Canada's Innovation Performance:

A Scorecard

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Centre for Digital Entrepreneurship
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About The Deep Centre

The Centre for Digital Entrepreneurship and Economic Performance (DEEP Centre) is a Canadian economic policy think-tank based in Waterloo, Ontario. Founded in 2012 as a non-partisan research firm, the DEEP Centre's work shapes how jurisdictions build fertile environments for launching, nurturing and scaling companies that will thrive in an increasingly connected world. The DEEP Centre provides objective research and advice on the changing drivers of success in the global economy and the critical interconnections between technology, entrepreneurship and long-run economic performance. Our goal is to help policymakers identify and implement powerful new policies, programs and services to foster innovation, growth and employment in their jurisdictions.

About the Author

Kirill Savine is a research analyst at the DEEP Centre and the resident data guru. He holds a degree in Economics and Finance from Wilfrid Laurier University. He has previously worked with The Laurier Centre for Economic Research and Policy Analysis, where he contributed to various economic policy publications and published periodic labour market newsletters, as well with Philip Morris International. Kirill's interests include economic policy research and computational finance methods for investing.

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Introduction

Does Canada have an innovation problem? Many commentators seem to think so. Yet despite receiving high-profile attention from policy and business leaders, innovation – and Canada's innovation performance – remains difficult to precisely measure. Many of the common metrics associated with innovation performance, such as research and development (R&D) spending and patenting activity provide an imperfect picture of national innovation performance. On the input side, R&D spending may not be efficiently translated into innovation. On the output side, patenting activity may reflect other factors – such as patent inflation or shifts in the intellectual property strategies of firms – rather than the first step in transforming research into path-breaking products and services.[1] Still, despite their individual imperfections, taken together such measures can help paint a rough picture of a country's environment for innovation.

In this context, this short paper draws on a series of proxy measures in an effort to gauge Canada's innovation performance. Using information obtained from the Organization for Economic Cooperation and Development (OECD), the World Intellectual Property Organization (WIPO) and Statistics Canada, the paper examines both inputs (research and development spending, personnel) and outputs (patenting activity, firm creation) associated with innovative activity. Taken on aggregate, these metrics paint a picture of a country that is failing to keep pace with its peers across a wide range of measures, and suggests the need for policymakers to take concrete steps to address this ongoing innovation gap.

1 Patent inflation generally refers to an increase in the number of patents granted that stem not from increased innovation, but rather from declining patent evaluation standards, perverse incentives which encourage additional patenting without reflecting underlying innovation, as well as growths in different types of patenting. For a discussion see: Brian Kahin, "Too Many Patents? How Patent Inflation Plagues Information Technology."

http://www.huffingtonpost.com/brian-kahin/too-many-patents-how-pate_b_85621.html

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An economy's approach to fostering innovation is often associated with its spending on research and development (R&D). In this section, we examine Canada's activity in this area with respect to both gross expenditure on research and development (GERD) and business expenditure on research and development (BERD). In addition, we disaggregate R&D spending by sector, demonstrating that Canada relies more heavily on the services sector for its total R&D spending than other comparable economies. Finally, we also consider expenditure on R&D personnel noting, in contrast to other metrics, that employment in this area grew significantly in the early to mid-2000s, before peaking and declining in 2007/8.

Trends in Gross and Business Expenditure on Research and Development

It is becoming increasingly clear that Canada is falling behind in R&D spending. As the graph below illustrates, Canada's gross expenditure on research and development (GERD), which encompasses both public and private R&D spending, has declined in recent years. This decline runs contrary to the trend among OECD countries, which has seen an overall increase in total R&D spending. The gap between Canada and the OECD average – both in gross spending and with respect to trends – is mirrored in business expenditure on R&D. Canada's BERD has consistently lagged behind the OECD average, and this gap has expanded in recent years as Canadian spending has continued to decline.

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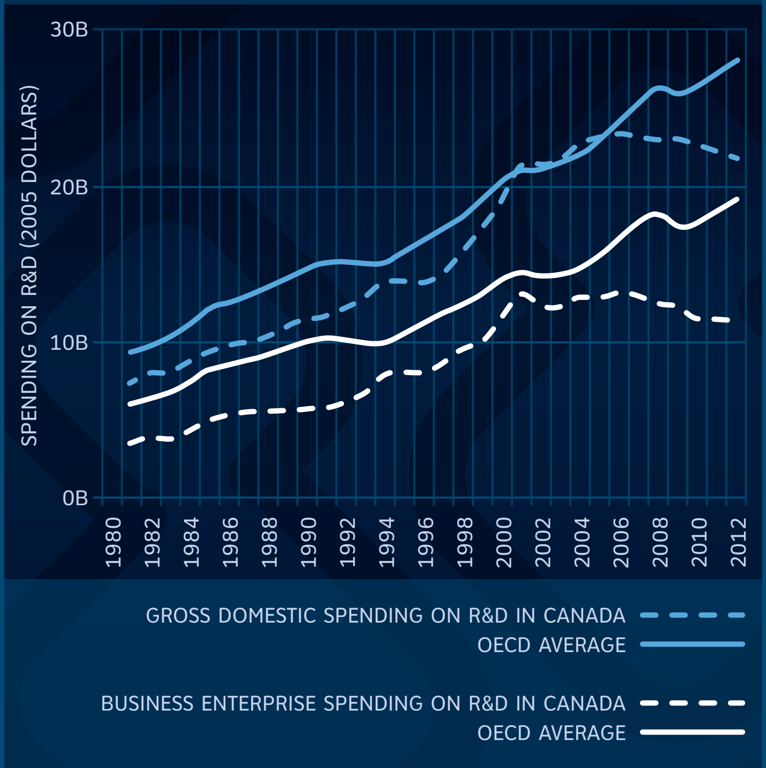
Figure 1: **Changes in Gross and Business Spending on R&D for Canada and an Average OECD Country**



R&D Spending by Sector

In both Canada and across the OECD the manufacturing and services sectors attract the most investment in R&D. However, while R&D spending in the Canadian service sector is roughly in-line with the OECD average, services drives a far greater share of overall R&D spending within the Canadian economy – nearly 40% – compared to an average 25% share among the broader OECD. Thus, while it remains an important sector, compared to OECD average Canada's manufacturing industry plays a relatively smaller role in driving national R&D spending, accounting for only (54%) of spending in contrast to (75%) across the OECD[2].

2 The percentages are based on the 2000-2011 average. Average manufacturing portions for the period 1987-1999 were: 66% and 83% for Canada and OECD respectively, which indicates that the gap between Manufacturing spending on innovation in Canada and an average OECD country has been widening.

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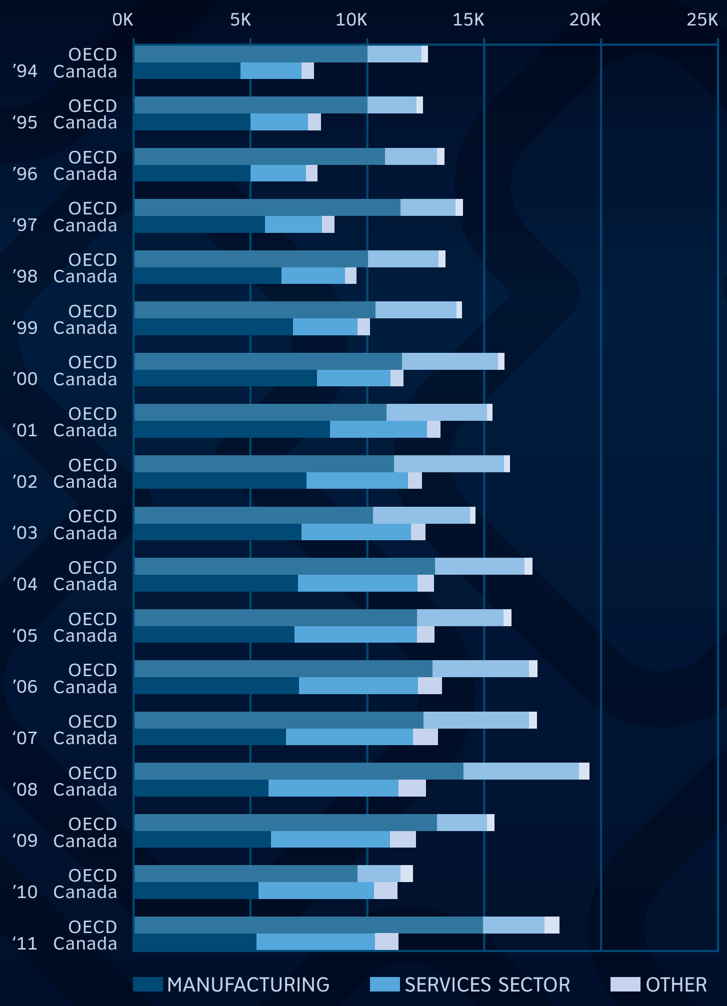
Figure 2: **Changes in BERD by Economic Sector in Canada and an Average OECD Country Plotted on the Same Scale**



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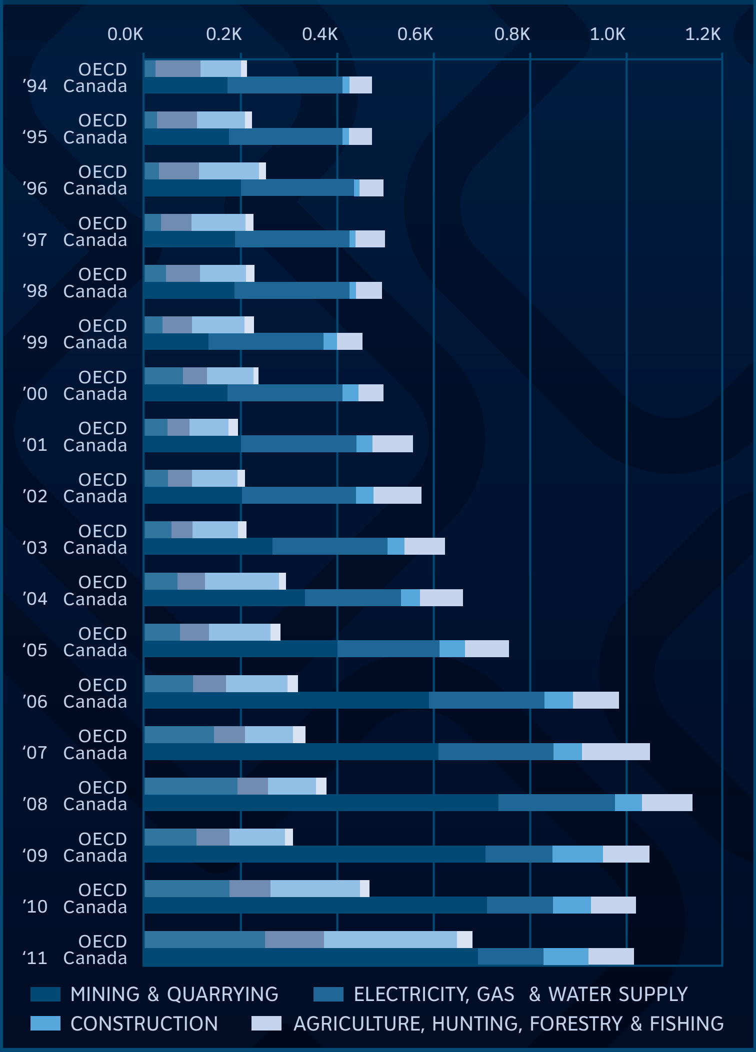
Canada also has a higher percentage of business R&D spending coming from the resources sector, broadly defined. As the second graph below illustrates, Canada witnessed a particularly pronounced uptick in R&D spending in the mining and quarrying sector through the early to mid 2000s, though this spending has declined somewhat from its 2008 peak.

Figure 3: **Changes in BERD by Specific Economic Sectors in Canada and an Average OECD Country Plotted on the Same Scale** (Agriculture, Electricity, Mining and Construction only)



As shown below in Table 1, across both GERD and BERD metrics, Canada has seen a significant relative decline in spending growth as compared to OECD peers. In particular, Canada's manufacturing industry has seen a significant retrenchment in spending while competitors elsewhere have increased their spending. While some of this differential can be explained by different levels of economic and industrial development, and thus a phase of catch-up investment, it paints a disturbing picture of Canadian investment and future competitiveness.

Table 1: **BERD and GERD Average Annual Growth Rates** (2008-2012 five-year average)

	Canada	OECD Average[2]
GERD	-1.4%	2.1%
BERD – Total	-2.6%	1.8%
BERD – Manufacturing[1]	-5.6%	6.5%
BERD – Services[1]	-0.1%	-1.9%

1 Based on 2007-2011 period.

2 For sectorial BERD only, the OECD average is based on an incomplete sample of OECD member countries due to limited data availability. For years where data was not available, it was estimated using the most recent year data point available for the corresponding country and industry.

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R&D Personnel

In addition to measuring R&D spending, metrics on the number of personnel (full-time equivalent) employed to conduct R&D also provide a useful indication of R&D-intensity. Despite the fact that most of the other Canadian R&D indicators are underperforming the OECD average, Canada's R&D personnel employment is one of the highest in the OECD group.[3] Among OECD countries Canada trails only Japan and Germany in total R&D personnel count.[4] As the chart in Figure 4 demonstrates, employment among R&D personnel in Canada rose rapidly throughout the late 1990s and 2000s period. Following this significant rise, however, in 2009 the number of full-time equivalent R&D personnel began to decline. This decline appears predominantly in the fields of natural sciences and engineering, which constitute the largest share of total R&D employment. This decline has not mirrored broader trends in the OECD average, raising questions about why R&D personnel employed in the so-called STEM fields – science, technology, engineering and mathematics – has declined in Canada since 2008.

3 For certain country/year groups the data was not available, it has been estimated using the most recent year value available for the country of that group. Out of the 34 OECD members, the OECD sample that was used consisted of fewer countries due to data limitation, specifically the following: Australia, Austria, Canada, Chile, Czech Republic, Denmark, Finland, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Mexico, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey.

4 The United States is excluded from this sample due to the absence of available data.

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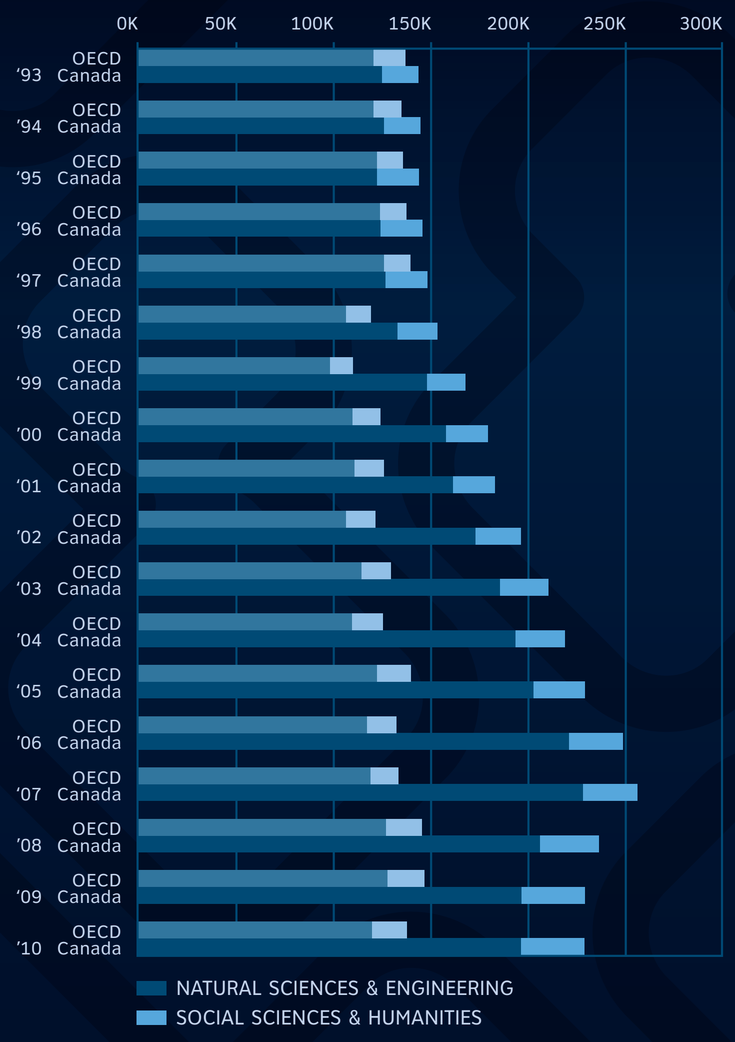
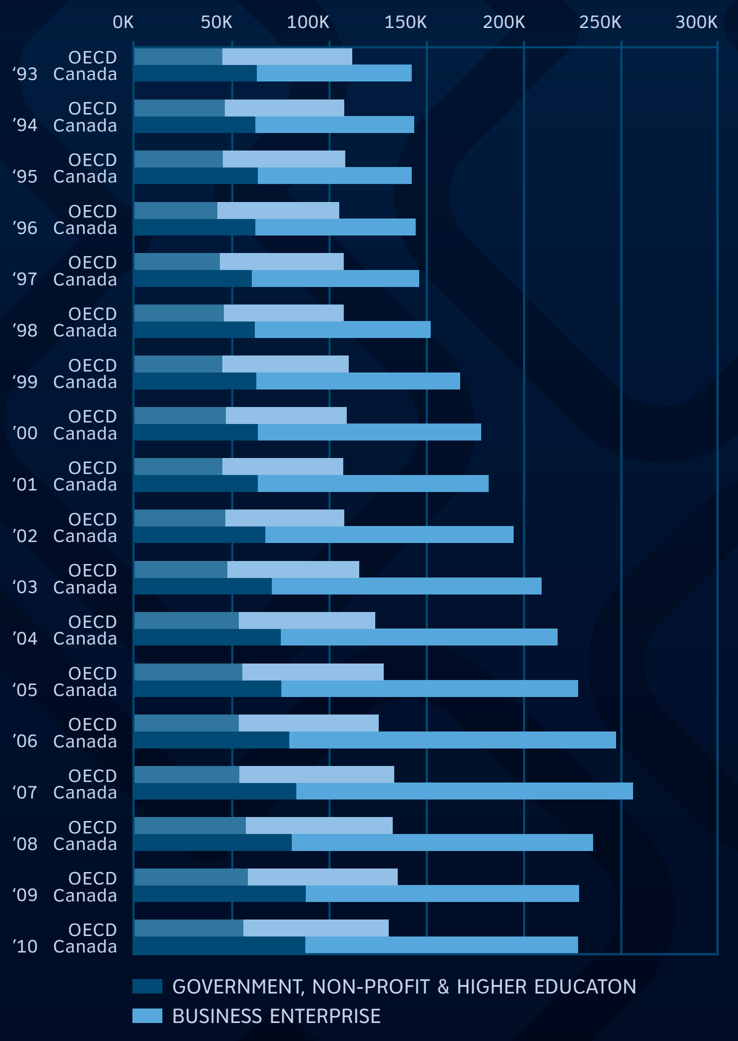
Figure 4: **R&D Personnel Count: Full-Time Equivalent on R&D by Field of Science: Canada vs. OECD Average**



Breaking down R&D personnel expenses by business enterprise and non-commercial sectors demonstrates that it is primarily firms which have driven growth and more recent decline in Canada's R&D personnel employment. In contrast, the split between public and private and sector employment is more even across the OECD average.

Figure 5: **R&D Personnel Count: Full-Time Equivalent on R&D by Sector of Employment: Canada vs. OECD Average**[5]



5 The OECD average is based on an incomplete sample of OECD member countries due to limited data availability. For years where data was not available, it was estimated using the most recent year data point available for the corresponding country and field of science or sector of employment.

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The graph in figure 6 illustrates the number of R&D personnel employed in business, government, and education as a percentage of total national R&D employment. On this metric, trends in Canada have converged with the broader OECD over time.

Figure 6: **R&D Personnel – Full-Time Equivalent, as Percentage of National Total: Canada vs. OECD Average**

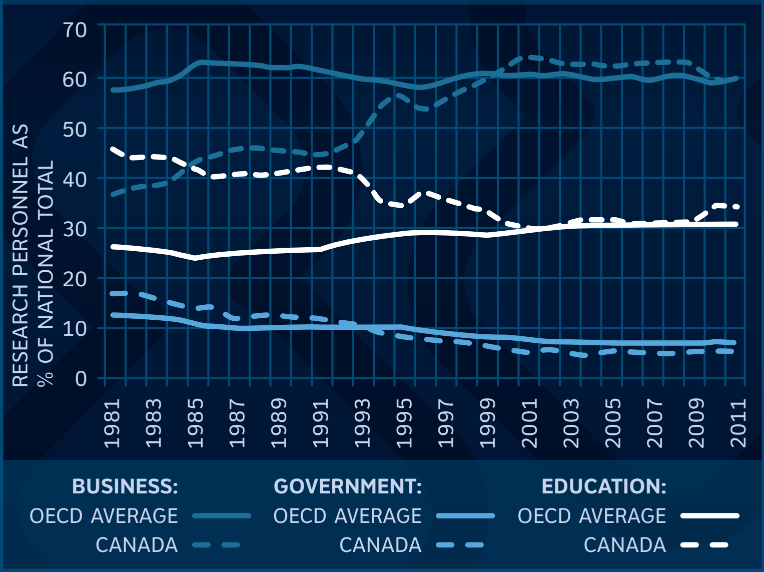

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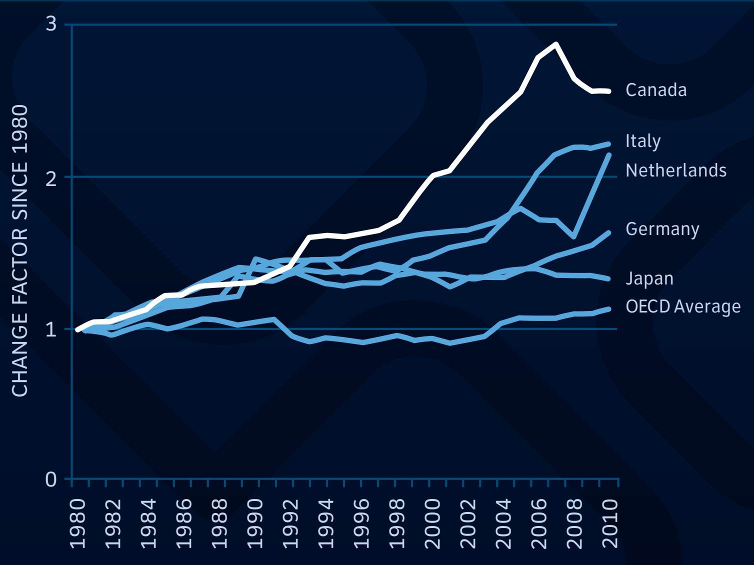
Figure 7 below examines changes in R&D personnel since 1980. Overall Canada has experienced greater change in this metric – both respect to growth and decline – than seen in other research-intensive economies. Interestingly, the sharp decline in employment which began in Canada in 2007 is not mirrored in the other economies examined here.

Although Canada has demonstrated the highest change factor since 1980 in R&D FTE personnel count, none of the individual research-intensive economies presented on this graph had such a sharp decrease in personnel in 2005 that Canada had. What is even more interesting is that this sharp decline is counter to the metric behavior of other economies in this sample. For instance, Italy, Netherlands, and Germany have demonstrated positive growth during the period after 2005.

Figure 7: **R&D Personnel – Full-Time Equivalent – Changes Normalized to 1980: Canada vs. Other OECD Economies and OECD Average**



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Patent Activity and Firm Creation

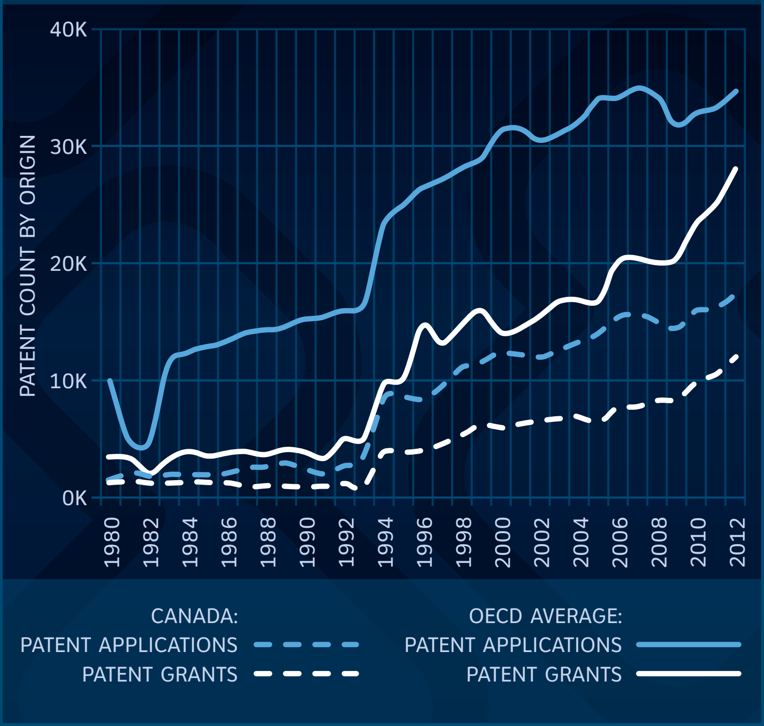
Innovation is, of course, not merely about money spent on R&D or the number of R&D personnel employed. On the output side, innovation is about generating new and marketable products, processes, and services. While measuring innovation outputs is difficult, patenting activity can provide useful – albeit imperfect – insights into innovation performance. In this section we examine Canada's performance in this area by tracking Canada's patenting activity both on aggregate and across sectors in comparison to other OECD countries. Perhaps unsurprisingly in light of its well-publicized intellectual property trade deficit, Canada generally falls behind its OECD peers with respect to patenting activity.

Given the relationship between innovation and firm creation, this section also examines broader economy-wide and sectoral trends in firm creation between 2001 and 2011. While this data is heavily influenced by the effects of the 2008 financial crisis and subsequent recession, breaking down Canada's firm creation performance by sector provides some interesting insights. In particular, while Canada has been relatively successful in producing firms in the retail sector, firm owners in Canada struggle to create sustainable firms in professional, scientific and technical services.

Patent Creation

The previous section highlighted Canada's lagging performance in overall R&D spending. In addition, as the graph below demonstrates, Canada continues to underperform the OECD average with respect to both patent applications and patent grants.

Figure 7: **Changes in Various Indicators of Patent Activity for Canada and OECD Average**



To get a clearer picture of Canada's relative performance on this metric, the figure below showcases Canada's patenting activity as a percentage of gross domestic product (GDP). Even when economy size is taken into account Canada continues to under-perform the OECD average in terms of both patent applications and patent grants. In other words, Canada generates fewer patents per dollar of GDP than the broader OECD average.

Trends in Canada have remained relatively steady since 1994 with respect to both patent applications and patent grants. As the graph below illustrates, across the OECD there has been a decline in patent applications over time, coupled with a recent upswing in patent grants.

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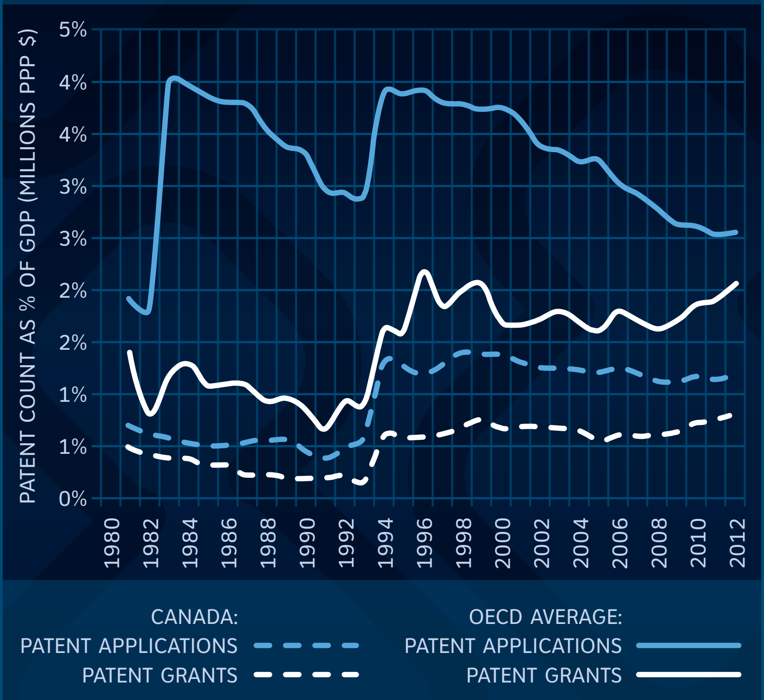
Figure 8: **Changes in Various Indicators of Patent Activity as a Percentage of GDP for Canada and OECD Average**



Patent Productivity

Interestingly, stagnant growth in BERD, as noted in the previous section, has not been accompanied by a corresponding decrease in the growth rate of patent applications and grants, indicating greater productivity of Canadian R&D spending in producing patenting activity over the 2000s. Patent applications and grants have grown over time in both Canada and among our OECD peers.

Despite this, Figure 9 on the next page demonstrates that Canada remains less efficient in creating patenting activity through BERD when compared to the OECD average. The graph below shows the ratio of patent applications and grants relative to a country's business spending on R&D. Note that for patent applications, represented in blue below, the gap between Canada and the OECD average has remained relatively constant,

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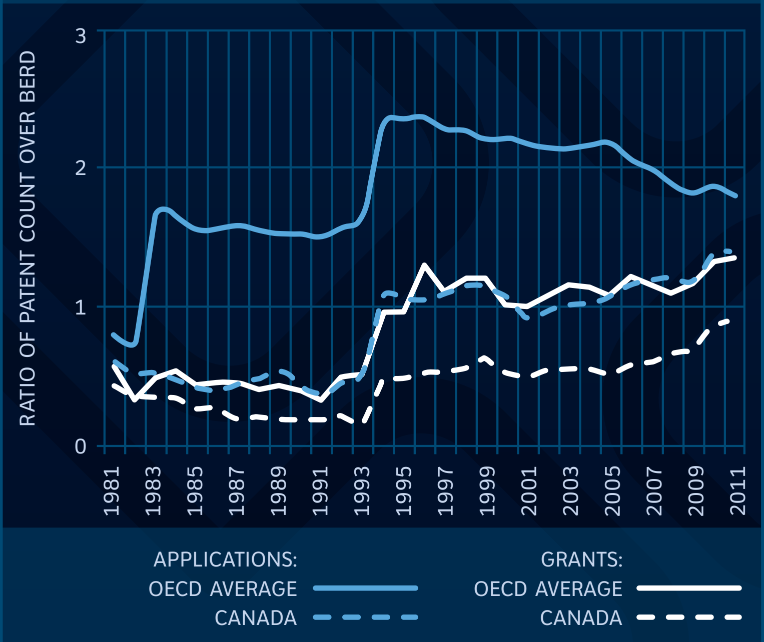
though there appears to be some movement towards convergence in the final years of our sample.

On the other hand, the gap between patent grants over BERD – that is, the number of patents granted for each dollar of business research and development spent – has been widening since the early 1990s, though trends in Canada have continued to mirror those of the broader OECD average. As the graph below makes clear, in the early 1980s the number of patents granted per dollar of BERD spent in Canada was on par with the rest of the OECD. A significant gap between Canada's performance and the OECD average first appeared in the early 1990s and has remained relatively constant over time.

Figure 9: **The Ratio of Patent Count over BERD Using Both, Patent Applications and Grants**



In the most recent year available (2011), in Canada one patent application 'cost' roughly one million dollars in business R&D. In contrast, the OECD average for this metric sees one patent application for every $500,000 in business R&D, or roughly half that spent in Canada.

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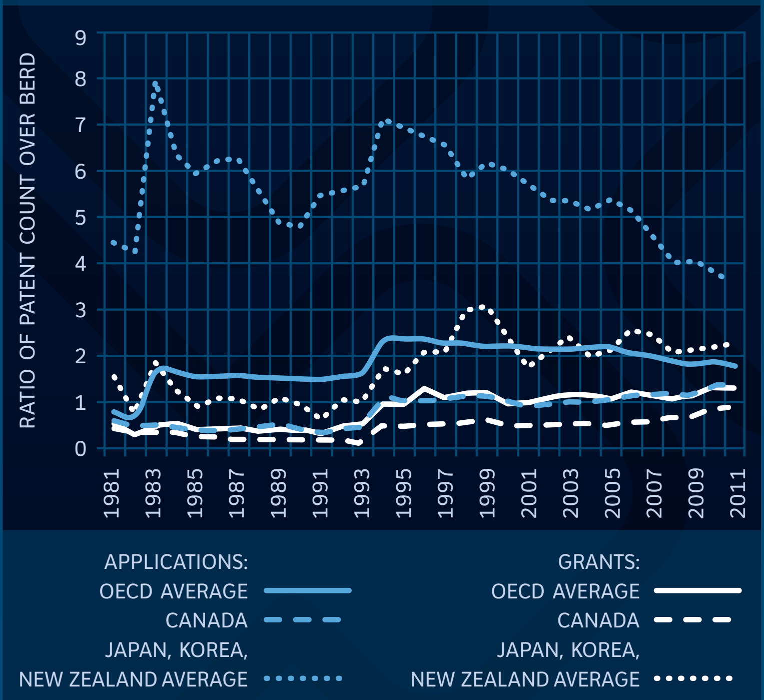
What does this discrepancy mean in practice? While it is difficult to know for sure, it may indicate that conducting research and development is more expensive in Canada relative to its OECD peers. Alternatively, it may simply suggest that a smaller share of Canadian R&D spending results in patenting activity as result of the nature of the type of R&D spending being undertaken by Canadian firms. Finally, it may suggest that R&D spending is not generating the same types of return on investment in Canada that are seen elsewhere.

In static terms, Japan, Korea, and New Zealand are currently the most efficient in producing patents relative to BERD. As the graph in Figure 10 below demonstrates, however, these countries are producing fewer patent applications and grants relative to national BERD over time. In contrast, Canada, the US, and the overall OECD average are trending slightly in the opposite direction.

Figure 10: **The Ratio of Patent Activity over BERD for Canada, OECD Average and the Average Between Three Best-Performing Countries**



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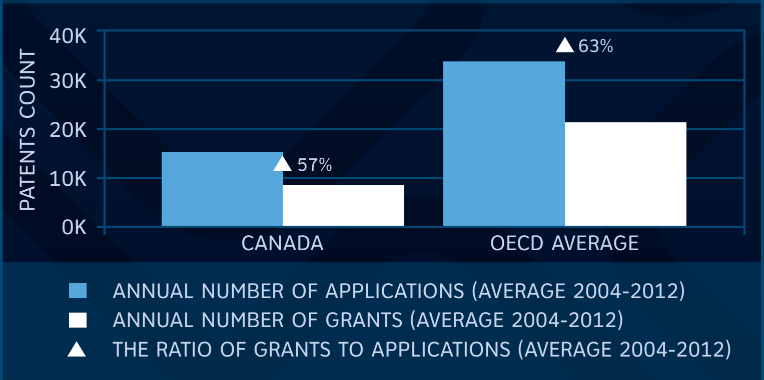
Patent Quality

The quality of patent applications can serve as another measure of Canadian innovation. It can be roughly assessed by measuring the percentage of patents granted relative to the number of patent applications over a period of time.[6] Doing so allows us to estimate the portion of applications that are successfully turned into patent grants.[7] The results are presented in Figure 11 below.

On this metric Canada, on average, slightly underperforms its OECD peers. The percentage of patent grants out of total number of applications for Canada is 57%, compared to 63% for an average OECD country. During the period since 2004, a patent has been granted for every 1.58 patent applications that haves been made during that period by an average OECD country. In comparison, in Canada a patent grant is awarded for every 1.74 Canadian patent applications.

Figure 11: **A Ratio of Patent Grants over Patent Applications as a Measure of Patent Quality**



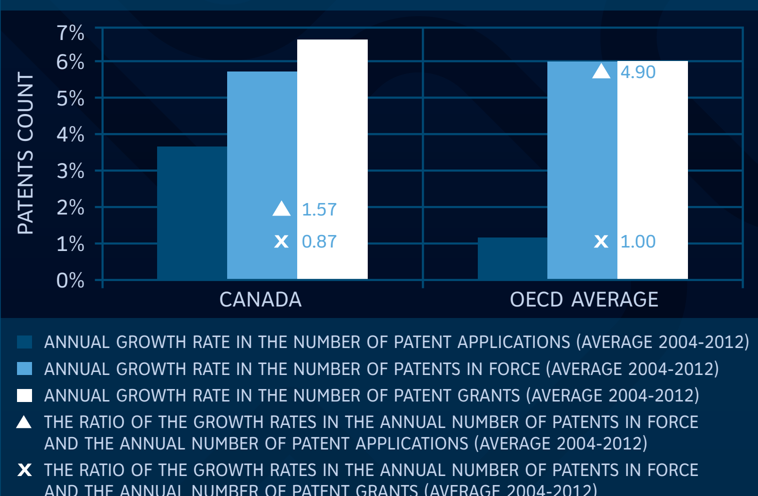
6 The time period selected for this ratio was 2004-2012 due to data availability for patents in force, which we will talk about next. The same time frame was selected for all ratios of patent activity for consistency. The reason for not calculating the ratio for year is the difficulty in interpretation of 1-year such ratio as there is a high possibility that a large of patent grants made is a certain year does not correspond to the patent applications reported for this year, since it takes up to several years to process a patent application.

7 Though this measure can be taken as an indication of patent quality, it should also be noted that it can reflect other trends, particularly in the quality of patent evaluation.

Patent productivity can also serve a proxy for innovativeness. Is Canada able to maintain a sufficiently growing pool of patents for a given number of applications and grants generated by Canadian researchers/entities? The graph in Figure 12 compares the growth rates of patent applications and grants to the growth of overall patents in force. The graph demonstrates that Canada has been growing its pool of patents in force much more slowly than the OECD average. Across the OECD average, the number of patents in force is growing at a pace 4.9 times faster than the growth rate of patent applications, whereas in Canada the number of patents in force has grown only 1.57 times faster than applications. This can be a sign of lower patent preservation due to lower patent quality.

Switching the focus to patent grants, we see that for the OECD group the patents in force and the number of grants are growing at the same speed (ratio of 1.00 marked with an “x”). For Canada the yearly growth rate in the number of patents in force is actually smaller than the growth rate in the number of annual patent grants. In contrast, both of these ratios are lower for Canada, which means that Canada has been less productive with its applications and grants in terms of accumulating patents in force over the period from 2004 to 2012.

Figure 12: **A Ratio of Growth Rates in the Number of Patents in Force, and Growth in Applications or Grants, as Measures for Patent Quality**



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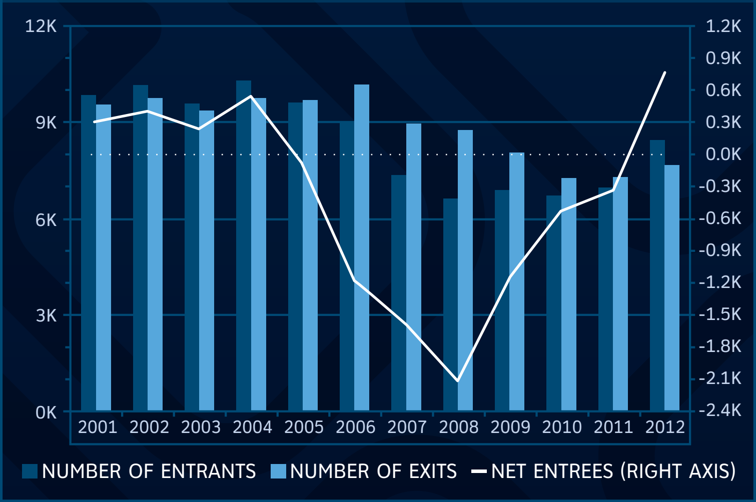
Business Creation

The number of new businesses created within an economy can also provide an important indicator of the health of its innovation ecosystem, though this measure is also heavily influenced by broader economic forces and external shocks. The methodology used to approximate the number of businesses born yearly in Canada consists of observing changes in number of businesses that issue T4 slips to their employees. As the graph in Figure 13 below demonstrates, Canada lost businesses in the period between 2005 and 2011, a trend which was accelerated by the 2008 financial crisis.

Figure 13: **Changes in Firm Births, Exits, and Net Entrees (Births less Exits) in Canada**



When we compare the number of incumbents to annual net entrant firms, we see a reduction in the ratio of entrants to incumbents beginning in 2005. The figure below illustrates the impact of the financial crisis on the ability of the Canadian economy to generate start-up firms. On the flip side, the most recent two years of available data show a positive recovery trend, though firm births as a percentage of total businesses in the economy remain below the level observed in 2004. In the last year of our sample net entrees reached their highest level in the sample.

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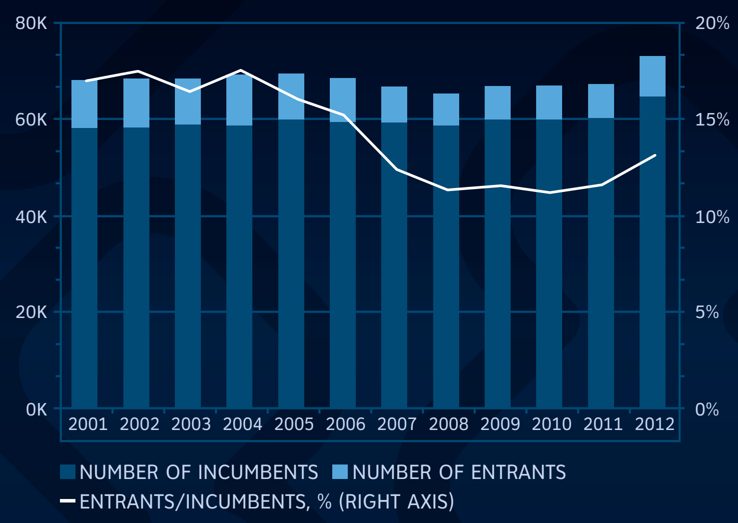
Figure 14: **Changes in the Ratio of Firm Births to the Number of Incumbents (Existing Firms) in Canada**



Breaking down firm entry and exits by industry provides more insight into the relationship between firm creation and failure within Canada. Between 2001 and 2012 firm births were highest in the retail, agriculture, and manufacturing sectors. Manufacturing, which is among the most research-intensive sectors in Canada in terms of spending on R&D, is one of the best performing in terms of number of net entrees annually (ranked 3rd out of 17), which is somewhat surprising in light of the broader discussion of the decline of manufacturing in Canada. However, it worth noting that the sector has grown four times less quickly as have the agricultural and retail sectors, which have significantly lower research intensities.

Professional, scientific and technical services, construction, and transportation and warehousing have experienced the highest negative values in the number of net entrees/exits. Thus, with the exception of manufacturing, Canada's more research-intensive sectors demonstrate negative average values for the annual net firm births over the past years, indicating that the economy is struggling to produce sustainable firms in these sectors.

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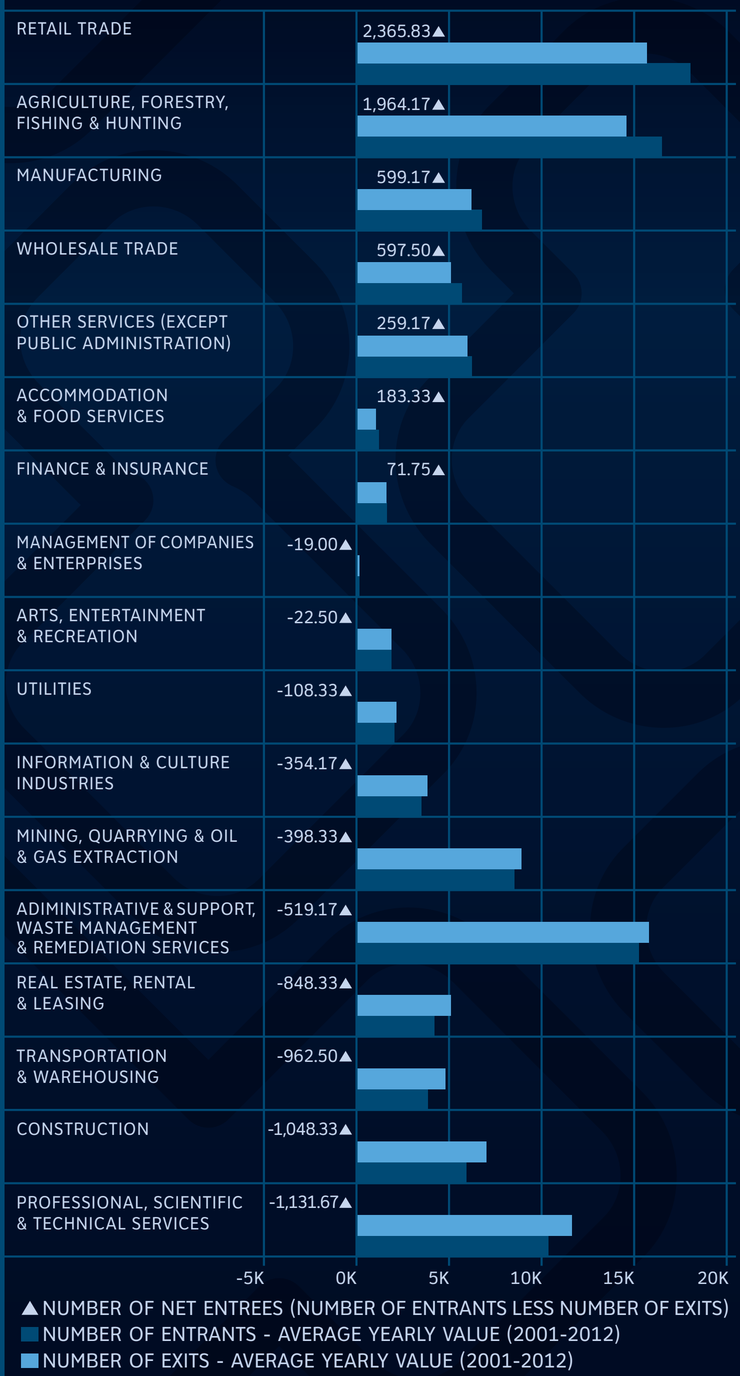
Figure 15: **Number of Firm Births, Exits, and Net Entrees (Births less Exits) by Industry in Canada, 2001-2012 Annual Average**



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The difference in Technology Mix: Where are Canada's Strengths?

Data produced by the World Intellectual Property Organization also allows us to compare patenting activity across sectors. To come up with a measure of technology specialization, we have calculated Canada's Relative Specialization Index (RSI) historically. Observing changes in Canada's specialization over time, as measured by the country's relative propensity to patent in a particular field, we can see that from 2000-2012 Canada's relative specialization increased most notably in computer technology, semi-conductors, audio-visual technology, and basic communications processes. In contrast, Canada RSI decreased in other consumer goods, furniture and games, analysis of biological materials and machine tools. Though somewhat less pronounced, Canada also became less specialized in environmental technology, biotechnology and pharmaceuticals, raising questions about why Canada appears to be experiencing a relative decline in specialization in these high growth, high-potential sectors of the economy.

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Figure 16: A Comparison of Relative Technology Mix of Canada in Patents in 2012 and 2000, Leftmost Column: 2012 less 2000

Figure 16A: **Canada-2012 & Canada-2000 Difference in Relative Specialization Index (RSI)**

RSI		TECHNOLOGY
0.384	6	Computer Technology
0.165	8	Semiconductors
0.154	2	Audio-Visual Technology
0.121	5	Basic Communication Processes
0.097	4	Digital Communication
0.090	27	Engines, Pumps, Turbines
0.078	19	Basic Materials Chemistry
0.059	17	Macromolecular Chemistry, Polymers
0.053	7	IT Methods for Management
0.041	31	Mechanical Elements
0.032	3	Telecommunications
0.032	14	Organic Fine Chemisty
0.014	21	Surface Technology, Coating
0.008	35	Civil Engineering
-0.029	10	Measurement
-0.042	28	Textile & Paper Machines
-0.045	18	Food Chemisty
-0.055	13	Medical Technology
-0.062	23	Chemical Engineering
-0.062	9	Optics
-0.087	1	Electrical Machinery, Apparatus, Energy
-0.100	30	Thermal Processes & Apparatus
-0.101	16	Pharmaceuticals
-0.101	32	Transport
-0.109	29	Other Special Machines
-0.109	12	Control
-0.146	22	Micro-Structural & Nano-Technology
-0.164	25	Handling
-0.165	15	Biotechnology
-0.189	24	Environmental Technology
-0.209	20	Materials, Metallurgy
-0.211	26	Machine Tools
-0.244	11	Analysis of Biological Materials
-0.308	33	Furniture, Games
-0.321	34	Other Consumer Goods

Relative Specilization Index (RSI):

Relative Specialization Index (RSI) is a measure of innovation strength and can be measured by field of science or technology (industry) and country (or geographical region). In particualr, it seeks to capture wether a given country tends to have a lower or higher propensity to file in certain technology (definition from: WIPO 2013 World Intellectual Property Report, data from: http://www.wipo.int/ipstats/en). This particular RSIs for a given year and a given geographical region are calculated using the following formula: log[(TC/C)/(T/P)], where:

***TC** = number of patents in a given Technology (T) published by applicants from the given geographical region or country (C) in the year of interest.*

***C** = total number of patents published by applicants from the given geographical region or country (C) ONLY across ALL technologies in the year of interest.*

***T** = total number of patents published in a given Technology (T) ONLY across all countries of the world in the year of interest.*

***P** = population of all patents published in the world across ALL technologies and ALL countries in the year of interest.*

interpretation: the higher the RSI, the higher the propensity to publish (or to be granted a patent) in this field of technology for this country or geographical region. Of RSI>0: higher than world's average, if RSI<0: lower than world's average.

***Technology**:*

The definitions of each industry (Technology) can be found here on pages 7-8 and 13-15 of this WIPO document: http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf

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Figure 16B: **Canada RSI Values by Industry (2012) Using Number of Grants**

RSI	INDUSTRY	
0.379	4	Digital Communication
0.279	3	Telecommunications
0.278	35	Civil Engineering
0.221	6	Computer Technology
0.153	15	Biotechnology
0.114	16	Pharmaceuticals
0.095	11	Analysis of Biological Materials
0.094	5	Basic Communication Processes
0.091	29	Other Special Machines
0.022	27	Engines, Pumps, Turbines
0.014	23	Chemical Engineering
- 0.002	24	Environmental Technology
- 0.005	33	Furniture, Games
- 0.015	7	IT Methods for Management
- 0.074	32	Transport
- 0.080	10	Measurement
- 0.082	13	Medical Technology
- 0.088	14	Organic Fine Chemistry
- 0.101	12	Control
- 0.120	26	Machine Tools
- 0.122	21	Surface Technology, Coating
- 0.126	25	Handling
- 0.130	31	Mechanical Elements
- 0.136	19	Basic Materials Chemistry
- 0.140	30	Thermal Processes & Apparatus
- 0.166	18	Food Chemistry
- 0.183	34	Other Consumer Goods
- 0.189	2	Audio-Visual Technology
- 0.196	20	Materials, Metallurgy
- 0.222	1	Electrical Machinery, Apparatus, Energy
- 0.310	17	Macromolecular Chemistry, Polymers
- 0.358	9	Optics
- 0.413	28	Textile & Paper Machines
- 0.499	22	Micro-Structural & Nano-Technology
- 0.705	8	Semiconductors

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Relative Specilization Index (RSI):

Relative Specialization Index (RSI) is a measure of innovation strength and can be measured by field of science or technology (industry) and country (or geographical region). In particualr, it seeks to capture wether a given country tends to have a lower or higher propensity to file in certain technology (definition from: WIPO 2013 World Intellectual Property Report, data from:

http://www.wipo.int/ipstats/en). This particular RSIs for a given year and a given geographical region are calculated using the following formula: log[(TC/C)/(T/P)], where:

***TC** = number of patents in a given Technology (T) published by applicants from the given geographical region or country (C) in the year of interest.*

***C** = total number of patents published by applicants from the given geographical region or country (C) ONLY across ALL technologies in the year of interest.*

***T** = total number of patents published in a given Technology (T) ONLY across all countries of the world in the year of interest.*

***P** = population of all patents published in the world across ALL technologies and ALL countries in the year of interest.*

interpretation: the higher the RSI, the higher the propensity to publish (or to be granted a patent) in this field of technology for this country or geographical region. Of RSI>0: higher than world's average, if RSI<0: lower than world's average.

***Technology**:*

The definitions of each industry (Technology) can be found here on pages 7-8 and 13-15 of this WIPO

document: http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf

Figure 16C: **Canada RSI Values by Industry (2000) Using Number of Grants**

RSI		INDUSTRY
0.340	11	Analysis of Biological Materials
0.318	15	Biotechnology
0.303	33	Furniture, Games
0.282	4	Digital Communication
0.270	35	Civil Engineering
0.247	3	Telecommunications
0.215	16	Pharmaceuticals
0.199	29	Other Special Machines
0.187	24	Environmental Technology
0.139	34	Other Consumer Goods
0.092	26	Machine Tools
0.076	23	Chemical Engineering
0.039	25	Handling
0.026	32	Transport
0.013	20	Materials, Metallurgy
0.007	12	Control
- 0.027	13	Medical Technology
- 0.027	5	Basic Communication Processes
- 0.040	30	Thermal Processes & Apparatus
- 0.051	10	Measurement
- 0.067	27	Engines, Pumps, Turbines
- 0.068	7	IT Methods for Management
- 0.120	14	Organic FIne Chemistry
- 0.121	18	Food Chemistry
- 0.134	1	Electrical Machinery, Apparatus, Energy
- 0.136	21	Surface Technology, Coating
- 0.164	6	Computer Technology
- 0.171	31	Mechanical Elements
- 0.214	19	Basic Materials Chemistry
- 0.296	9	Optics
- 0.343	2	Audio-Visual Technology
- 0.353	22	Micro-Structural & Nano-Technology
- 0.370	17	Macromolecular Chemistry, Polymers
- 0.371	28	Textile & Paper Machines
- 0.870	8	Semiconductors

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Conclusion

The data examined here show that Canada lags behind other comparable economies in a number of key metrics related to innovation performance. Crucially, Canada's overall performance on both gross and business expenditure on research and development has failed to keep pace with other *OECD* countries. While other countries have increased spending on R&D, Canada's GERD and BERD continues to shrink. Breaking down Canada's BERD provides some useful insights, particularly highlighting the declining – those still prominent – role of Canada's manufacturing sector in driving R&D spending within the broader economy. In contrast with the OECD average, Canada is becoming more reliant on services and other smaller sectors as a source of private R&D spending. Somewhat anomalously, however, R&D employment in Canada grew in Canada over roughly the same period that BERD and GERD declined, though employment in this area peaked and began a sharp decline beginning in 2007/8.

On the output side, we see that Canada's performance in a variety of metrics related to patenting activity has also consistently under-performed the OECD average. While patents are certainly not a perfect indicator of innovation, they provide some insight into the process whereby research activity generates marketable products and services. In this regard, the data presented here demonstrates that Canada is less efficient in generating patenting activity in relation to BERD spending when compared to the OECD average.

Firm creation is another indicator of innovation performance, though it is vulnerable to the influence of broader economic conditions and external shocks. In this context, firm creation and destruction in Canada has largely mirrored prevailing economic conditions both before and since the 2008 global financial crisis, which had a suppressing effect on entrepreneurship.

Potentially more interesting is the sectoral composition of firms created between 2001 and 2011. Whereas Canada has seen net growth in sectors such as retail and agriculture, it has experienced a decline in sectors traditionally associated with R&D and innovation, particularly professional, scientific, and technical services. Manufacturing, in contrast, represents an anomaly within the data. Whereas this data indicates relatively strong growth in the number of manufacturing firms in Canada in this period, other work recently concluded by the DEEP Centre points to broader shifts in Canada's traditional manufacturing base. Finally, using data from WIPO, our report has highlighted Canada's ongoing strengths and weaknesses in patenting activity relative to other countries in the OECD.

Measuring innovation remains fraught with difficulties, and each of the metrics presented here provides an imperfect picture of Canada's overall performance. Despite their individual imperfections, taken on aggregate all of these measures paint a picture of a country that is failing to keep pace with its peers across a wide range of metrics.

Based on this analysis, the following four questions emerge as key to understanding Canada's innovation performance:

- What steps can be taken to encourage a re-investment in research and development spending across both the public and private sectors?
- What are the longer-term consequences of the declining share of R&D performed by Canada's manufacturing sector, and are there steps policymakers can – or should – take to reverse this trend?
- What innovative policy tools can be deployed to address Canada's lagging performance in patenting activity, alongside the country's intellectual property deficit?
- Why has Canada struggled to produce new firms in the area of professional, scientific, and technical services, despite the relative ease of starting a business?

Coupled with ongoing insights and discussions in other forums, these questions point to the broader need for immediate, concrete action to address Canada's lagging innovation performance.

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