identified 6 criteria to comparatively analyze the candidate measures or instruments: These are:

- **Substantive – in terms of $, # Clients:** This criterion addresses those instruments which account for the largest shares of the budget for public R&D in their respective categories; the SR&ED is the single largest expenditure accounting for over 3 billion dollars annually. Others such as IRAP, the NCEs and the NSERC industrial partnerships program are also substantive.
- **Adaptive to Changes in S&T-Markets:** This criterion refers to the agility of an instrument and its ability to adapt to an environment characterized by constant change. E.g. the NCEs were created for this purpose and to offer a more agile alternative to the "bricks and mortar syndrome" characteristics of traditional R&D Institutes.
- **Collaboration Opportunities with Industry:** Increasingly it is becoming evident that innovation requires sustained collaboration across the innovation ecosystem. Government rarely leads innovation. The system is becoming more complex but still values collaborative agility as the digital economy has made new connections, transparencies possible and rendered impacts more visible. Industry demands more agile instruments in order to be collaborative.
- **Cost-Effectiveness Track Record; Applied "D" or Commercialization:** Over time the different instruments have demonstrated differential rates of commercial application i.e. "Big D" because a primary goal of this report is to identify cost-effective measures or instruments it is important to be able to refer to either documented or anecdotal track record success stories.
- **Responsive to Changing Policy Context:** As a key partner in private sector innovation public authorities that sponsor R&D also must take into account the changing policy context associated with changes in governments. Because governments are also very bottom lined and fiscally disciplined the measures selected are expected to have at least average and usually better than average cost effectiveness ratios.

- **Innovativeness – for Global Competition:** Finally, the measures should also include a proxy for their international uniqueness. Several of Canada's newer measures are relevant for this study and possibly to ACOLA precisely because they represent innovative assemblies and applications that are being tried and tested for their effectiveness in improving research productivity and commercialization.

TFCI believes that this group of six evaluative criteria has enabled the selection of a well-defined set of measures – with the exception of # 6 National Priority which is really a new integrated strategic type of measure - having proven themselves through application covering a variety of time periods, policy regimes and technology eras.

V. Key Measures / Instruments

V.1 SR&ED Tax Credit

In 1986, the term Scientific Research and Experimental Development (SR & ED) was first added to Canada's *Income Tax Regulations Act.* Administered by the Canadian Revenue Agency (CRA) (Formerly Revenue Canada), SR&ED was developed as means to encourage Canadian businesses to perform R&D. On an annual basis, the program is responsible for providing over 3 billion dollars in tax credits to over 20 000 claimants.[2] While the term SR & ED officially originated in 1986, prior to that, as early as 1944, the Government of Canada had provided businesses with some tax incentives in order to encourage R&D spending. Therefore, even though the term SR & ED did not surface until 1986, its foundation was formed decades earlier and has been evolving ever since. Amendments to the act have occurred for a variety of reasons, and include:

- Improving Accessibility, Consistency, Predictability, and Straightforwardness across Canada.
- Eliminating abuses
- Preventing unintended benefits
- Simplifying the verification process

Currently, the SR & ED works by providing tax incentives for three types of research: basic, applied and experimental. These tax incentives are provided to businesses in 3 ways: 1) an income tax deduction. 2) an investment tax credit (ITC) 3) or in certain instances a refund.

The SR&ED tax credit is Canada's most well-known program for supporting R&D and as result is the most scrutinized (Industry Canada, 2011). It has received considerable

[2] Figures and facts from this section were taken from http://www.cra-arc.gc.ca/txcrdt/sred-rsde/menu-eng.html unless otherwise sourced.

commentary both positive and negative. On the one hand businesses have praised the SR & ED for: its encouragement of new investment in R&D, how it offsets the high cost of exploratory work, its ability to facilitate access to credit and cash flow, and finally how it leaves businesses with the freedom to choose their specific R&D activity (Ibid). On the other hand, the SR&ED tax credit has been criticized for being inconvenient, complex and time consuming (Ibid). Due to the uncertainties surrounding these issues, businesses often exclude the SR&ED program from their R&D decisions (Ibid). Furthermore, some industry associations have criticized it for defining R&D too narrowly as it does not include some important aspects of product development and commercialization (Council of Canadian Academies, 2009).

As noted previously, (Problem challenge for public R&D section) measuring the net benefit of the SR&ED tax credit program has been a highly contentious endeavor. Parson and Phillips, (2007) estimated that the SR&ED has a net economic benefit of 11 cents per dollar of tax expenditure. It is important to note that like any tax credit the SR&ED has an opportunity cost, (which Parson and Phillips accounted for in conducting their assessment) in this instance it's mostly the foregone tax revenue that could have been used to lower taxes or increase government spending (Ibid). While this provides some perspective on the effectiveness of the SR&ED tax credit it should be taken with a grain of salt as others have noted the methods for obtaining this data are prone to measurement error (Industry Canada, 2011).

V. 2 Networks of Centres of Excellence

In 1989, the Natural Sciences and Engineering Research Council, the Social Sciences and Humanities Research Council, the Canadian Institutes of Health Research, Industry Canada and Health Canada collaborated creating a joint initiative known as Networks of Centres of Excellence of Canada (NCE). Ultimately, the NCE program seeks to bring together experts across multiple disciplines in order to solve major economic, social and health issues that are of critical importance to Canadians. Approximately 90 million dollars annually is contributed to the program from government, industry and not for profit organizations who also provide expertise in addition to financial support. The program has received international acclaim, and as a result, other countries such as South Africa, Australia and some within the European Union have adopted features of the NCE model into their programs. Since the NCE's inception, it has helped train more than 45 000 personnel, as well as aided in the creation of 143 spin off companies and 910 start-up companies. Approximately two billion dollars has been invested in commercialization, research and knowledge translation by the NCE from the time of its creation. As a result of those investments, the NCE has received approximately 1.5 billion in contributions from industry and other partners. In 2013-14, more than 3700 partners in Canada and abroad participated in the program; including 1496 from industry.

The day to day operations of the NCE are provided by a secretariat. Periodic national competitive processes are run by the secretariat where successful applicants are chosen on the advice provided by a number of panels and boards. In order to receive funding, proposed centres

and networks must demonstrate to these panels and boards that they are able to meet the highest standards of excellence.

This is a highly competitive process that follows a multi-stage procedure which includes top experts conducting a comprehensive review. To ensure the process is as impartial as possible, the program uses a peer-review system, which is an assessment of the proposals by non-partisan experts in their respected fields. Of the numerous centres to qualify for the program there are countless success stories examples of which include:

- **The Stem Cell Network:** This network's research has led to 399 patent applications, 60 issued patents, 43 licenses granted, and the formation of 11 start-up biotechnology companies and the creation of a new Centre for the Commercialization of Regenerative Medicine (CCRM).
- **Graphics, Animation and New Media Canada – (GRAND)** has helped expose over 300 SMEs to technologies being developed in labs all across Canada, which includes more than 120 research demonstrations and the commercialization of 11 new technologies.
- **Canadian Institute for Photonic Innovations – CIPI / Canadian Photonic Industry Consortium - CPIC (1999-2013):** CIPI's research has led to 15 start-ups of which 8 are still active. Funded over 500 projects, and provided 2300 person years of training.

However, as one of our interviewees noted these NCEs are not solely focused on commercialization but rather collaboration. He stated that "the real value is in the collaboration and the money these companies invest. These partnerships encourage the free flow of ideas between businesses and academe and researchers gain insights they wouldn't have known otherwise. They are able to learn things that do not necessarily relate to their projects but are important for other things." When viewed from a traditional commercialization lens, the amount of research that is transitioning in the form of market ready products from these NCE's may not be perceived as substantial. However, if you apply a broader conceptualisation of commercialization, (which we advocate) and take into account the NCE's primary goal of increasing collaboration and partnerships then the results are increasingly significant. For example, in 2013-14 NCEs connected Canadian research talent with 179 foreign universities and 192 other foreign organizations.

While these NCE's may not solely be focused on commercialization in the traditional sense, another branch of networks are just that. Centres of Excellence for Commercialization and Research (CECR) are not for profit corporations, created by a university, college, not-for-profit research organization, firm or other interested non-government party that aligns the business community with clusters of research expertise.

The main goal of these centres is to share knowledge, expertise and resources so that new technologies can be brought to market faster. These centres are able to stimulate

commercialization activity that may never have taken place without their establishment. Among the commercialization highlights of these centres are:

- **Centre for Drug Research and Development (CDRD)** - Has evaluated 825 technologies thus far for their commercial potential. Of which, 125 were selected for incubation within the CDRD, of those 47 have successfully advanced toward commercialization.
- **Wavefront** – 75 new companies have been created. An independent, third party analysis concluded that Wavefront has generated $4.80 per every dollar invested in it, and produced almost 37 million dollars in GDP across the Canadian economy.

- **Canadian Digital Media Network (CDMN) –** Has helped 104 Canadian companies, land in 19 countries to increase business opportunities internationally. As a result, these companies now have a presence in markets such as the U.S., Brazil, Australia, United Arab Emirates, Germany, Costa Rica, the U.K. and China.

In addition to NCEs, and CECRs we have also chosen to examine Business-Led Networks of Centres of Excellence (BL-NCEs). BL-NCEs are large-scale collaborative networks headed by not-for-profit industry syndicates that seek to increase private sector investments in Canadian research, and to accelerate the process of translating research into commercial products and services. These networks handle real world challenges facing Canadian industry. Some of the commercialization highlights that can be attributed to the work of BL-NCEs include:

- **CQDM-** The launch of five start-up companies can be attributed to CQDM-supported research this includes NDEI Inc., a company that has been commercializing biomarkers for diagnosing schizophrenia and bipolar disorder, which will lead to better care of Schizophrenic patients and the development of more effective drugs.
- **Green Aviation Research and Development Network – (GARDN)** has been involved in the development of advanced algorithms that enable airlines to reduce fuel burn and CO2 generation in the cruise and descent phases of flight.
- The software has been implemented on the CMA-9000 flight management system, which is being installed on 300 Sukhui Superjet 100 Russian regional airliners, and an additional Airbus A300 and A310 airliners.

Table 2 lists each of the NCEs, CECRs, and BL-NCEs along with the duration of the network, the GOC's contribution in millions of dollars, the partners' contribution in millions of dollars and the number of partners involved in the network. N/A represents not available and is used when the Data cannot be found. As Table 2 shows there are 42 networks, which comprise

over 1.1 billion dollars in GOC contributions, over 1 billion dollars in partner contributions and have attracted over 3000 partners.[3]

Table 2 Overview of the NCES				
Name of NCE	***Duration***	***GOC $ M Contribution***	***$M Partners Contributions***	***Number of Partners***
1. Aging Gracefully across Environments Technology to Support Wellness, Engagement & Long Life	2014-2019	36.6	N/A	N/A
2. Allergy, Genes and Environment Network – Allergen	2014-2019	74.4	84.1	139
3. ArcticNet	2003-2018	113.2	169.3	310
4. AUTO21	2001-2017	81.1	59.1	208
5. BioFuelNEt	2012-2017	25	6.5	167
6. Biotherapeutics for Cancer Treatment	2014-2019	25	N/A	N/A
7. Canadian Arrhythmia Network	2014-2019	26.3	N/A	N/A
8. Canadian Glycomics Network	2014-2019	27.3	N/A	N/A
9. Canadian Water Network	2001-2017	61.5	41.5	222
10. Graphics, Animation and New Media Canada	2009-2015	23.2	11.2	99
11. Marine Environmental, Observation, Prediction and Response Network –	2012-2017	25	1.9	65
12. NeuroDevNet	2009-2019	39.1	6.5	157
13. Stem Cell Network	2001-2017	83.3	69.1	261
14. Technology Evaluation in the Elderly Network – TVN	2012-2017	23.9	0.625	146
		Average = $ 47.5 M Total: $ 664.9 M	**AVG= $ 98.2 Total= $ 449.8**	**AVG= $ 177.4 Total= $ 1774**

Table 2b) Centres of Excellence for Commercialization and Research				
1. Accel-Rx Health Sciences Accelerator	2014-2019	14.5	N/A	N/A
2. Advanced Applied Physics Solutions Inc.	2008-2017	15	6	16

[3] The facts and figures from this section are taken from http://www.nce-rce.gc.ca/ along with some of the individuals NCE's sites; which are all linked through this site.

3. Bioindustrial Innovation Canada	2008-2015	15	194	18
4. Canadian Digital Media Network	2009-2019	19.5	45.8	456
5. Centre for Commercialization of Regenerative Medicine	2011-2016	15	6.2	31
6. Centre for Drug Research and Development	2008-2018	23	56.7	25
7. Centre for Imaging Technology Commercialization	2011-2016	13.3	10.1	58
8. Centre for Probe Development and Commercialization	2008-2018	28.8	22.8	35
9. Centre for Surgical Invention and Innovation	2009-2017	14.8	24.3	14
10. Centre for the Commercialization of Antibodies and Biologics	2014-2019	15	N/A	N/A
11. Centre of Excellence in Energy Efficiency	2009-2015	9.6	23	24
12. Centre of Excellence in Next Generation Networks	2014-2019	11.7	N/A	N/A
13. GreenCentre Canada	2009-2019	18.2	16.5	45
14. Leading Operational Observations - LOOKNorth	2011-2016	7.1	4.3	88
15. MaRS Innovation	2008-2016	29.9	39.2	30
16. MedDev Commercialization Centre	2014-2019	14.9	N/A	N/A
17. MiQro Innovation Collaborative Centre	2011-2016	14.1	16.4	8
18. NEOMED	2014-2018	12	N/A	N/A
19. Ocean Networks Canada Innovation Centre	2009-2018	11	7	50
20. Pan-Provincial Vaccine Enterprise	2008-2017	15	14.7	8
21. Tecterra	2009-2016	11.7	45.9	146
22. The Prostate Centre's Translational Research Initiative for Accelerated Discovery and Development – PC-TRIADD	2008-2018	26.3	7.1	41
23. Wavefront	2011-2016	11.6	5.6	143
		AVG:15.9 Total: 367	**AVG=30.3 Total=545.6**	**AVG=68.6 Total=1236**

Business-Led Networks of Centres of Excellence				
CQDM	2009-2017	20.8	35.6	85
Green Aviation Research and Development Network	2009-2018	25	30.5	45
Prethera Research	2014-2018	15	2.6	7
Refined Manufacturing Acceleration Process	2014-2018	7.7	0.092	3
Ultra Deep Mining Network	2014-2018	15	0.161	N/A
	Range 2001-19	**AVG:16.7 Total: 83.5 Overall Total= 1115.4**	**AVG=13.7 Total=68.953 Overall total= 1064.3**	**AVG=35 Total=140 Overall total=3150**

V.3 The "Endowed Foundations"

V.3.1 Canadian Foundation for Innovation

In February of 1997, the Canadian Foundation for Innovation was created (CFI) with the mandate to increase Canada's ability to undertake world-class research and to develop technologies. The CFI strives to accomplish this by funding infrastructure that includes state-of-the-art equipment, databases, laboratories, scientific collections, computer hardware and software, communication linkages and the buildings required to conduct innovative research. Since its creation, the CFI has provided funding for 8770 projects, at 144 research institutions, in 70 municipalities across Canada, at a price tag of over $ 6 B (As of January 2015). In order to fund the development of the various infrastructures, an independent, competitive, merit-based assessment process is administered that rewards excellence.

For this assessment, experts across Canada and the world are called upon to ensure that only the most worthy projects receive financial support. Institutions are awarded CFI funding not individual researchers and funding must support an institution's research plan.

To assess their results as they relate to the overall objectives of the CFI, the CFI publishes an annual progress report. Data is collected in the form of online questionnaires that are completed by project leaders and submitted by the host institution. The data is not independently verified and is self-reported. According to the report, in 2014, CFI funded infrastructure contributed to the development of:

- 264 provisional patents;

- 143 patents granted;
- 57 licensing agreements; and
- 51 spinoff companies

There were also 1,179 jobs created within the institution and 459 jobs created outside of the institution.[4]

V.3.2 SDTC

Sustainable Development Technology Canada (SDTC) was created in 2001 and is funded by the GOC. The SDTC characterizes their approach by their willingness to take risks, which is accomplished by working with entrepreneurs to help them bring their clean-tech innovations to the market. Funding is allocated through either one of three funds:

1) The SD Tech Fund- Provides funding for projects that tackle climate change, air quality, clean water and clean soil.
2) The SD Natural Gas Fund – Provides funding from new downstream natural gas technology, supported from the development to the demonstration stage.
3) The NextGen BioFuels Fund- Provides funding for the creation of first-of-kind facilities capable of producing next-generation renewable fuels.

In addition to funding, SDTC offers mentorship to Canadian clean-tech companies in their quest for success. According to their website (www.sdtc.ca), as of 2014 they have helped generate 8200 jobs and stimulate $ 1.1 billion in annual revenues for Canadian clean-tech companies. More than just the economic benefit, and perhaps to a greater extent, the SDTC also benefits Canada environmentally. 2014 also saw 66 clean-tech technologies reduce Green-house Gas emissions by approximately 4.5 megatonnes of Carbon dioxide equivalent.

V.3.3 Council of Canadian Academies CCA

Beginning operation in 2005, with $ 30 M GOC endowment, the Council of Canadian Academies (CCA) was mandated to provide independent, evidence-based assessments to help inform public policy development in Canada. Typically, an assessment begins through the submission of a question by a sponsor. A multi-disciplinary panel is then formed, and its discoveries or answers to the answers question are formulated into a report. To ensure quality and objectivity, the report undergoes a formal review process conducted by expert peers. In its beginnings, the CCA received an endowment from the GOC, and as a result, in accordance with their funding agreement, the GOC can submit up to five topics annually. To date, the CCA has conducted 33 assessments, one of which (Innovation and Business Strategy: Why Canada Falls Short) is notably relevant to this report, and therefore we have decided to include its Executive Summary in the ANNEX.

V.3.4 Genome Canada

[4] Facts and figures found on www.innovation.ca

Genome Canada was created with the intent to foster networks of expertise in Canada, while investing in genomics research, amidst the goal of generating economic and social benefits for Canadians. Over two billion dollars has been invested in Genome Canada with over half of that investment originating from partners.

This two billion dollar plus investment has seen tangible results in the form of: 155 large scale research projects, more than 4500 research publications, the creation of over 20 companies, and 350 patent applicants and patent awards, and 24 license agreements. Moreover, there are six regional Genome centres located across Canada with 10 000 highly skilled employees. [5]

V.3.5 CANARIE

In the digital economy of today, digital infrastructure and advanced broadband networks are critical for the distribution of massive amounts of data and information almost instantly. CANARIE designs and distributes this infrastructure. Currently their network is accessed by one million researchers, scientists and students at approximately 2,000 Canadian institutions, including universities, colleges, research institutes, hospitals, and government laboratories. CANARIE is a non-profit organization founded in 1993 that receives the majority of its funding from the GOC. In April of 2015, the GOC announced plans to renew its commitment to CANARIE by promising $ 105 million over five years 2015-2020.

Canadian startups have also benefited from CANARIE as their cloud computing resources allow them to accelerate product development. Presently there are over 400 entrepreneurs and businesses that utilize CANARIE's DAIR cloud service. Their ultra-high-speed research and education network spans over 23,000 kilometers and in 2014 they reported 117,000 terabytes of traffic carried across their network. [6] With students, researchers, entrepreneurs and higher-education faculty increasingly turning online for academic information, it is encouraging to see the GOC's continued financial support of CANARIE.

V.4 Research Granting Councils Strategic Partnerships

V.4.1 NSERC

The Natural Sciences and Engineering Research Council of Canada (NSERC), was founded on the first of May in 1978. Initially NSERC started with a budget of 112 million dollars, which has since grown to 1.1 billion dollars. According to the Natural Sciences and Engineering Research Council Act the functions of the council are to:
a) Promote and assist research in the natural sciences and engineering, other than the health sciences; and
(b) Advise the Minister in respect of such matters relating to such research as the Minister may refer to the Council for its consideration.

[5] Facts and figures found at http://www.genomecanada.ca/
[6] Facts and figures found at www.canarie.ca/

- In order to carry out these functions, the act further grants the council certain powers, these powers as defined in the act are: (a) expend, for the purposes of this Act, any money appropriated by Parliament for the work of the Council or received by the Council through the conduct of its operations; and (b) publish and sell or otherwise distribute such scholarly, scientific and technical information relating to the work of the Council as the Council considers necessary.

After a year of consultations with businesses, and a decade of reports painting a grim picture of Canada's innovation record, in 2009, NSERC decided to launch a new platform for stimulating innovation. Building on NSERC's past, the Strategy for Partnerships and Innovation was founded with several aims which include:

- Facilitating Canadian business investment in research and development
- Accelerating commercialization
- Linking university and college expertise to industry
- Helping students obtain skills of value to businesses

Currently, NSERC has partnerships with more than 3000 businesses, (One of our interviewees stated that number has since risen to 3400) with 75 percent of these being small to medium size enterprises, which represents the largest share of Canada's business landscape. In addition, NSERC works with 65 of Canada's top 100 R&D investing firms. In 2014, NSERC released some figures on its Strategy for Partnerships and Innovation program and there are some promising results. During a five year span, (2009-14) the program doubled from 1500 to 3000 industry partners.

Company contributions are also up significantly from 108 million in 2009 to 195 million in 2014. In order to help stimulate this investment, 2014 also saw NSERC establish the Engage Grant. This grant helped establish 4450 new projects, which provided solutions to Canadian companies facing technical obstacles.

While business investment in NSERC partnerships is up 67 percent from 2008-14, overall Canadian business investment in R&D was down 0.6 percent during that same time frame. A troubling sign suggesting that while NSERC'S Strategy for Partnerships and Innovation program is pulling its weight other components of Canada's Business R&D sector are not. Of the businesses who are involved in NSERC's Strategy for Partnerships and Innovation program who received an NSERC Engage Grant, the overwhelming majority are pleased with the results. In fact, the numbers are heavily tilted depicting the program in a positive light; these businesses report:

- 94% describe the project as a success;
- 96% gained new knowledge or technology
- 98% would recommend engage to another company;
- 76% reported a direct impact on their business
- 50%+ developed a new product or process.
- 36% increased their R&D capabilities[7]

V.4.2 Social Sciences and Humanities Research Council

[7] Facts and figures found at http://www.nserc-crsng.gc.ca/index_eng.asp

In 1977, the Social Sciences and Humanities Research Council (SSHRC) was created by an act of parliament. SSHRC is a federal agency that encourages and facilitates post-secondary research in the humanities and social science fields. The SSHRC's primary goal is "To make Canada a world leader in social sciences and humanities research and research training." As a result, the SSHRC has designed all of its programs and initiatives with the desire to achieve this goal.

The SSHRC acknowledges that this is an ambitious goal and one that they cannot achieve on their own, but rather one that will require partnerships with Canada's 22, 500 full time faculty and 60, 000 graduate students that comprise Canada's social science faculties. In addition to Canada's academic institutions, if SSHRC is to achieve their goal, they are also reliant on partnerships with a plethora of private, public and not for profit organizations that use the social sciences to achieve their respective mandates.

Through a process involving foresight and on-going collaboration with universities, colleges and other organizations, SSHRC was able to identify three key areas or principles that have shaped their 2013-16 strategic plan ***Strengthening Canada's Cultures of Innovation.*** These priorities are:

1) Promote and support Canadian excellence in social sciences and humanities research and talent development;
2) Work with Canadian postsecondary institutions and other organizations to build a 21st-century research and training environment in the humanities and social sciences;
3) Position knowledge and expertise about human thought and behaviour to bring maximal benefits to Canada and the world

2012-13 SSHRC Operations

337 million in grants, fellowships and scholarships.
12,563 applications received
8674 research projects
30 Disciplines

[8]

V.4.3 Canadian Institutes of Health Research

The Canadian Institutes of Health Research (CIHR) was created in 2000, under the authority of the Canadian Institutes of Health Research Act; it acts as the GOC's health research investment agency. It is comprised of 13 institutes, which provide leadership and support to health researchers and trainees across Canada. The following institutes make up the CIHR:

1. Institute of Aboriginal Peoples' Health
2. Institute of Aging

[8] Figures and facts found at http://www.sshrc-crsh.gc.ca/home-accueil-eng.aspx

3. Institute of Cancer Research
4. Institute of Circulatory and Respiratory Health
5. Institute of Gender and Health
6. Institute of Genetics
7. Institute of Health Services and Policy Research
8. Institute of Human Development, Child and Youth Health
9. Institute of Infection and Immunity
10. Institute of Musculoskeletal Health and Arthritis
11. Institute of Neurosciences, Mental Health and Addiction
12. Institute of Nutrition, Metabolism and Diabetes
13. Institute of Population and Public Health

In 2013-14, the CIHR provided 718.2 million in research grants, 135.6 million in tri-agency programs and 67 million in training awards. These funds were responsible for more than 3,600 grants that supported research teams comprising 6,844 investigators.[9] Some of these teams are working on projects that include: preventing tooth decay in first nations children, building a better prenatal test, streamlining post treatment care for cancer patients and measuring the impact of tobacco control measures. The CIHR is also leading a joint-program initiative with 17 European Union countries and Israel on antimicrobial resistance.

V.5 The NRC Revitalized: Flagship and IRAP Programs

V.5.1 NRC Flagship Programs

In 2011, the NRC decided to shift its research focus toward more applied and commercial- -ready industrial level research. This shifting in priorities resulted in the creation of three flagship programs:

- ***The Canadian Wheat Improvement Flagship*** is a NRC collaborative partnership with Agriculture and Agri-Food Canada (AAFC), the University of Saskatchewan's Crop Development Centre and the Province of Saskatchewan. It has budget of $ 97 million from 2013-2018, and a goal of improving the yield of Canadian wheat crops, and on determining the use of chemical fertilizers as efficiently as possible.
- ***The Algal Carbon Conversion Flagship*** Program is a NRC collaborative partnership, consisting of the NRC, Canadian Natural Resources Limited (Canadian Natural) and Pond Biofuels. A $ 19 million facility is being

[9] Figures and facts found at http://www.cihr-irsc.gc.ca/e/193.html

constructed in Alberta as part of this flagship, which seeks to develop an algae system to recycle carbon emissions from oil sands.

- Finally the NRC has established a ***Printable Electronics Flagship***. This Flagship seeks to provide Canadian industry with the resources it requires to be a powerful global player. The NRC's efforts involve coordinating key industrial areas that include materials, ink, printing, ICT and digital manufacturing. It is their hope that in coordinating these efforts, Canada will be able to develop a profitable large-scale printable electronics sector.

Each of these flagships is relatively young, and therefore it is still too early to judge their successes and failures. This relative youth makes comparisons to other Canadian programs as well as International programs of a similar standing especially difficult. Early indicators may help determine if they are venturing on the right path, but ultimately, more time will be required in order to gauge their true impact. What is promising about them is the extensive work of a preparatory nature that underpins their business planning and the clear focus on commercialization through partnerships.

In the tradition of the NRC, an institution that has seen many significant changes during its almost 100 year history, these prospective programs combine both fundamental research capabilities and market sensitive /anticipatory capabilities and, - where business partners will be sufficiently motivated to invest and provide the discipline for market readiness - their prospects seem favourable. The NRC's new structure which combines flagship initiatives with foresight focused on emerging technologies (game changers) plus the IRAP mechanism to enlist small companies, and support entrepreneurs to transfer the technologies seems well positioned.

Table 3. NRC Flagship Research Initiatives[10]

1. Advanced photonic components for communications	19. Lightweighting of Ground Transport Vehicles
2. Aeronautics for the 21st century	20. Marine Vehicles
3. Aeronautical product development technologies	21. Mid-rise wood buildings
4. Air defence systems	22. Marine Infrastructure, Energy and Water Resources
5. Algal carbon conversion flagship	23. Measurement science for emerging technologies
6. Arctic Program	24. Metrology for industry and society
7. Bioenergy systems for viable stationary applications	25. Mining materials wear and corrosion
8. Biologics program	26. Multimedia analytic tools for security (MATS)
9. Building regulations for market access	27. National Institute for Nanotechnology (NINT)
10. Canadian wheat improvement flagship	28. Natural health products program
11. Civilian unmanned aircraft systems	29. Printable electronics flagship
12. Critical concrete infrastructure	30. Quantum Photonic Sensing and Security
13. Energy storage for grid security	
14. Gallium nitride (GaN) electronics	

[10] These are prospective research initiatives i.e. only a few are presently operative

15. High efficiency mining 16. High performance buildings 17. Industrial biomaterials 18. Learning- performance support systems	31. Reducing aviation icing risk 32. Scientific support for the national measurement system 33. Security Materials Technology 34. Therapeutics beyond brain barriers program 35. Vaccines program 36. Working and travelling on aircraft

V.5.2 Industrial Research Assistance Program (IRAP)[11]

The NRC's Industrial Research Assistance Program helps small to medium sized Canadian enterprises undertake technological innovation by providing financial support. In order to be eligible for this financial support, businesses must meet the following criteria:

- be a small and medium-sized enterprise in Canada, incorporated and profit-oriented;
- have 500 or fewer full time equivalent employees; and
- have the objective to grow and generate profits through development and commercialization of innovative, technology-driven new or improved products, services, or processes in Canada.

Businesses have the objective to grow and generate profits through development and commercialization of innovative, technology-driven new or improved products, services, or processes in Canada seeking to qualify for this support, must first go through an individual consultation with one of the NRC's Industry Technology Advisors (ITAs) who have extensive business and technical experience and are located across Canada. These advisors are assessing both the firm and the project. Specifically, they try to determine the firm's business and management capabilities, as well as the company's ability to achieve the expected results of the project. Furthermore, ITAs assess the firm's potential to commercialize the developed technologies; and finally they assess the technical aspects of the project and how it will impact the firm. If a project does receive the green light from the ITAs, then the ITAs can potentially have a much larger role in the project than simply approving it.

[11] Figures, facts, and procedures as well as more success stories can be found at http://www.nrc-cnrc.gc.ca/eng/irap/index.html

Throughout the project, ITAs can provide strategic assistance to firms by acting in an advisory capacity. They are available to aid in every stage of the innovation process, from concept to commercialization, providing technical and business advice, while providing referrals and other innovation services as needed. ITAs can also establish links with additional resources, and thereby assist their clients in areas such as:

- technology and business financing and scale – up assistance;
- literature and patent searches;
- referrals to other programs and services;
- expertise searches;
- linkages and networking to appropriate resources; and
- strategic intelligence.

The program has had numerous success stories over the years, assisting many of Canada's most innovative and subsequently much larger firms; (e. g, RIM, Open Text;);

The following paragraphs will highlight a select few.

1. ***Multi-Purpose Engineer Vehicle:*** This vehicle was developed by ARVA, a small 42 person firm in St-Thomas Ontario. This vehicle has an excavator, can operate in temperatures ranging from -40 F to +120 F; it can travel at speeds of up to 110 kilometres per hour; and is built to withstand the blast of roadside bombs. IRAP provided ARVA with recommendations and guidance along with funding. The company has built 30 of the 600 thousand dollar vehicles for the Canadian military, and has marketed them to other countries as well, including the United States.

2. ***OCION Water Sciences Group Ltd*** (formerly EnvirEau Technologies) is a Richmond, British Columbia based firm that has developed a product that controls algae and bacteria in water, crops and food. With the help of IRAP's financial contributions, the firm was able to conduct laboratory analyses and field testing that would improve the ionization of the minerals in its products. The company now creates self-mixing compounds that can control algae and bacteria in potable water compounds, as well as odour and bacteria in waste treatment facilities. OCION now markets its products through distributors in nine countries in Europe and Asia, and ultimately has its sights on becoming a global leader in this field. In addition, OCION has collaborated with many independent laboratories and facilities in countries such as: The Netherlands, South African, Greece and the Philippines. OCION continues to fund R&D in the fields of water treatment, agriculture, waste management, and food protection.

Social media or social networking is an area of technology that has expanded exponentially over the past decade. Managing all of a firm's social networking accounts can be a time consuming process.

Realizing a potential shortfall in the social media marketplace, in 2008, Invoke Media Inc. approached the National Research Council of Canada Industrial Research Assistance Program (NRC-IRAP) to help develop its social media management product; what follows is perhaps IRAP's greatest recent success story.

3. ***Hootsuite:*** Developed in 2009 the company spun off of Invoke as a separate incorporated company. With financial support and advisory services from IRAP, Hootsuite developed a dashboard that could be used for managing multiple social media profiles. Hootsuite is used in over 175 countries, has over 9 million users and is the most widely used social relationship platform. It boasts over 500 global employees from Vancouver to Hong Kong, and its customers include 744 of the fortune 1000. Accordingly, some firms have valued Hootsuite at more than 1 billion. (Times of India, 2014)

V.6 National Priority

The National Priority measure - instrument is really an integrated, strategic approach which would be capable of leading a national conversation of the issues raised in James Balsillie's May 8th 2015 article (attached below as Annex B).

Essentially Mr. Balsillie is calling for a combination of measures which would be identified when a technology becomes a national priority requiring special mechanisms, particularly measures which can deliver: patient capital, science and technology foresight, commercial support services (e.g. competitive intelligence for global markets) and teams of seasoned IP experts and entrepreneurs; to steer the integrated partnership forward to fully engage Canada's innovation eco system assets.

This new strategic instrument would ideally have the following characteristics:

- Capable of identifying national technology/innovation priorities and strategic mechanisms to ensure protection and development of commercial opportunities:
- Balanced funding of research and commercialization across the spectrum of basic to showcase demonstration activities:
- A national S&T Foresight capability that can be broadly deployed across the innovation eco-system;
- Government and business cooperation on all matters leading to commercial investments, including special measures to support "Gazelles", ensure firm scale up, and designation-supply of venture capital to accelerate the commercialization of key national interest technologies.

- Include or develop a Canadian legislative approach that will ensure Canadian public research IP and commercialization assets are maximized, protected and adequately funded following the US experience of the Bayh-Dole Act.

V.7 Measures-Instruments Summary and Analysis

Each of these measures selected has its advantages and disadvantages, and evidently some are proving to be more beneficial than others. While they differ in many regards, ultimately they share the same goal of stimulating R&D in Canada, and in turn commercialization. Perhaps then, as the R&D system in Canada has been widely considered to be mediocre, each program deserves some share of the blame. Another perspective is that the measures that Canada has used are indeed appropriate its situation and its capacity as a smaller economy. Many of the measures identified have endured through changes in regimes. Indeed, the weakness of Canadian commercialization does not seem attributable to the existence of inadequate or poorly designed instruments.

While some of these measures are highly regarded, they are also not well known; therein lies a potential dilemma. In a survey conducted by the Jenkins panel (2011) of 1009 R&D performing firms, one third claimed that they had never tried accessing a federal program that supported business R&D. When pressed as to why they never had, from a prompted list, more than half the businesses claimed they were not aware of any programs (Ibid).

Even if Canada had the best R&D and commercialization stimulating programs in the world, if few businesses are aware of them then they are doomed to fail. Ultimately, the Canadian Government needs to do a better job of marketing these programs to businesses, so that more and more businesses are encouraged to invest in R&D that otherwise would not have.

One of the principal objectives of this review was an assessment of the potential application of these Canadian style instruments- measures to the Australian context. While TFCI believes that there will be opportunities to adapt some Canadian measures to Australia's research commercialization challenges, there was not sufficient time as part of this report for us to become familiar with either the policies or the institutions associated with research commercialization in Australia.

We would therefore recommend that ACOLA consider launching a subsequent project (e.g. a joint colloquium) involving leading Canadian and Australian innovators to independently address this challenge. In our experience such a face-to-face colloquium would have the advantage of mutual strategic experiential learning compared to this current review process.

ACOLA explicitly asked about Canada's experience with the development, implementation and ongoing support for and defence of longer term measures or instruments that both enable excellent research by public authorities and are also able to accelerate commercialization of the research results.

Each of our six measures-instruments has a somewhat unique story in this regard. Below is our analysis of four of the six measures in the context of their longer term application.

- SR & ED Tax Credit

  Enduring for at least 30 years, this program continues to attract firms to invest in R&D

and yet every few years it has been singled out for reform, usually as being less cost-effective than more targeted or sector specific alternatives. The most recent reform proposal was the Jenkins Panel which advised that the tax credits should only support labour costs and that a portion of the annual $ 3 B budget should be redeployed:

"to a more complete set of direct support initiatives to help SMEs grow into larger competitive firms "(see Annex C)

Unfortunately, the data is not available to enable a direct comparison between the presumed more cost-effective direct support measures and the indirect tax credits.

- Networks of Centres of Excellence (NCE)

The NCE program, originally started as a pilot initiative in 1989 by the second Mulroney Administration, is a clear example of a measure or instrument that has successfully transitioned regime changes (i.e. 5 PMs - 3 Conservatives and 2 Liberals) for almost 30 years.

Funded until at least 2018, the NCEs now include two additional categories of networks - the Business Led Centres; - the (BLCE) and the Centres of Excellence for Commercialization and Research (CECR). With a federal election looming in the coming months, it will be instructive to see whether or not these BLCEs and the CECRs will continue to prosper (i.e. receive further funding past 2018) under a new government, if one is elected.

Given the relatively strong commercialization track record of the early NCEs (see section V.2), it seems plausible that future governments will continue to be supportive of these more direct initiatives to accelerate commercialization.

- The "Endowed Foundations"

The various "Endowed Foundations" represent a partnership model that enables the public authorities to have some stable investments through the life of a government- and hopefully beyond, without having to obtain new funding each year. The appeal of the model is its *agility* (i.e. it can function like a private corporation in many respects) its *public accountability* through ownership and board nominations and its potential for *mandate stability* over time (where because of its somewhat independent legal status and endowment funding - an administrative culture emerges rather than a policy (and politics) determined one.

It also can serve the cycles of change in government budget situations – which during periods of relative volatility make it hard to forecast further than one year ahead- i.e. in tough times this

model functions just like any of the other instruments – competing for renewal and adjustments in funding; but when government experiences a surplus this model shines as a convenient place to put funds back into the system as an investment for prospective future rewards.

E.g. If we examine two of the "endowed foundations" we can appreciate how they have contributed over time according to the pace of demand for and availability of funds.

1. **SDTC** uses a rigorous gating process to allocate its annual budget. The process can be tightened or loosened and priorities shifted within the broad mandate of clean technology. This agility has enabled the SDTC to be refunded several times since its inception in 2001, by 2014 resulting in a cumulative amount of approximately $ 700 M - a substantial increase over its initial endowment allocation of $ 100 M. By 2014, SDTC was allocating about $70 M annually to projects.(see WWW.SDTC.CA) ;
2. **CCA** In contrast to the SDTC, the CCA operates primarily as an assessment organization bringing advice to government on designated subjects. The endowment base of 30 million dollars remains intact while annual expenditures rarely exceed $ 5 M. Their endowment was renewed in 2015, with an additional increment of 15 million dollars over five years.

In September 2006, the Council of Canadian Academies (CCA) published its first expert panel assessment, The State of Science & Technology in Canada, which provided the evidence base for the designation of the priority areas in the new federal government's science and technology strategy. Since then, the Council has completed additional multidisciplinary expert panel assessments that have analyzed in great depth Canada's performance in science and technology (S&T) and innovation from several perspectives.

CCA Assessments of Science & Technology and Innovation

1. The State of Science and Technology in Canada (2006) provides an extraordinarily detailed analysis of Canada's strengths and weaknesses, relative to global benchmarks, in almost 200 fields of research and technology, and related infrastructure. The findings on major areas of strength have been incorporated in the federal government's 2007 S&T strategy as priority areas for support.

2. Innovation and Business Strategy: Why Canada Falls Short (2009) provides a deep analysis of business innovation and its relation to Canada's productivity growth over several decades. It analyzes the principal factors that determine whether or not an individual Canadian firm adopts an innovation-focused business strategy.

3. Catalyzing Canada's Digital Economy (2010) explores the puzzling weakness of Canadian business investment in information and communication technologies (Its; hardware, software, and systems), and links this to sub-par business innovation, the study identifies the barriers that discourage ICt investment by small and medium-sized enterprises, and proposes a program solution that strongly influenced the creation of the government's $80-million digital technology adoption Pilot Program in 2011.

4. Informing Research Choices: Indicators and Judgment (2012) assesses global best practices for the use of quantitative indicators and expert judgment to inform the allocation, among fields in the natural sciences and engineering, of government support for research.

5. The State of Science and Technology in Canada, 2012 (2012) updates and significantly extends the 2006 report, using leading-edge bibliometric analysis and a unique survey of more than 5,000 of the world's top-cited researchers to assess Canada's research performance in 20 major fields and 176 sub-fields across science, engineering, humanities, and the arts. The report includes data on the distribution of research strength by province, as well as a "technometric" assessment of Canadian patenting.

6. Innovation Impacts: Measurement and Assessment (2013) assesses the current state of knowledge and practice on assessment/measurement of the impact of government investment to foster business innovation. A firm-centric framework is developed that conceptualizes innovation as occurring within an ecosystem of multiple actors. Thus, an assessment of the full impact of an investment needs to take into account its impact on the relevant parts of the innovation ecosystem.

7. The State of Industrial R&D (2013) examines the magnitude and distribution, across industries and provinces, of business R&D and analyzes quantitatively the R&D intensity gap between the United States and Canada. (The report complements The State of Science and Technology in Canada, 2012.) Aerospace, ICT, oil and gas, and pharmaceutical and medical manufacturing are identified as Canadian industries with strong R&D intensity relative to global measures.

- NRC-IRAP, Flagship Programs

IRAP has been a stable instrument of the GOC since the late 1940s. It has endured numerous adjustments but retains a formula which has been successful; the direct involvement of ITAs in the assessment and delivery of grants to SMEs. IRAP's success is attributed to its non-bureaucratic and independent technical support and delivery. Despite frequent attempts to change its culture (i.e. to become more policy responsive and hence "bureaucratic"), the GOC has normally resisted these attempts and continued to rely upon the NRC for delivery. As indicated in the summary of the Jenkins recommendations (See Table 4 Conclusion), we do not support the IRAP recommendation, which we believe would result in a change of culture for the IRAP administration.

The NRC represents a unique set of research and technology capabilities which, like IRAP have evolved within a mostly technological culture. Since 1985, the NRC has been re-organized at least three times:

1) Under President Pierre Perron -1990-91 to re-align its divisions into institutes

2) Under President Arthur Carty - 1995-2004 to add new incentives for applied research and spin-off companies, to bring in regional cluster initiatives and to strengthen external R&D linkages

3) Under President John McDougall - 2010-2015 to refocus on flagship program technologies and to add foresight for emerging technologies.

Each of these changes has been to strengthen the NRC's historical connection to Canadian industrial needs for technological assistance and collaboration. Each has been portrayed as bringing the NRC closer to a strategic focus on commercialization of public research. What is notable is that during these 30 years, the nature of the NRC mission has not been fundamentally altered; mainly its management practices and structures. The core capability of the NRC – i.e. to

be able to provide mid-to-longer term strategic and applied solutions to industrial problems-remains.

While each presidential regime has emphasized the importance of a refocused approach, they are still working with or faced with similar objectives and challenges. The NRC has always taken a longer term applied technical approach (although some critics have described this as basic or fundamental research) and offers a source of partnership that has not fundamentally changed. Most researchers trained as PHDs do not automatically become entrepreneurs or founders of competitive firms. What has changed is the relative urgency of technological transfer and application in the marketplace which is altering the incentive structure of labs and governments, and the new competitive capabilities of research intensive universities.

Changes in research culture typically require a new generation of researchers. As long as most R&D managers come from the research community it can be expected that shifts in R&D culture will be periodically overstated by governments promoting commercialization and understated by governments promoting research enhancement

VI. Success Stories of Canadian Public Research

When examining Canada's business sector taken as a whole, the weight of evidence suggests that Canada's business innovation sector is significantly weaker when compared to the U.S. sector, and in fact is weaker than many of Canada's peers that comprise the OECD (Council of Canadian Academies, 2009). With that being said, there are still many instances of successful research initiated innovation by Canadian businesses which will subsequently be the focus of this section. Unfortunately two of Canada's greatest success stories (Nortel and RIM-Blackberry) are no longer the powerful players they once were, but at the height of their ascent were major players in their respective fields (telecom – carrier, systems architecture and switching for Nortel; and Mobile wireless devices for RIM). In each case there are now evaluations of what went wrong, and these are being used to inform future research commercialization strategies.

To begin we have Nortel, who at the height of its ascendancy, was a company so large it accounted for approximately one third the value of the Toronto Stock exchange, had 94,500 employees and a market value of $ 398 Billion (Hasselback & Tedesco, 2014). The company would eventually enter bankruptcy courts in both Canada, and the United States but at one point was the ultimate Canadian success story.

A comparable, although not completely identical fate has been happening to another once massively popular Canadian business; RIM-Blackberry. In 2007, RIM-Blackberry had a share price of $ 230, which as of June 12th, 2015 was at $11.38. At the beginning RIM - Blackberry was a very innovative company, being one of the first globally recognized spinoffs from the University of Waterloo. Quantifying success is not easy, and while the preceding description

cited two Canadian companies who were once massively successful, their subsequent downfall serves as a lesson in the importance of agility and in adapting to a changing marketplace. The subsequent success stories are companies attempting to do just that.

Clearpath Robotics Inc, and Shopify may not have the mass global recognition of a RIM-Blackberry yet, but they are still relatively early in the infancy stage and have the ambition to be world leaders.

Clearpath was founded in 2009, while its founders were still students at the University of Waterloo. Once they had established a track record they started working with several funding initiatives; notably the Ontario Centres of Excellence and the NRC's IRAP. The company was growing so quickly that they reached a point where their order book was filling faster than they could finance through their own profit and government grants (Jermyn, 2014). To deal with these orders they looked to the local angel investment community and received a small angel investment to finance the orders. Clearpath currently boasts millions in annual revenue and employs 75 people (Ibid). Their robotic products are used in over 30 countries for research and development. Some of their high-profile customers include: Honda, Microsoft, Intel, NASA, the Canadian Department of National Defense, as well as the U.S Army and Navy. The company's vision is to "Automate the world's dullest, dirtiest, and deadliest jobs". It is a Canadian company worth paying attention to.

Another Canadian company that has experienced exponential growth over the past several years is Shopify. According to their website, (www.shopify.ca) Shopify started as a team of five working out of a coffee shop, to a company that now employs over 500, with four offices situated across Canada. Shopify develops computer software for businesses that allow them to create online stores and retail point of sale systems. There are currently 165,000 active Shopify stores accounting for sales of 8 billion dollars. In May of 2015, Shopify became the first Canadian e-commerce company to go public on a U.S. stock market since 2001. Demand for the stock was high with sources close to the deal claiming it was 30 times oversubscribed (Silcoff, Dingman, 2015). On opening day, it closed at $25.75, up 51 per cent on the day, which puts the value of the company at 1.9 billion dollars. Shopify's IPO may have the unintended effect of inspiring other Canadian tech companies to go public as well. Ryan Holmes, CEO of Hootsuite, (a success story listed under IRAP) has been quoted saying:

> *"The Shopify deal definitely has created a lot of buzz and really got our team thinking about timing on an IPO. I think within the next 12 to 18 months we're targeting as a time frame where we could be ready to come out if the markets look good. With IPOs, you want to have a number of events connect and converge at the perfect time." (Ibid)*

While one of our interviewees felt that Canada has no real leaders or champions of science in Government, it is satisfying to see that there are firms in Canada's private sector striving to be industry leaders. Say what you want about Blackberry, but their success has been beneficial in aspiring Canadian companies such as Clearpath to be world leaders.

Companies such as Shopify, Hootsuite and Clearpath may never reach the size of Blackberry at its peak, but at least they have a Canadian benchmark to measure up against and attempt to surpass.

TFCI is optimistic that these companies can build upon their success, inspire new Canadian entrepreneurs and businesses, while providing the quality innovative leadership Canada is presently lacking at the government level. As Tobias Lutke, CEO of Shopify and the Globe and Mail's 2014 CEO of the year has stated:

"We have a lot of really great companies in Canada, and I think there's always been this fear that 'great' in Canada doesn't mean 'great' on a world stage. We need more self-confidence."

It is our hope that future Canadian businesses will have the confidence and leadership they need to be successful on a global stage, and can look to home-grown companies such as Shopify for their inspiration.

VII. Conclusions

Despite its many advantages (e.g. geography, natural resource endowments and a multicultural, diverse and a well-educated population, supported by generally safe and affordable infrastructure, food and health systems) Canada has long been a relatively poor innovator, when measured in terms of global product success. When services, entrepreneurship and skill capabilities are included, as earlier in this report (section 2) we have advocated they should, Canada fares somewhat better as a relatively good innovation process adopter – adapter and public services manager. [12]

The reasons for the poor product record have been extensively explored in numerous reports - including the three referenced in Annexes B (Balsillie), C (Jenkins Panel) and D. (Nicholson Panel) so we have not carried out any additional analysis in this regard, since it was not the primary motivation for this review.

Consequently, the focus of this review on behalf of ACOLA has been to first describe which public research measures-instruments are most useful and cost-effective, and second to understand what mix of measures - instruments seems most suitable for and capable of

[12] http://www.cbc.ca/news/business/entrepreneurship-in-canada-ranks-2nd-in-world-report-says-1.3093290

advancing the broader conception of commercialization that we believe will enable both Canada and Australia to succeed in the coming digital - knowledge and capabilities driven economy.

Our review of the 45 instruments and measures has confirmed:

- there exists a wide variation of experience regarding their application and impacts;
- performance data on commercialization – both the narrow and broader concepts is scant, inconsistent and clearly a challenge for a system designed to champion inputs rather than impacts;
- new measures are continually being introduced (CICP, SADI) while legacy measures continue to work through a sort of life cycle (SDTC, TPC); whereas others are able to be adapted to changing circumstances (SR&ED, NRC FP - IRAP);
- transparency is lacking for a systemic view of comparable measures, and evaluations or other validations generally are not evident, regular or available where they do exist;
- there is a growing awareness of the need for more aggressive, globally-competitive strategies amongst Canada's STI policy community-that we expect will intensify the strategic conversation that James Balsillie has initiated.

VII.1 The Jenkins Report

When addressing issues in the STI policy realm, it is virtually impossible not to have a position on the key recommendations associated with the Jenkins report. Since this review actively engages many of the same issues as Jenkins, it is important to communicate the TFCI position because several of the recommendations remain unresolved.

Our major concern is the implication that the NRC is not capable of commercialization. On the contrary we believe that the NRC's applied Flagship research and commercialization initiatives plus the agility that comes from enhancing IRAP will be more than sufficient to ensure that viable commercial opportunities are realized in partnership with innovators.

The past history of NRC from 1916 to the present is a testament to its agility and its dedication to technical excellence. It is in this context that we believe the NRC should be recognized and enhanced as an effective commercialization agency rather than being disbursed by sector or policy authority.

The innovation – commercialization gap that really needs filling is the lack of funds for showcase demonstrations so the focus on creating a new delivery capable organization (e.g. like a SDTC for wider application than leading edge clean technologies) would be more effective if directed toward this gap than seeking to break up and distribute the NRC.

Table 4. Commentary on the Jenkins Report Recommendations

#	*Recommendation*	*TFCI Comments*
1.	**Industrial Research and Innovation Council** We envisage a new, whole-of-government program delivery vehicle — the Industrial Research and Innovation Council (IRIC) — that would be the centrepiece of the federal government's	*TFCI supports the concept of a whole-of-government coordination vehicle focused on S&T commercialization but questions the wisdom of assigning delivery of IRAP to it.*

	efforts to help entrepreneurs bring their innovative ideas to the marketplace and grow their companies into internationally successful businesses. To this end, the IRIC should take on at least the following industry facing activities: • Deliver an expanded Industrial Research Assistance Program (IRAP) and a commercialization vouchers pilot program that connects SMEs to providers of commercialization support; • Provide a national "concierge" service and associated website to help firms find and access the support tools they need work with partners to develop a federal business innovation talent strategy. • Moreover, the IRIC could assume the following responsibilities: in partnership with the federal granting agencies, joint oversight of appropriate business-facing programs administered by those agencies; technical assessment of the innovation element of project proposals submitted to the regional development agencies; and oversight of federal support for business-oriented collaborative research institutes evolved from the current institutes of the National Research Council, as further discussed below.	*IRAP has survived, adapted, and prospered, since 1948, because it has **not** been attached to or managed by a policy-led (non-technical) organizational culture.* *Oversight and concierge roles are bureaucratic functions rather than hands-on technology adoption/ development–oriented and they are not the same as IRAP ITAs*
2.	**Scientific Research and Experimental Development (SR&ED) Tax Credit** In line with feedback from stakeholders, we are recommending that the SR&ED program should be simplified. Specifically, for SMEs, the base for the tax credit should be labour-related costs, and the tax credit rate should be adjusted upward. The current base, which is wider than that used by any other countries, includes non-labour costs, such as materials and capital equipment, the calculation of which can be highly complex. This complexity results in excessive compliance costs for claimants and dissipates a portion of the program's benefit in fees for third-party consultants hired to prepare claims. Canada's program mix is heavily weighted toward the SR&ED program and, during our consultations, we heard many calls for increased direct expenditure support. As well, many leading countries in innovation rely much less than Canada on indirect tax incentives as opposed to direct measures. That is why we are recommending other improvements to the SR&ED program that will generate savings for the government. The savings should be redeployed to fund direct support measures for SMEs, as proposed in our other recommendations.	*TFCI supports the review of SR&ED terms, but overall believes the budget should be gradually expanded rather than contracted as the Jenkins panel recommends.* *Canada still needs incentives to attract SME's of all types to engage in the R&D enterprise. Budget redeployment will be seen as a reduction and will discourage many SME's from participating in R&D. Adjusting the terms and conditions rather than reducing access would be preferable.*
3.	**Risk Capital** Innovative, growing firms require risk capital, yet too many innovation-based Canadian firms that have the potential for high growth are unable to access the funding needed to realize their potential. The government can play an important role by facilitating access by such firms to an increased supply of risk capital at both the start-up and later stages of their growth. We therefore recommend measures to establish risk capital funds that target these areas. The federal government's contribution to the funds would be delivered through the Business Development Bank of Canada (BDC), with incentives and governance designed to ensure strong private sector participation and leadership.	*TFCI supports and endorses this recommendation - but is also aware of concerns about the exclusive or primary delivery role being assigned to the BDC- which has been characterized by many SMEs as too costly, too slow, risk averse and overly bureaucratic. More options would be helpful.*

4.	**Collaborative R&D Institutes** Canada needs a fundamentally new approach to building public–private research collaborations in areas of strategic importance and opportunity for the economy. Accordingly, we recommend that the business-oriented institutes of the National Research Council (NRC) should become independent collaborative research organizations, intended to be focal points for sectoral research and innovation strategies with the private sector. Those NRC institutes that perform primarily fundamental research would become affiliates of universities, while those with core public policy mandates would be transferred to the most relevant federal department or agency.	*TFCI disagrees with the intent of the recommendation i.e. the privatization and dissolution of the NRC. The NRC has proven itself very capable of adapting itself to changing requirements over 100 years. Many of its commercial successes (e.g. lasers, vaccines) required patient management until there were commercial receptors.* *The NRC is a technical organization, and so is less prone to current policy fads or trends. This has enabled the NRC to concentrate on technical development rather than becoming a bureaucracy.*
5.	**Public Sector Procurement** The government should make better use of its substantial purchasing power to create opportunity and demand for leading-edge goods, services and technologies from Canadian suppliers. This will foster the development of innovative and globally competitive Canadian companies connected to global supply chains, while also stimulating innovation and greater productivity in the delivery of public goods and services. We therefore recommend that encouragement of innovation in the Canadian economy should become a stated objective of procurement policies and programs. Further to this end, we recommend, among other measures, that the current pilot phase of the Canadian Innovation Commercialization Program (CICP) evolve into a permanent, larger and effective program that provides incentives for solving operational problems identified by federal departments.	*TFCI supports and endorses the recommendation.*
6.	**Whole-of-Government Leadership** The responsibility to foster innovation cuts across many functions of government and requires a system-wide perspective. For this reason, the government needs to establish business innovation as a whole-of-government priority. This will require the designation of a Minister as the voice for innovation, with a stated mandate to put innovation at the centre of the government's economic strategy and to engage the provinces in a dialogue on innovation to improve coordination and impact. Effective implementation of our action plan will depend on an oversight structure that ensures the timely achievement of desired outcomes. We recommend that the government's main tool in that regard should be an external Innovation Advisory Committee (IAC) — a body with a whole-of-government focus that would oversee the realization of our proposed action plan, as well as serve as a permanent mechanism to promote the refinement and improvement of the government's business innovation programs going forward.	*TFCI agrees that the designation of a Minister of (Science, Research & Innovation should be a priority for the next government.* *TFCI also supports this as distinct from the Minister of Industry role.*

Additionally, we need to remind ourselves also to consider the commercialization capacities of our research- intensive universities and applied technology colleges – where, according to James Balsillie, the trend is positive.

> *" Canadian universities play an important role helping to build the infrastructure for an innovation economy, which is why they receive most of the yearly $12-billion (Canadian) invested in postsecondary research and development. Judging by the number of incubators, accelerators and hubs that are now associated with virtually every postsecondary institution, as well as in-research licensing offices, it's clear that commercializing research has become one of the top priorities for these institutions. In tight fiscal times, this is a welcome development – there is a lot of money to be made by commercializing university research. "*
>
> *James Balsillie, May 8 2015 Toronto Globe and Mail*

And finally lest Canadians become too complacent - Balsillie also reminds us of the importance of developing an effective national consensus about the challenges we face:

> *I am certain, however, that Canada's innovation performance will not improve unless the country's business, university and political leadership come together to consider radically different policies, programs and tools. Canadian taxpayers deserve better returns on their enormous investments in innovation.*

We wish to thank ACOLA for their support in preparing this report and we hope that these observations and conclusions will be applicable to the Australian research environment.

Jack E. Smith, Jason van Dieen July 15th, 2015

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ANNEX A: INTERVIEWS

Interview with Mark Henderson

Mark Henderson is the Managing Editor of RE$EARCH MONEY, which is a newsletter that delivers intelligence on research and development, science and technology, innovation and knowledge based economic development. (http://www.researchmoneyinc.com/about.php) We talked to Mark regarding Canada's current state of research and development, highlights from that conversation include:

- Mark felt that the various mechanisms governments established are generally the right ones but it's a matter of scale, and recent governments have been still starving the innovation system to some degree. All the mechanisms are not big enough, NSERC and IRAP, for example should be twice the size. If you look at comparative countries they are putting an emphasis on this.

- Industry Canada has become very secretive, so much so that innovation system stakeholders don't have a sense of their strategies. If you're trying to rally people around the flag of innovation this is not a good way to do so. Communication is this government's biggest weakness; it does not seem to know how to engage the players. People that should be engaged in a process aren't even aware of it due to a lack of communication.

- A major part of the problem has been the Federal government largely ignoring sectors aside from natural resource producing sectors. When the oil industry started to falter, only then could you see government paying attention to more industries. An effective public research agenda needs to be based on a balanced innovation strategy, if it is to provide the engine for future growth of a diversified economy.

- In terms of national priorities and approaches it is still too easy for companies to be sold to foreign entities in this country. (Mostly American) A few weeks ago there was a change in legislation in Ontario, to extend the period for a company to decide if they're going to fight a takeover bid. Canada is being used as an R&D branch plant to a large degree. We need something tailored to Canada along the lines of the US Bayh-Dole Act. Governments have resisted that as long as I've been covering this industry.

- Respecting the NRC it is a little early to say if their new Flagship Programs have been effective. Although I think they are maintaining some fairly detailed metrics. This seems to be the kind of direct coordinated support I think Canada should be looking at to get greater BERD.

- Public Policy Forum report- Provides anecdotal evidence that Canada is winning fewer global project mandates then we have in the past. Clearly we do not have a lot of managerial talent familiar with the innovation ecosystem; it also seems to be a weakness of our business schools.

- The research commercialization challenge is continually evolving and requires adapting; there are new financing models making it easier for companies to get to market i.e. peer to peer lending, Kickstarter, crowdfunding. The U.K. seems to be ahead in this regard. These alternative funding models if we become an early adopter could give us an advantage. But it is still too early to tell.

- Canada has a solid basis upon which to build an effective financing eco system for innovative companies but it’s a matter of scale and leadership.

- We need a clear concise plan, something to rally around. Canada doesn’t have any science and technology champions in the current government. If you don’t take your science advisor seriously you will not gain a lot of traction. Other countries with a stronger central champion in the enterprise are doing better.

Interview with Bert van den Berg

Interview with Bert van den Berg

Bert van den Berg is the Director of - Colleges, Commercialization & Portfolio Planning, for NSERC. We talked to Bert regarding NSERC, commercialization and their Strategy for Partnerships and Innovation program. Highlights from that conversation include:

On the Strategy for Partnerships and Innovation program:

- Our main instrument is grant money, Money is used to build research infrastructure. We want to influence the nurturing of talent. We also - more indirectly – apply other instruments e.g. our IP polices are influential in how institutions deal with intellectual property.

- The Strategy for Partnerships and Innovation program had one key performance measure: to double the number of companies involved in our programs and in retrospect we can see that this performance measure shaped behaviour in the organization. Therefore one performance measure can be very effective. When we were considering subsequently allocating resources this measure encouraged us to consider the impact of those resources on growing the number of participating companies. In the early days, this performance measure encourages us to protect initiatives that might not have been continued if they had not been able to demonstrate alignment with our objective; talking particularly about Engage grants.

On the transformation of research culture over the past two decades:

- 1) Universities have seen substantial intake of new faculty; new faculty are much more open to partnerships. 2) Companies who have experienced economic shocks to their industries have become much more open to innovation. 3) Research infrastructure capabilities for supporting business R&D have been evolving and improving. Helps bring faculty to partnerships. Over the past 5 years colleges have become an important part of the overall partnered research storey.

\On commercialization and innovation:

- NSERC only spends about 30 million on what we call commercialization. High risk and high reward. Net incremental benefit to universities (licenses minus TTO administrative costs) is about 15 million a year.

- Idea to innovation (I2I) program is the closest thing we have to pure commercialization of university inventions. I2I is focused on helping a university invention get to the point where it can attract capital. Something like 14% of grants shows up in products/services in market within 5 years. Nothing huge out of the park, but there are jobs and companies continually being created and growing.

- The research in Canada is indicating that companies don't manage innovation as well as in other countries, and don't understand commercialization as well as some foreign competitors. One related factor is that the education level of senior level in Canadian companies is not as high compared to other countries senior level management and therefore Canadian companies are less likely to take on the risks that innovation implies, and/or hire people with higher education levels.

- Investments we're making in universities and colleges constitute an important part of the infrastructure needed to help businesses succeed.

On measures:

- Performance measures are useful but since policy needs change the performance measures also need to change: don't expect them to be permanent. More nuanced things that represent particular initiatives will change over time. Performance measurement is a function of what you're trying to achieve, and since that changes over time, your performance measure changes.

On start-ups:

- Deloitte recently conducted a study talked about start-ups. Canada is well represented and start-up growth is excellent. Mid-size is poor and we tend to sell. Half of start-ups end up outside the country. We don't lack start-ups; we lack the ability to generate wealth (i.e., profitable midsize and large companies) from promising start-ups.

ANNEX B: Article by James Balsillie
published in the (Toronto) *Globe and Mail* May 8 2015

Jim Balsillie is a co-founder of Research In Motion, now BlackBerry Ltd. He currently invests in and mentors five Canadian technology companies.

One frigid morning this January, I broke into a cold sweat thinking about the future for Canadian entrepreneurs. At a patent conference with some of the world's foremost innovation experts and practitioners, the lead strategist from one of the world's most valuable technology companies announced: "We don't sue Canadian companies until they start to matter to us. The money is not

worth it when they're small and we don't want to look like a bully. We wait until they get big enough, then we go after them. And we kill them."

What I learned in 20 years of growing Research In Motion from an idea into a global business with $20-billion in sales is that, in the realm of generating wealth from ideas, Canada isn't equipped for global competition. This lack of capacity is no longer optional, because low commodity prices and the steady decline in manufactured exports (due to competition from low-cost countries such as Mexico and China) have placed Canada at a competitive disadvantage.

The good news is that Canadian entrepreneurs have the potential to generate great wealth. Our innovators and entrepreneurs are world class. Their desire to grow a business here benefits every Canadian. But if we don't create an ecosystem where they can flourish, Canada's prosperity is at risk.

Countries leading in the innovation economy do it on the back of entrepreneurs and the commercialization of their ideas. High-margin profits generated from the sale of products or services underpinned by valuable patents account for billions in profits. This has quickly made technology companies the most valuable in the world, and added great amounts of private and public wealth to their home nations. That's why the competition is always ready to point the gun at Canadian entrepreneurs if they dare to break out and scale their companies globally.

Canada's terrible record of commercializing its ideas won't change until we build proper infrastructure to help our entrepreneurs succeed on the global stage, where the real money is made. The infrastructure and policies required for the innovation economy are significantly different from what's required for our traditional resource and manufacturing economies. Policies that helped us design infrastructure for traditional industries have little impact on an innovation economy.

Ownership of ideas is not decided by traditional ownership rules. If a Canadian entrepreneur has an idea with potential to generate great wealth, ownership of this idea will be decided in courts beyond Canada, by foreign judicial and geopolitical systems designed to make another country prosperous. This difference fundamentally shapes a business's potential global scale.

Canada's current infrastructure and our public and private leadership do not foster the needed capacity to contend effectively in the complex, predatory and state-sponsored ideas ownership game. That means that RIM will stay an anomaly until we fix critical gaps in our prosperity strategy.

Why Canada lags behind

In Canada, policies required for the innovation economy are either absent or inadequate. That is why we have zero growth in multifactor productivity (the standard measure of the commercialization of innovation) over the past three decades, as reported by Statistics Canada.

Both the Canada-U.S. free-trade agreement and the subsequent North American free-trade agreement (NAFTA) have been critical for Canadian businesses trying to compete in global

markets, because they allow a freer flow of goods across borders. Codified in the 1988 FTA is the government's statement that Canadian companies are "ready to compete now" in emerging technology sectors such as "computers and equipment." Our results have shown that we were not ready to compete, at least at scale. Open borders are a useful asset for Canadian oil, lumber or beef. They do enable the movement of technology products, but they don't address the ownership of ideas, which is the foundation for their profitable commercialization.

Both the FTA and NAFTA contain little about intellectual property rights (IPR), the currency of the innovation economy. The only IPR reference is a mutual commitment to "National Treatment," a principle in international law that means all parties agree to treat foreigners and locals equally. The National Treatment rule may work for our traditional economies, but it does nothing for a Canadian entrepreneur trying to grow a business from an idea. Ideas are not tangible goods – their possession is ambiguous and almost always decided in foreign courts.

Those courts are usually in the United States, because that's where the market for technology goods and services is created. A National Treatment case there takes years to prosecute and carries substantial risk of failure unless it presents clear evidence of mistreatment. These enforcement guidelines may be appropriate for a softwood lumber case, but they are useless for seeking justice in fast-moving high technology markets. That's why there hasn't been a single case of a Canadian company using the National Treatment clause on an IPR issue with the United States since NAFTA.

While NAFTA functions well for manufacturing and resource businesses, it leaves our policy makers believing that opening more international markets is the key to success for all sectors – even as that strategy fails to provide equitable results for Canadian companies competing to scale up their ideas globally.

Industry Canada's 2008 report Compete To Win lays out a broad premise that "removing legal, regulatory and policy impediments to competition [will provide] the conditions to better enable Canadian companies to compete in global markets." Compete, maybe. But win, certainly not. The report completely fails to address the conditions required to win in the innovation economy.

Geopolitics is at the heart of commercializing ideas. The money is enormous and the possession of ideas (and their ensuing profits) is manipulated at the national level. Because ownership is almost always determined in the United States, and the ensuing settlements usually must be effective globally, U.S. courts are effectively the world's IPR court system. That should make anyone else concerned with Canadian prosperity sweat, too.

Working together to win

Canadian politicians and policy-makers need to update their understanding of how the innovation economy works. Our American counterparts realized this long ago by jointly developing sophisticated intellectual property and commercialization expertise between the public and private sectors, and then aggressively using it. This was evident in the high-profile patent battle between Apple and Samsung, involving billions of dollars of annual royalty payments.

In June, 2013, South Korea's Samsung scored a major victory over Apple in a U.S. International Trade Commission decision to ban the import of Apple products because of infringement of Samsung patents. Two months later, in August, U.S. President Barack Obama vetoed the ITC decision, the first time in more than 26 years such a veto has been exercised. Two months after that, in October, Mr. Obama declined to veto a similar ban of Samsung products in the United States, ensuring that Apple maintained its profitable leverage over its competitor. A ban of certain Samsung smartphones is still in effect.

The wealth at stake is enormous, so governments and corporations work together to win. High-margin intellectual property rights account for half of U.S. exports, contribute $3.5-trillion (U.S.) a year to the American economy and employ nearly 18 million workers in high-paying jobs. That's prosperity from ideas commercialization.

NAFTA is just as insufficient for the American innovation economy as it is for the Canadian, which is why U.S. policy-makers are busy making major amendments to federal copyright law to ensure that the profits generated by its creative content keep flowing. The 1998 Copyright Term Extension Act and the 2011 America Invents Act are just two examples of a legislative strategy that provides flexibility to the benefit of U.S. interests and keeps all others on unstable footing.

As a major creator and distributor of creative content, the United States has a great deal to gain from lobbying for rules making it illegal to enjoy American creative work without new licences. Canada recently passed the Copyright Modernization Act, which was created in response to U.S. government and corporate interests working in a sophisticated fashion to advance American interests at the expense of other countries, including our own.

Disturbing WikiLeaks cables from the 2005-2009 period show systemic and effective lobbying by U.S. officials, who pressured Canadian politicians to implement stricter copyright laws. Cables from 2006 show Canada's industry minister promising the U.S. ambassador that final copyright legislation "would be in line" with American priorities. Another cable, from 2009, recounts a senior Industry Canada policy official asking a U.S. counterpart to put public pressure on Canada to create the needed justification to give Washington what it wanted.

Our policy-makers need a reminder that Canada's interests are not served this way. Without a domestic innovation lobby that can vouch for the interests of Canadian ideas and creative content, Canadian politicians are inadvertently legislating in American interests.

Canada's Compete to Win report contains the same policy gaps as the FTA and NAFTA, failing to address the infrastructure required for idea commercialization. The report has many laudable points, but the only tangible intellectual property recommendation it made was that Ottawa bow to U.S. pressure and "ensure new copyright legislation" that will "strengthen counterfeit and privacy laws."

I'm supportive of appropriate IPR protection, but we need strategies that make Canada prosperous, too. A couple of years ago, I participated in a conference of CEOs in Toronto where a former head of Canada's civil service said: "The government has done everything needed, so now it's time for entrepreneurs to step up and do their job." I believe we haven't even begun to

deploy smart strategic public policy options that will improve our innovation record. We need a strategy to advance our prosperity beyond the incomplete mantra of greater domestic IPR protection and open borders because these policies have not contributed to the growth of an indigenous innovation economy in Canada.

Europe is equally sophisticated in its IPR strategy. This is evident in the Comprehensive Economic Trade Agreement, which ensures more prosperity in Europe for its high-margin pharmaceutical industry and higher drug costs in Canada. Canada needs to puts IPR laws at the centre of its trade negotiations.

Countries that owe their prosperity to innovation rely on sophisticated engagement between entrepreneurs and policy-makers. Google executives, including co-founder Larry Page and executive chairman Eric Schmidt, have visited the White House 230 times since Mr. Obama took office, an average of nearly once a week. If Google, Apple and other U.S. tech companies get help from all branches of government to advance their collective prosperity, why are we insisting that Canadian entrepreneurs do it alone?

How we innovate better

I remain bullish on Canada's prospects. Outside the country, I've seen strategic public policy work hand-in-hand with entrepreneurs to help economies rise. We can do the same. We have invested hundreds of billions of dollars in our public and private institutions to achieve greater prosperity for all Canadians. But instead of spending more money to improve performance, we need to shift strategies.

Commercializing ideas does not automatically favour a large country. Israel, Sweden and South Korea are just a few of the smaller economies succeeding in this game. What they all have in common – and what we're missing in Canada – is a country-specific private and public framework designed to capture wealth from ideas.

A judicial strategy is a critical place to start. Canada's Federal Court could be given greater powers to combat unacceptable behaviour by domestic and foreign "patent trolls" – companies that do not make or sell a product but sue other companies for patent infringement based on existing patent rights the troll has secured. New legislation could allow for injunctions to prevent a troll from filing a U.S. lawsuit while Canada's Federal Court rules on whether the Canadian company has infringed on an asserted patent. Trolls could be required to be much more specific about how the target company's product infringes on the patent troll's claim – right now they can send out threat letters with general claims of infringement – and they could face sanctions when they are found to be using bad-faith tactics. Canada's Competition Bureau could be given the power to target anti-competitive activity.

As part of our new free-trade deal with the European Union, Ottawa could negotiate to become a member of the Unified Patent Court. The EU has made its patent enforcement system much more attractive and globally competitive by implementing the unitary European patent protection and court system, so that the ownership of ideas within the European market will be decided inside

the UPC. By becoming a member of the court with a venue in Canada, Canadian companies can have the same standing as European entities.

Other legal measures might include creating a sovereign patent pool and a prior art library to help Canadian small and medium-sized enterprises when they encounter litigation threats.

Our policy community can also propose strategic collaborations to better commercialize our ideas in the U.S. marketplace**.** A good example comes from Israel, which created a comprehensive set of idea commercialization strategies, including the Binational Industrial Research and Development (BIRD) Foundation, established in 1977 to support industrial research and development co-operation with the United States. BIRD supports an average of 20 projects a year, and the cumulative sales of products developed through it exceed $8-billion.

Canadian universities play an important role helping to build the infrastructure for an innovation economy, which is why they receive most of the yearly $12-billion (Canadian) invested in postsecondary research and development. Judging by the number of incubators, accelerators and hubs that are now associated with virtually every postsecondary institution, as well as in-house university research licensing offices, it's clear that commercializing research has become one of the top priorities for these institutions. In tight fiscal times, this is a welcome development – there is a lot of money to be made by commercializing university research.

We have a long way to go, however. The University of Toronto's commercialization office states that it is "in a class with the likes of MIT and Stanford." But Stanford has generated $1.3-billion (U.S.) in royalties for itself and the Massachusetts Institute of Technology issued 288 U.S. patents last year alone; U of T generates annual licensed IP income of less than $3-million (Canadian) and averages eight U.S. patents a year. Statistics Canada reports that in 2009, just $10-million was netted by all Canadian universities for their licences and IP. Even when accounting for universities that have open IP policies, this is a trivial amount by global standards.

Higher education expenditures on research and development have increased every year from 2006 to 2014, totalling more than $100-billion. The federal government's granting councils provide more than $3-billion a year toward research, making Canada one of the world's highest per capita government spenders on R&D. This funding covers grants that span the spectrum from basic research all the way to business-led research partnerships.

Many Canadian innovation reports speak of the importance of enhancing links between universities and business to spur commercialization of university research. Yet our universities need to create better incentives for researchers to spur commercialization.

Current tenure and promotion policies at 44 Canadian higher education institutions emphasize research, teaching and service to the institution. For hiring, the same criteria are used, except that the new candidates are judged by their potential as indicated by research publication and teaching experience. There is no evidence in these evaluation practices that any tangible value is given to commercialization of university research. Indeed, incentives for commercializing are essentially seen as perverse, because if a faculty member is spending time commercializing research then, by current evaluation standards, they are not doing their real job.

If we expect universities to be part of our prosperity strategy, then faculty interested in such pursuits should devise new institutional approaches for their career advancement that reward rather than punish them when pursuing commercialization of their research. A university's revenues affect the entire institution, so better incentives for successful commercialization is a prudent strategy that could also ease the pressure for more public funding.

Universities also need to be part of a wider strategy to better teach and encourage the commercialization of ideas. Barry Sookman, a Toronto-based lawyer and a leading authority on IP law, recently conducted a survey of 16 Canadian law schools. He concluded that "very few programs offer courses or opportunities that focus on teaching lawyers about commercializing IP or IP law strategies."

Our entrepreneurs graduating from law, business, computer science or engineering programs need to receive the proper education for commercializing on the global stage. Too many Canadian startups and small or medium enterprises lack IP strategies. Even businesses that do patent rarely have viable strategies for using or enforcing their intellectual property rights. In Silicon Valley, patent-protection strategies are present at all phases of R&D, from the outset.

Our government invests heavily in R&D through tax incentives and grants, with the objective of seeing Canadian companies better commercialize their ideas globally. We should explore creating an ideas-protection strategy as part of the process to obtain government funding. Robust strategies would better equip innovative companies to achieve meaningful global sales growth.

Beyond the universities, Canada has other publicly and privately funded incubators and centres of excellence, where entrepreneurs can learn to start and grow a business. These agencies and organizations represent a critical piece of our innovation economy, providing unique and intensive environments for learning, collaborating and mentoring.

One of Canada's largest startup incubators, Toronto-based MaRS, has recently come under scrutiny owing to potentially outsized claims of its success in generating revenue and helping its entrepreneurs. In my experience, this is not an isolated problem. Kitchener, Ont.-based Communitech, an incubator I helped to create in 1997, boasted for years on its website that it had "helped build a tech cluster that now generates more than $30-billion in revenue." But as I write this, the site no longer makes any revenue claims.

Equally troubling are superlatives that have nothing to do with business success yet are advertised as key indicators, such as the number of startups created. Creating a startup is considerably easier and cheaper than starting a traditional business. Yet the measure of success for every business, regardless of sector is the same: sales, profits, merger and acquisition expectation prospects, and value creation for shareholders.

If we are looking at these centres to play a role in our prosperity, then the success needs to be measured in revenue and company valuations from external financing or M&A. The public and private financiers of these institutions should demand these metrics as a condition of future funding.

The myth of lack of capital for private technology companies dominates the narrative in a lot of incubators and policy circles. Some of these myths have been around for decades, at least since I first set out to raise money for RIM. And yet, in 1996, after one day of meetings on Bay Street, we received $100-million in common equity investment orders for our private company. Four years later, in one week, we raised more than $900-million in common equity. There is plenty of investment money for ideas that can be successfully commercialized.

Raising capital for technology in Canada is difficult because so many investors are losing money. Venture capital in Canada is one of the worst-performing asset classes. A 2013 study by Thomson Reuters and the Canadian Venture Capital Association reported a staggering divergence in 10-year pooled average returns between U.S. and Canadian VCs. The American VCs' return was 13.5 per cent, while the Canadian VCs' lost 3.4 per cent. A 2014 Cambridge Associates study of early-stage VCs was even more troubling, with U.S. VCs reporting a return of 20.5 per cent and Canadian VCs reporting a loss of 5.6 per cent.

Meanwhile, Canada's low ranking in the OECD's business enterprise expenditure on research and development rankings is often blamed on the national tendency to "sit on dead money" because of "cultural risk aversion" or "insufficient outward-looking attitudes." But these arguments don't account for how business investment works. An investment in the ideas sector is made for the reasonable prospect of profit from commercialization – just like in venture capital. Business moves with the carrot of profit, not the stick of hectoring. If you own a good idea with a reasonable plan to address and protect your market opportunity, investment capital is virtually limitless. We are inadequate at protecting ownership of our ideas, which undermines commercialization and, in turn, return on investment.

'Mission-oriented' leadership

Canadians are capable of creating national wealth when we approach prosperity systematically and strategically. Our best 20th-century example of "mission oriented" economic development leadership was Alberta Premier Peter Lougheed's 1974 establishment of AOSTRA, the Alberta Oil Sands Technology and Research Authority. The Crown corporation's original government funding of $100-million increased over time to $1-billion, with the objective of developing technologies and processes that would get the private sector back working on the 90 per cent of the oil sands that were too deep to be surface mined. The intellectual property it developed was owned by the province and licensed to commercial operators, providing the critically needed "freedom to operate."

Approaches like AOSTRA and, more recently, Own the Podium, in the field of high-performance sport, have proved that Canada can set a goal, then do what it takes to achieve it. We can make commercialization of ideas a source of our prosperity if we apply strategic approaches.

Our infrastructure needs to be updated to include forums where commercialization of Canadian ideas are given strategic and integrated policy focus. We need an indigenous innovation lobby that exclusively advances the interests of Canadian entrepreneurs trying to grow their businesses globally. I was the only Canadian ever asked to join the U.S. Business Council, whose members

included CEOs of some of America's best-known companies. At the last meeting I attended, half of a two-day event was spent discussing the protection and commercialization of American intellectual property abroad. Attending the meetings were former and current State Department officials whose roles were intrinsically linked to advancing U.S. economic interests.

There are many forums where American businesses and trade associations work closely with policy-makers to advance their economic interests. But in the innovation economy, lobbying efforts are not confined to private enterprise. Universities have a large stake in the U.S. patent system, so they actively participate in advancing their interests along with (or sometimes in competition with) the private sector. American universities shrewdly lobbied to attain an exceptionally valuable carve-out from the America Invents Act, immunizing university patents from a "prior user" rights defence in infringement suits. This advantage translates into hundreds of millions of dollars in new university revenues.

We need a Canadian complement to this innovation lobby, centred on Canadian-domiciled companies selling Canadian ideas globally, to obtain the full commitment of federal politicians and policy-makers to act in ways that support their profitable growth. And we need Canadian universities to actively participate in advancing their own prosperity. The valuable "prior use" exemption was granted only to U.S. universities, but Canadian universities could pursue a National Treatment case under NAFTA that would give them greater leverage to dramatically increase their net licensing revenues.

The commercialization of ideas is a chain of systematic and deliberate events. This is how wealth is generated in an innovation economy. Growing and scaling up a critical mass of ideas-based companies in the global marketplace is difficult, but not impossible. Yet for us to expect that the results of our current innovation policies and investments will miraculously spur new companies and significant economic growth is, as many people like to say, the definition of insanity: doing the same thing over and over again, and expecting a different result.

More than 16 years after RIM launched BlackBerry, it remains the only Canadian company listed among the world's top innovators because it owns one of the most valuable technology portfolios in the world. My business experience is unique in Canada, but I do not claim to have all the answers. I am certain, however, that Canada's innovation performance will not improve unless the country's business, university and political leadership come together to consider radically different policies, programs and tools. Canadian taxpayers deserve better returns on their enormous investments in innovation.

Prosperity is not for entrepreneurs, business or government to foster alone. It's not exclusively for the political left or right. Every Canadian wants this country to be prosperous. We have a duty to our next generation of entrepreneurs – those with the potential to build great companies and employ vast numbers of Canadians – to build a commercialization ecosystem that will help them grow and scale up. Not merely to compete in the global innovation economy, but to win.

ANNEX C: EXECUTIVE SUMMARY OF THE JENKINS REPORT 2011

What We Heard and Learned

During our extensive consultations, we learned about many Canadian success stories and heard from numerous entrepreneurs who said that federal programs have served them well. We also heard that there is opportunity to enhance the impact of programs to make them even better. We heard that the government should be more focused on helping innovative firms to grow and, particularly, on serving the needs of small and medium-sized enterprises (SMEs). We heard that programs need to be more outcome-oriented as well as more visible and easy to access. We heard that whole-of-government coordination must be improved and that there should be greater cooperation with provincial programs, which often share similar objectives and users. We also learned that innovation support is too narrowly focused on R&D — more support is needed for other activities along the continuum from ideas to commercially useful innovation. This extensive feedback, supplemented by research and analysis and interpreted in the course of the Panel's internal dialogue, forms the basis of our advice.

A Framework for Action

Our work has been guided by a long-term vision of a Canadian business sector that stands shoulder-to-shoulder with the world's innovation leaders — ultimately, this means a more productive and internationally competitive economy that supports rising living standards for Canadians. To transform this vision into reality, we believe that the government must focus its efforts on the goal of growing innovative firms into larger enterprises, rooted in Canada but facing outward to the world and equipped to compete with the best. Achieving the Panel's vision requires public policy action on a number of fronts, including ongoing efforts to refine and enhance marketplace and regulatory policies that influence the climate for private sector competition and investment. While these framework policies are not within the scope of this review, we would emphasize that the impact of our advice depends ultimately on complementary efforts to strengthen those policies — especially as they relate to encouraging the competitive intensity that is a central motivator of innovation. The core of our advice can be summarized in six broad recommendations, the details of which are elaborated subsequently. Taken together, they provide a framework for action.

Industrial Research and Innovation Council

We envisage a new, whole-of-government program delivery vehicle — the Industrial Research and Innovation Council (IRIC) — that would be the centrepiece of the federal government's efforts to help entrepreneurs bring their innovative ideas to the marketplace and grow their companies into internationally successful businesses. To this end, the IRIC should take on at least the following industry facing activities:

- Deliver an expanded Industrial Research Assistance Program (IRAP) and a commercialization vouchers pilot program that connects SMEs to providers of commercialization support;
    - Provide a national "concierge" service and associated website to help firms find and access the support tools they need work with partners to develop a federal business innovation talent strategy.
    - Moreover, the IRIC could assume the following responsibilities: in partnership with the federal granting agencies, joint oversight of appropriate business-facing programs administered by those agencies; technical assessment of the innovation element of project proposals submitted to the regional development agencies; and oversight of federal support for business-oriented collaborative research institutes evolved from the current institutes of the National Research Council, as further discussed below.

Scientific Research and Experimental Development (SR&ED) Tax Credit

In line with feedback from stakeholders, we are recommending that the SR&ED program should be simplified. Specifically, for SMEs, the base for the tax credit should be labour-related costs, and the tax credit rate should be adjusted upward. The current base, which is wider than that used by any other countries, includes non-labour costs, such as materials and capital equipment, the calculation of which can be highly complex. This complexity results in excessive compliance costs for claimants and dissipates a portion of the program's benefit in fees for third-party consultants hired to prepare claims. Canada's program mix is heavily weighted toward the SR&ED program and, during our consultations, we heard many calls for increased direct expenditure support. As well, many leading countries in innovation rely much less than Canada on indirect tax incentives as opposed to direct measures. That is why we are recommending other improvements to the SR&ED program that will generate savings for the government. The savings should be redeployed to fund direct support measures for SMEs, as proposed in our other recommendations.

Specifically, to ensure a greater focus on promoting the growth of firms, the portion of the credit (claimed by SMEs) that is refundable — that is, paid regardless of whether the firm generates taxable income — should be reduced, such that part of the benefit would depend on the company being profitable. Given the central importance of the SR&ED program to firms across the country, our recommended changes should be phased in over several years to allow time for adjustment.

Risk Capital

Innovative, growing firms require risk capital, yet too many innovation-based Canadian firms that have the potential for high growth are unable to access the funding needed to realize their potential. The government can play an important role by facilitating access by such firms to an increased supply of risk capital at both the start-up and later stages of their growth. We therefore recommend measures to establish risk capital funds that target these areas. The federal government's contribution to the funds would be delivered through the Business Development Bank of Canada (BDC), with incentives and governance designed to ensure strong private sector participation and leadership.

Collaborative R&D Institutes

Canada needs a fundamentally new approach to building public–private research collaborations in areas of strategic importance and opportunity for the economy. Accordingly, we recommend that the business-oriented institutes of the National Research Council (NRC) should become independent collaborative research organizations, intended to be focal points for sectoral research and innovation strategies with the private sector. Those NRC institutes that perform primarily fundamental research would become affiliates of universities, while those with core public policy mandates would be transferred to the most relevant federal department or agency.

Public Sector Procurement

The government should make better use of its substantial purchasing power to create opportunity and demand for leading-edge goods, services and technologies from Canadian suppliers. This will foster the development of innovative and globally competitive Canadian companies connected to global supply chains, while also stimulating innovation and greater productivity in the delivery of public goods and services. We therefore recommend that encouragement of innovation in the Canadian economy should

become a stated objective of procurement policies and programs. Further to this end, we recommend, among other measures, that the current pilot phase of the Canadian Innovation Commercialization Program (CICP) evolve into a permanent, larger and effective program that provides incentives for solving operational problems identified by federal departments.

Whole-of-Government Leadership

The responsibility to foster innovation cuts across many functions of government and requires a system-wide perspective. For this reason, the government needs to establish business innovation as a whole-of-government priority. This will require the designation of a Minister as the voice for innovation, with a stated mandate to put innovation at the centre of the government's economic strategy and to engage the provinces in a dialogue on innovation to improve coordination and impact. Effective implementation of our action plan will depend on an oversight structure that ensures the timely achievement of desired outcomes. We recommend that the government's main tool in that regard should be an external Innovation Advisory Committee (IAC) — a body with a whole-of-government focus that would oversee the realization of our proposed action plan, as well as serve as a permanent mechanism to promote the refinement and improvement of the government's business innovation programs going forward.

ANNEX D: PARADOX LOST; CCA NICHOLSON REPORT

INNOVATION AND BUSINESS STRATEGY: WHY CANADA FALLS SHORT

The Expert Panel on Business Innovation

Executive Summary

Executive Summary

This report addresses the fundamental factors that influence the innovation behaviour of businesses in Canada. Innovation is of great economic importance because it is, directly and indirectly, the key driver of labour productivity growth (increased output per hour worked) and the main source of national prosperity. The panel has therefore approached innovation as an *economic* process rather than as a primarily science and engineering activity. The theme is the link between business strategy and innovation activity. The focus is on the long run, spanning several turns of the economic cycle. The findings therefore remain relevant despite the current shock to the global economy. As requested by the government, the report is primarily a diagnosis, not a policy prescription, though it provides a body of facts and informed opinion that is of policy relevance.

INNOVATION DEFINED

Innovation is new or better ways of doing *valued* things. Innovation is not limited to products but includes improved processes like the assembly line, and new business models like web-based commerce. An "invention" is not an innovation until it has been implemented to a meaningful extent. Radical innovations like the steam engine and the transistor create entirely *new markets*. Much more prevalent is incremental innovation in e*stablished markets* in which goods and services are continuously improved – a process that is responsible for the majority of labour productivity growth. Although the strategies and policies appropriate for .innovation in new markets are generally quite different from those in established markets, they are complementary because successful new markets, like the "smartphone" market today, eventually become established markets.

INNOVATION AND PRODUCTIVITY

Canada has a serious productivity growth problem. Since 1984, relative labour productivity in Canada's business sector has fallen from more than 90% of the U.S. level to about 76% in 2007. Over the 1985-2006 period, Canada's average labour productivity growth ranked 15th out of 18 comparator countries in the OECD.

Long-term analyses by Statistics Canada and the OECD show that Canada's relatively poor productivity growth is due mainly to weak growth of *multifactor productivity* or MFP. (MFP broadly reflects the effectiveness with which labour and capital are combined in the economy.) Canada's productivity weakness is not due to shortcomings in its workforce. Neither, for the most part, does it refl ect inadequate capital investment, though business investment in information and communications technologies (ICT) has been especially weak and subpar investment in advanced equipment and software can also hold back MFP growth. The rate of MFP growth over suitably long periods primarily reflects the contribution of business innovation to labour productivity growth – including better organization of work, improved business models, the efficient incorporation of new technology and the payoff from research and development (R&D) and from the insights of entrepreneurs.
Canada's weak growth of MFP indicates that the country's lagging productivity growth is largely due to weak business innovation.

OTHER INNOVATION INDICATORS

Canada's weakness in business innovation is also signalled, more conventionally, by persistently lagging investment in R&D and, more recently, in ICT, though
these indicators are far less comprehensive as measures of innovation than is the long-run rate of MFP growth.

Research and development: Since the collapse of the technology boom in 2001, Canada's business expenditure on R&D has remained roughly fl at after taking account of inflation. Expressed as a percentage of GDP, business R&D declined by 20% between 2001 and 2007 and has consistently fallen below the OECD average. The gap in business R&D spending between Canada and the United States diminished significantly between the mid-1980s and the peak of the technology boom in 2001, but has since begun to open up again. The most significant drivers of the long-run trend have been (i) a sharp reduction in the contribution of the manufacturing sector to the Canada-U.S. gap, implying that Canada has been making some progress in manufacturing innovation; and (ii) an offsetting increasing gap in business services R&D (particularly in wholesale and retail trade). The broad shift of output and employment toward services and the application of ICT in service sectors have been occurring more rapidly in the United States than in Canada.

Machinery and equipment: Investment in machinery and equipment (M&E) is a principal channel through which innovation drives productivity growth because such investment "embodies" the prior innovation of producers of capital goods, including software. M&E investment also stimulates innovative changes in processes and work organization to take best advantage of the new capital. (The productivity improvement resulting from such changes is captured statistically within MFP growth.) Annual investment by Canadian business in M&E (as a percentage of GDP) has not always lagged the United States as has been the case with R&D, though a gap has opened up since the early 1990s. The M&E investment gap has been mostly due to Canada's persistently weaker investment in ICT.

Average ICT investment per worker in Canada was only about 60% of the U.S. level in 2007. This is a serious shortcoming since the production and application of ICT have been the key drivers of innovation and resulting productivity growth in the United States and several other countries.

THE CENTRAL ROLE OF BUSINESS STRATEGY

Business strategy drives innovative behaviour. Explaining business innovation performance in Canada therefore comes down to explaining the business strategy choices of Canadian firms. *If innovation is good for business, why don't more businesses in Canada choose to compete on the basis of innovation?* To address this question requires a shift of perspective away from innovation activities themselves – e.g., inputs like R&D and investment in M&E – to a focus instead on the factors that influence the choice of business strategy. This reframing of the innovation puzzle is the most important contribution of the panel's analysis.

FACTORS THAT INFLUENCE CHOICE OF AN INNOVATION STRATEGY

The principal factors that influence the business innovation decision can be categorized broadly as (i) particular characteristics of the firm's sector; (ii) the state of competition; (iii) the climate for new ventures; (iv) public policies that encourage or inhibit innovation; and (v) business ambition (i.e., entrepreneurial aggressiveness and growth orientation). The relative importance of these factors will vary from sector to sector and over the life cycle of individual fi rms. The foregoing factors are themselves influenced by certain long-standing features of Canada's economy, of which the two most significant are the following:

1. *Canada is "upstream" in many North American industries".* This positioning is the result of Canada's resource endowment and development history as a commodity supplier and technology adopter. Canada's upstream position in many continentally integrated value chains limits contact with ultimate end-customers – who are a strong source of motivation and direction for innovation – and shapes the nature of business ambition in many sectors.
2. *Canada's domestic market is relatively small and geographically fragmented.* Small markets offer lower potential reward for undertaking the risk of innovation and tend to attract fewer competitors, thus providing less incentive for a business to innovate in order to survive. On the other hand, the innovation success of countries like Finland and Sweden shows that the disadvantage of a small domestic market can be offset by a strong orientation toward innovation-intensive exports.

Industry Structure Characteristics

The effect of structural factors – particularly sector mix and foreign control – on business strategy choice is most readily seen through analysis of the gaps between Canada and the United States in respect of R&D spending and ICT investment (interpreted as indicators of emphasis on innovation as a business strategy).

Sector mix: A sector by sector analysis of the overall U.S.-Canada R&D gap shows that generally lower Canadian R&D spending within the *same* sectors in both the United States and Canada accounts for a greater portion of the

gap (the precise share of which varies from year to year) than does Canada's adverse sector mix – i.e., the greater weight in Canada's economy of resource-related and other activities that have inherently low R&D spending. Resource-based industries invest heavily, though indirectly, in innovation that is embodied in advanced equipment. The puzzling failure of Canada to develop global export leaders in advanced M&E for the resource sector is one particularly telling indicator of the country's innovation shortcomings.

Foreign control: The foreign control of several major Canadian businesses is part of the explanation for low R&D intensity – e.g., accounting for very low Canadian R&D in the automotive and chemicals industries. This reflects the traditional tendency of global corporations to conduct most innovation activity near their headquarters. There is nevertheless a trend underway to distribute innovation activities globally so as to take advantage of lower costs and special skills, and to be closer to important concentrations of customers. Foreign control does not automatically lead to low R&D activity in Canada. In fact, foreign subsidiaries in several sectors – e.g., pharmaceuticals and computers – have been major contributors to Canadian R&D. Moreover, if the foreign-controlled facilities were not here, there is no guarantee that Canada would have developed a "replacement set" of domestically owned R&D performers.

Canada's failure to develop a greater number of innovative Canadian-based multinationals has been a key contributor to the country's overall R&D weakness.

Structure and ICT investment: Empirical studies suggest that only about 20% of the U.S.-Canada gap in ICT investment can be explained by structural characteristics related to sector mix and firm size distribution. Further study is needed to determine definitively the other factors that account for this perplexing gap. For now, it can only be said that relatively low ICT adoption is consistent with a view that *Canadian businesses on the whole, but always with notable exceptions, are technology followers, not leaders.*

Competitive Intensity

Competition stimulates innovation in most circumstances. In Canadian sectors that are well exposed to international trade (whether as exporters or competing against unconstrained imports), there do not appear to be significant innovation gaps, though many of Canada's export industries are either specialized at the upstream end of the value chain or dependent on technology and innovative practices in foreign-controlled firms. The relatively small size of Canada's domestic market – made even smaller by regional fragmentation – tends to limit both competitive intensity and the returns to innovation in domestic sectors, which underlines the importance of increasing Canada's presence in global export markets for innovation-intensive goods and services. Innovation is needed to move from a domestic to a global growth strategy.

Reciprocally, a heavy investment in innovation usually requires Canadian businesses to go for the scale of global markets. Canadian businesses, on the whole, have so far failed to aggressively grasp the opportunities created by globalization, a shortcoming that is demonstrated by the relative lack of innovation oriented Canadian-based multinationals.

The Climate for New Ventures

Despite some dynamic clusters – such as in Waterloo and in the largest Canadian cities – Canada needs to do better in creating the conditions to enable more of the country's impressive number of startups to become viable, growing businesses still based in Canada. The following three key conditions determine the quality of the environment in Canada for the support of such businesses.

Financing new ventures: A vibrant angel investor community is the key to bridging the "valley of death" that separates a promising idea from a viable startup business. (Angels are produced when innovative entrepreneurs succeed and thus generate both the financial resources and the experienced mentors to stimulate and guide a new generation of innovators.) The limited data available on "informal" investment sources in Canada suggest that they are much less extensive, in relative terms, than comparable sources in the United States. (Canada has produced a number of successful angel investors in several ICT subsectors, but relatively few in the life sciences.) Venture capital (VC) is the post-angel stage of funding when the basics of the business proposition have already been developed and larger sums are needed to ramp up to commercial scale. The generally weak performance of Canada's VC industry is due to the fact that the industry is still relatively young, and thus has not yet developed suffcient depth of experience to select and mentor the best potential investment candidates. It is also the case that several issues related to the VC activities of tax-advantaged Labour Sponsored Investment Funds (particularly outside Québec) have affected incentives and performance in the industry. While there is no quick or easy fix for

Canada's VC industry, better performance depends on the industry maturing through competitive experience. Policy makers can positively influence the availability of risk capital funding, particularly at the earliest stage and also at the critical later (VC) stage of expansion and market growth.

Commercializing university research: Canada's record of university-based research activity is strong and ranks among the best of the OECD countries, but the commercialization of university research in Canada has been, on the whole, disappointing. The principal causes relate to (i) the shortage of commercial receptor capacity in Canada, due to the fact that relatively few established firms in this country are committed to research-based innovation (and would therefore be in a position to transact with universities); (ii) the relative weakness of new venture financing in Canada at both the angel and later VC stages; and (iii) the inherent differences in the incentives and professional values of the university and the business firm, an issue not unique to Canada. The situation could be helped through better infrastructure for identifying and mobilizing potentially commercializable knowledge as it emerges from university-based research. In many cases this will involve well designed partnerships between universities and private sector businesses and/or government labs.

Supporting innovation clusters: Innovation is fostered by the close personal and supplier linkages that occur in certain geographic concentrations, creating local innovation "ecosystems". Public policies designed to create such clusters from scratch have yet to demonstrate much success in Canada or elsewhere, though continued learning from initiatives like MaRS in Toronto will aid the design of supportive policies. Some pre-existing advantages and a strong local catalyst appear to be critical factors. The Waterloo story is one good example and shows that cluster developement may require both considerable time to mature and the convergence of several favourable features that are typically specific to the locality.

The Public Policy Environment

In broad terms, and over time, Canada has provided a progressively more encouraging environment for business innovation, at least in respect of those factors over which public policy has direct influence – for example, prudent fiscal and monetary policies, a trend of lower tax rates and support for university research. The business innovation problem nevertheless persists, so there is still much work to do.

Human capital: The continuing development of human resources is clearly necessary for innovation success and, in general, this is an area of relative Canadian strength. More specifically, the federal government's strong commitment since the mid-to late 1990s in support of university research has increased the supply of leading-edge skills and research capacity and, other things being equal, made Canada a more attractive location for innovative business. On the other hand, Canadian business managers are, on average, not as well trained as those in the United States. This education gap may leave many Canadian managers less aware than their U.S. counterparts of developments at the leading edge of technology and business practice, and thus less likely to choose business strategies that emphasize innovation.

R&D incentives: The Scientifi c Research and Experimental Development tax incentive provides by far the largest direct fi nancial support for business innovation in Canada – representing about $4 billion of federal tax foregone in 2007. While there is good evidence that the tax credit has a positive net benefit, many business leaders believe that the program should be improved – e.g., by extending the "refundability" of the credit beyond small businesses to R&D performers of any size. While Canada's total government support for business R&D (tax and direct spending combined) is somewhat larger, relative to GDP, than that of the United States and the United Kingdom, it is noteworthy that Canada's reliance on the tax assistance channel to stimulate R&D is unusually heavy. Although most countries have been increasing the use of tax credits in their R&D support programs, more evaluation is needed to determine the right mix.

Sector strategies: The ICT sector, among others such as aerospace, provides several examples of the government's catalytic role in enabling innovative activities to take root and build scale to the point where commercial viability emerges. This initiating influence has taken many forms – early procurement (for example, stimulating IBM's

substantial presence in Canada); public-private commercial partnerships in support of a national mission (for example, creation of Telesat in 1969); and research support through targeted university funding and sector oriented government facilities and programs.

Business Ambition

Are Canadian businesses good enough to compete in global markets, aggressive enough, willing to take risks, and sufficiently outward-looking beyond the huge and accessible U.S. market? Clearly, the many Canadians who have built successful global businesses have the necessary attributes. But the issue is whether there are enough of them to ensure the long-term prosperity of the entire economy. The panel's view is that today, there are not. This is not due to any lack of innate capacities of Canadian business people – it is not in the "DNA", so to speak. Canadian business as a whole has been profitable despite its mediocre innovation record – pre-tax business profit in Canada, as a percentage of GDP, has exceeded that of the United States in most years since 1961. So the behaviour of Canadian business is unlikely to change unless its circumstances change. Those circumstances are, in fact, changing radically due not only to the current turmoil in the world economy but, more fundamentally in the long run, to a massive reallocation of the share of global economic activity as China and others become full participants in world commerce. The demographics of the Canadian business community are also changing as immigrants and a younger generation of entrepreneurs, unencumbered by traditional attitudes, expand their presence. So whether by necessity or inclination, there is reason to expect that Canadian business will become more ambitious and innovative.

ADDRESSING CANADA'S BUSINESS INNOVATION CHALLENGE

Canada has a serious productivity growth problem. The statistical evidence is unambiguous and of long standing. The panel believes that Canadians should be concerned about the productivity of our export-oriented economy as competition from China and other emerging economies intensifies. Strong productivity growth is the way to remain internationally competitive with a rising standard of living. The panel also believes that Canadians should be concerned about the long-run consequences of continued weak productivity performance in the domestic economy as the population ages and competition intensifies among the mature economies for the best human skills, and particularly for entrepreneurial talent. Because *Canada's productivity problem is actually a business innovation problem*, the discussion about what to do to improve productivity in Canada needs to focus on the factors that encourage, or discourage, the adoption of innovation-based business strategies. This is a complex challenge because the mix of relevant factors varies from sector to sector and requires a much broader conception of innovation than the conventional R&D-centered view which, while important, is too limiting. There is no single cause of the innovation problem in Canada, nor is there any one-size-fits-all remedy. Public policy in respect of innovation therefore needs to be informed by a deep understanding of the factors that influence business decision makers, sector by sector, and this clearly requires extensive consultation with business people themselves as well as the further development of innovation surveys and other forms of micro-analysis of the innovation process. (The report provides several examples of industry-specific innovation challenges and strategies through short case studies of the automotive, life sciences, banking and ICT sectors.) Overarching the sector-specific factors that influence innovation strategies are certain issues of pervasive influence identified in the panel's analysis that suggest the need for proactive public policies to:

- encourage investment in advanced M&E in general, and in ICT in particular (such incentives should be designed only in light of a more thorough understanding of the reasons for the relatively slow adoption of ICT in Canada to date);
- sharpen the incentive for innovation-oriented business strategies by increasing exposure to competition and by promoting a stronger export orientation on the part of Canadian firms, particularly in goods and services that are downstream in the value chain and thus close to end-users;
- improve the climate for new ventures so as to better translate opportunities arising from Canada's university research excellence into viable Canadian based growth businesses, bearing in mind that better early-stage financing and experienced mentorship hold the key; and

- support areas of particular Canadian strength and opportunity through focused, sector-oriented strategies, such as was done in the past in, for example, the automotive, aerospace and ICT industries. The many successes of Canadian businesses in the hyper-competitive global market place show that there is nothing innate or inevitable in the national character that prevents Canada's businesses from being just as innovative and productive as those of other nations. The panel has completed its analysis of business innovation in the shadow of the most severe global economic downturn in decades. The panel has nevertheless remained focused on the long term because Canada's innovation conundrum is deeply rooted and has little to do with the booms and busts of the economic cycle. As

governments in Canada continue to take measures in the near term to mitigate the downturn, the panel's diagnosis of the nature and underlying causes of Canada's generally weak business innovation performance can help to target those measures so that they also strengthen the nation's economy for the long term.

LIFE SCIENCES: GREAT PROMISE BUT MIXED RESULTS

Life sciences comprise the most R&D-intensive sector of the economy and generally exhibit a strong strategic commitment to innovation. The scientific dynamism generated by the genomics revolution and its applications promise to make life sciences a defining industry of the 21st century. While the broad definition of life sciences encompasses biological science and technology in relation to health, agriculture and the environment, the focus in what follows is on health-related biotechnology and pharmaceuticals. Companies in health-related life sciences are of three main types, each of which faces different issues (Clark, 2008):

• Large, brand name pharmaceutical companies are foreign owned and dominate the industry with more than 80% of total sales, most of which are patented medicines. In this sector, corporate success globally is dependent on finding new drugs, and in Canada on selling them at competitive prices in an environment where market access and pricing are largely determined by government policies.

• Small R&D-oriented companies – biotech and medical devices – account for relatively insignificant sales, but are important generators of innovation and future growth. These companies, many of which are startups, rely on VC financing, and therefore are sold (perhaps outside Canada) or wound down when VC support ceases.

• Generic pharmaceutical manufacturers represent more than 15% of industry sales and 40% of volume, but do relatively little R&D. (This R&D is aimed primarily at copying established medicines whose patents are about to expire.)
Canadian generic firms are nevertheless quite competitive and export a significant proportion of their sales.

Canada's Performance

Canada's role in the global pharmaceutical industry roughly mirrors the country's overall size. With approximately 2.5% of global sales (and also 2% of global business R&D spending), Canada is a small player in the sector overall (Table 10).

However, even those small amounts are sufficient to place Canada in the global top 10 by most measures. Within biotechnology, Canada ranks even higher and is typically in the top five. In generics, Canada is also well ahead of its population rank, with strong global competitors in Toronto and Montréal.

Table 10
Share of Global Business Expenditure on Pharmaceutical R&D
% OF GLOBAL EXPENDITURE

U.S.	37.3	41.5	38.3	36.5
Japan	16.2	14.9	14.3	14.8
U.K.	12.1	11.8	13.3	11.1
France	6.4	8.5	7.8	7.6
Germany	8.1	5.0	6.7	7.5
Sweden	2.1	2.7	3.7	3.6
CANADA	**1.2**	**1.5**	**1.7**	**2.0**
Rest of World	16.6	14.1	14.2	16.9

Data Sources: Macher et al., 2008, p. 209; for Canada, calculations derived from OECD data (2008i)
National currencies converted to $US at purchasing power parity (PPP) exchange rates as published by the OECD.

In total, Canada spends a little more than $6 billion annually on R&D in the health-related life sciences sector (Figure 10.2), but that overall figure masks a complex reality:

• Global pharmaceutical firms fund clinical research in health care facilities, which accounts for a large share of total spending. Some of their Canadian affiliates also maintain pre-clinical research facilities, which contribute only a small percentage of their R&D efforts.

• Generic firms spend about $70 million in development R&D.

• Governments and private non-profit organizations fund significant basic and pre-commercialization research in universities and teaching hospitals, which accounts for more than half of the total spending.

• Finally, biotech and medical devices firms spend in total a few hundred million dollars per year, which is funded by VC firms, large pharmas under co-operative arrangements, and refundable SR&ED tax credits.

Anecdotal evidence suggests that the total life sciences research effort is generating significant discoveries, although reliable and up-to-date data are difficult to obtain

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85.one study that looked at drugs approved by the U.S. Food and Drug Administration between 1998 and 2003 found that 2% had Canadian origins, based on the locations of the patent holders (Kneller, 2005). This would be comparable to Canada's current share of global business R&D spending, but greater than Canada's share when the discoveries would likely have been made. In 1990, for example, Canada's share of global business expenditures on R&D was only 1.2%.

The Role of Public Policies

The life sciences sector has been of significant interest to policy makers and investors for more than 20 years. Beginning in the 1980s, Canadian governments adopted a variety of policies intended to promote the development of the sector, and specifically policies intended to promote the development of the sector, and to encourage growth in R&D. These policies included patent law changes and additional government funding for research. The multinational pharmaceutical companies committed to spend 10% of their sales on R&D in return for favourable patent legislation (colloquially referred to as bills C-22 and C-91). These policies were successful in generating additional R&D in Canada.

(Figure 10.3). Business spending on pharmaceutical R&D grew from less than $200 million in 1988 to more than $1.2 billion in 2003. Private-sector spending has been complemented by significant public-sector investments, with both the federal and provincial governments increasing their support for health-related R&D more than threefold over this period. No other sector has received this level of direct public R&D support. The public investment nevertheless failed to produce the economic results desired or expected.

$1,525
$1,760
$1,315
$ 357
$ 521
$ 833
TOTAL: $6.3 Billion
$ Million

*Statistics Canada estimates used for 2007.
**Higher Education includes teaching hospitals and comprises expenditures by the institutions from their own revenues (some of which are provided via general support from governments).
Data Source: Statistics Canada, 2008f

Figure 10.2
Sources of Health R&D Funding in Canada

Public sources (governments, universities and teaching hospitals) contributed about 55% of the funding to support health R&D in Canada, or about $3.4 billion in 2007. The actual performance of the R&D would be more heavily concentrated in universities and hospitals.

Although private R&D funding – mostly by the Canadian affiliates of global pharma – has increased six fold, the share of the pharmaceutical industry in Canada's business GDP has fluctuated around 0.5%. Meanwhile, the U.S. share has almost doubled, growing from about 0.6% of business GDP in 1987 to 1% in 2002 (Figure 10.4(a) and (b). While Canada's pharmaceutical exports have grown significantly from $1.5 billion in 1998 to $6.8 billion in 2007, the industry still represents less than 2% of Canada's total exports (Industry Canada, 2008). In sum, although Canada has had a policy to promote pharmaceutical R&D spending in Canada, and has had success doing so, the domestic economic impact has been limited.

Even in areas where Canadian research has been successful, the commercial exploitation of that knowledge has tended to take place elsewhere. This has been the case for not just the R&D undertaken by the large pharma companies, but also by the growing biotech industry – e.g., Biochem Pharma and QLT. While there has been some modest success growing mid-sized firms in Canada, most have been absorbed by larger global enterprises. The one area where Canada has had increased commercial success is in generics, which benefited from the government's previous policy of compulsory licensing.

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[i] Research and Development Spending
http://www.statcan.gc.ca/daily-quotidien/141017/dq141017c-eng.htm

Canada's gross domestic expenditures on research and development (R&D) are expected to total $30.6 billion for 2014. This is virtually unchanged from total

R&D expenditures in 2013 of $30.7 billion.

For 2014, business enterprises performing R&D expect to spend $15.4 billion, down 0.9% from the previous year. For R&D funding, the business enterprise sector is expected to finance $14.1 billion in 2014, down 1.1% from the previous year.