An Impact Brief
May 2017

Canada's Patent Puzzle

Do we have a problem with securing patents or with the commercialization of them?

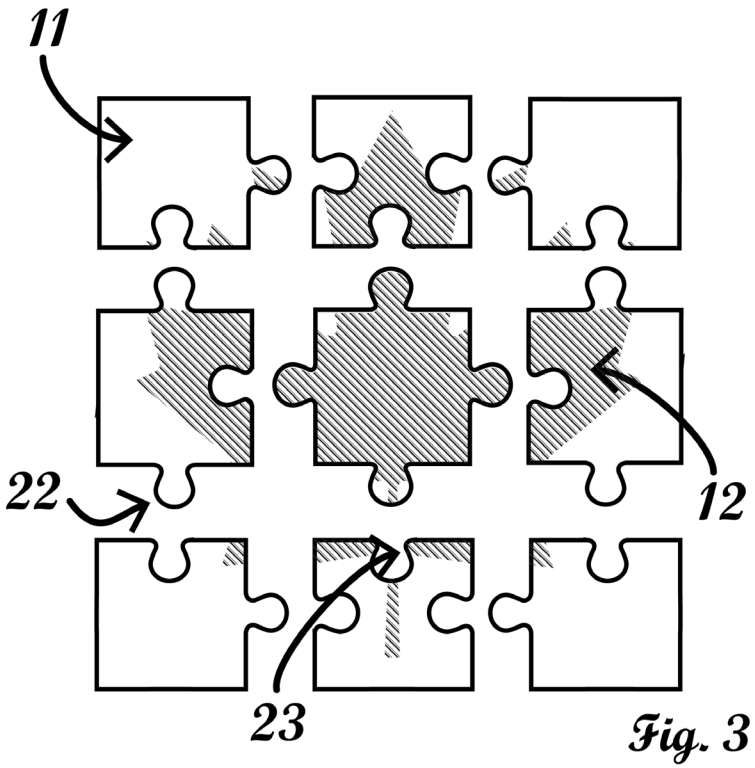

Fig. 3

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Challenging Long-standing Myths in Innovation

"By examining individual firm behaviour, comparing patenting practices of small and large firms, and the issuance of patents in Canada's largest market (the US), we can demonstrate that the way we have looked at patents so far has been fundamentally flawed."

The prevalent Canadian narrative is that as a country, we struggle to compete in the global innovation economy. This conclusion is based on three frequently cited and well-known metrics that have shaped our industrial research and development (R&D) strategy and policy conversation for decades:

1. expenditures on research and development,
2. the number of patents granted, and
3. multifactor productivity.

In this Brief, we look more closely at Canada's performance in the numbers of patents granted. When blended with other metrics, patents are thought to be an effective measure of a country's ability to convert knowledge into novel inventions that allow it to reap the commercial benefits of the newly protected intellectual property (IP). But Canada has fared poorly on this specific indicator: the Conference Board of Canada has given us a "D" grade, placing Canada 14th out of 16 peer countries in the number of triadic patents (Conference Board of Canada's Patents Index, 2010). Triadic patents are defined as patents issued for the same patent family in three major jurisdictions: the US, Europe, and Japan.

Although there are drawbacks with using triadic patent counts in the assessment of innovation, they are generally considered the gold standard for IP-related metrics and continue to be used liberally.

But, by examining individual firm behaviour, comparing patenting practices of small and large firms, and the issuance of patents in Canada's largest market (the US), we can demonstrate that the way we have looked at patents so far has been fundamentally flawed.

Triadic Patents

Triadic patents largely reflect the patenting of multinational firms with operations in all three sectors of the globe. We found a high degree of correlation between the number of large technology companies headquartered in a particular country (expressed in terms of business revenue as a percentage of the country's gross domestic product [GDP]) and a country's triadic patent ranking. Therefore, triadic patents are in part an indication of industry structure and scale—rather than innovativeness. Since this finding also points to a shortage of world-class Canadian companies that are capable of pursuing markets and IP protection around the world, it suggests a problem of commercialization and scale, and not a problem of R&D.

US Patents

Canada's success in obtaining patent grants in the US has improved by 143% over the last ten years. The number of patents with one or more Canadian inventors climbed from 3,661 in 2005 to 8,903 patents in 2015, placing us eighth on a per GDP basis against competitor countries in 2015 and in terms of our growth rate over 10 years.

However, of the patents granted to Canadian inventors by the US Patent Office in 2016, 58% were assigned to companies domiciled in other countries. This is up from 45% in 2005. This means that Canada earns a return through commercialization for less than half of the patents granted in the US to Canadian inventors. Therefore, Canada's critical issue is not an inability to turn invention into innovation. Our challenge is to ensure that Canada retains some of the economic and social benefits from our innovation activities.

Role of Leading Canadian R&D Firms

Of the top 50 R&D spenders in Canada in 2015, 17 were subsidiaries of foreign companies (including Ericsson, IBM, Cisco, and PMC Sierra.) The subsidiaries represented 32% of all patents granted in the US to the 50 leading Canadian R&D firms. However, 96% of the patents granted to the foreign subsidiaries were assigned to parent companies in another country.

Subsidiaries of foreign companies conducting R&D in Canada are also eligible for a scientific research and experimental development (SR&ED) tax credit equal to 15% of eligible expenditures (subject to stringent rules.) But if the benefits of Canadian R&D are transferred to other countries through patenting practices, are Canadian taxpayers subsidizing research whose long-term impact is felt elsewhere?

Patents as a Metric

Using granted patents as a measure of innovativeness is also exacerbated by the fact that patents are an input metric; they do not correlate well with results-oriented measures such as revenue. Patents also range significantly in the quality and nature of the underlying invention (i.e., process versus product IP) that must be accounted for in the analysis.

Although using patents as a metric for how well we are performing internationally may have worked in the industrial economy, it does not work in an internationalized knowledge economy. Patenting is an international, not a local activity; and the nuances of the process must be considered before the numbers are aggregated into a single indicator for the purpose of policy making. If we are serious about improving our ability to compete internationally using R&D as a base for international growth, then we need to ensure that we use appropriate metrics rooted in strong and valid assumptions. Otherwise, our efforts will most likely remain misdirected or ineffective.

Triadic Patents

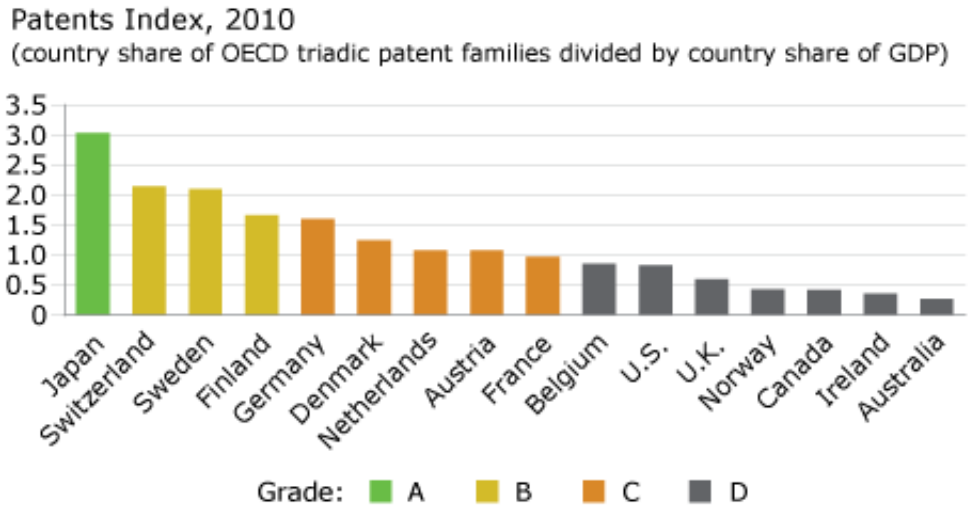
The prevailing conversation about innovation in Canada suggests that we lag other Organisation for Economic Co-operation and Development (OECD) countries in our ability to patent. Canada ranks 14th out of 16 peer countries in the number of triadic patents (Figure 1, reproduced from Conference Board of Canada's Patents Index, 2010). Triadic patents are defined as a set of patents filed for one invention at the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO) by the same applicant or inventor. According to the OECD, "Triadic patent family counts are attributed to the country of residence of the inventor and to the date when the patent was first registered" (www.data.oecd.org).

Triadic patents are considered the gold standard for measuring patents on a worldwide basis. Since triadic patents are tied to commercialization and the impact of science and technology, they are continuously used to highlight Canada's failure to innovate.

But why do small countries with significantly smaller populations and potential pools of inventors like Switzerland, Sweden, and Finland rank so high when it comes to triadic patents?

The answer to this question ties back to the nature of the underlying technology and the patenting practices of firms of various sizes, which will be explored in the next two sections .

Benchmarking Countries in Terms of Triadic Patent Families
(Reproduced from the Conference Board of Canada)
Figure 1



Underlying Technologies

Table 1 is a summary of triadic patent counts broken down by country and by technology across major OECD countries in 2011. The data demonstrate that the patenting is highly concentrated in five technology sectors: 74% of the triadic patents issued were related to inventions in biotechnology, information and communications technology (ICT), nanotechnology, medical technology, and pharma.

If countries are ranked according to the number of triadic patents, then countries with a high composition of firms operating in these sectors will probably score better than countries with an economy such as Canada that has a greater percentage of its economy focused on natural resources. Hence, rather than looking at triadic patents as a single bulk indicator, we must examine the core assumptions behind patent metrics to see what bias they contain. Certainly, a country with a large number of multinational biotechnology, ICT, nanotechnology, medical technology, or pharma companies will tend to do better in triadic patents.

Number of Triadic Patents, 2011
Table 1

Country	Total Triadic Patents	Biotech	ICT	Nano	Med Tech	Pharma	Total Tech Patents
Australia	314	60	92	6	63	69	291
Austria	359	44	112	2	31	41	230
Belgium	459	66	168	12	31	85	362
Canada	576	83	286	11	69	92	540
Denmark	254	67	72	1	61	51	252
Finland	223	24	97	7	25	17	170
France	2,565	229	942	49	204	281	1,704
Germany	4,736	302	1,422	37	638	460	2,859
Ireland	68	9	24	0	20	9	63
Israel	350	47	152	2	119	60	381
Japan	17,078	548	7,951	206	1,245	430	10,379
South Korea	2,346	119	1,296	63	129	146	1,753
Netherlands	958	89	472	21	157	54	794
Spain	210	39	56	9	28	62	195
Sweden	609	60	245	4	100	65	473
Switzerland	1,040	102	265	13	154	181	715
United Kingdom	1,699	179	612	40	280	255	1,365
USA	13,030	1,654	6,123	256	2,113	2,042	12,188

Patents as a Function of Firm Size

If you have just invented a product and you are deciding where to patent it, then your first and second questions may be: "Where do we think we are going to sell it?" and "How much money do we have to register a patent?"

The answers depend on the scope of your operations. If you are a large Canadian firm that sells internationally across North America, Europe, and Asia, you may want to register a triadic patent to cover your operations in all major markets. Filing only in the US and the OECD looks like an attractive option, if you are running a mid-sized business and see your organization operating only in North America and Europe in the foreseeable future. But, the number of choices diminishes quickly for small businesses that when faced with limited resources may opt to take out only a US patent.

Clearly, the question of where patents are filed depends on the size and resources of the company and the nature of its operations. Thus, one could argue that countries whose industries are made up of larger, multinational companies will tend to file more triadic patents. But is this reflected in practice?

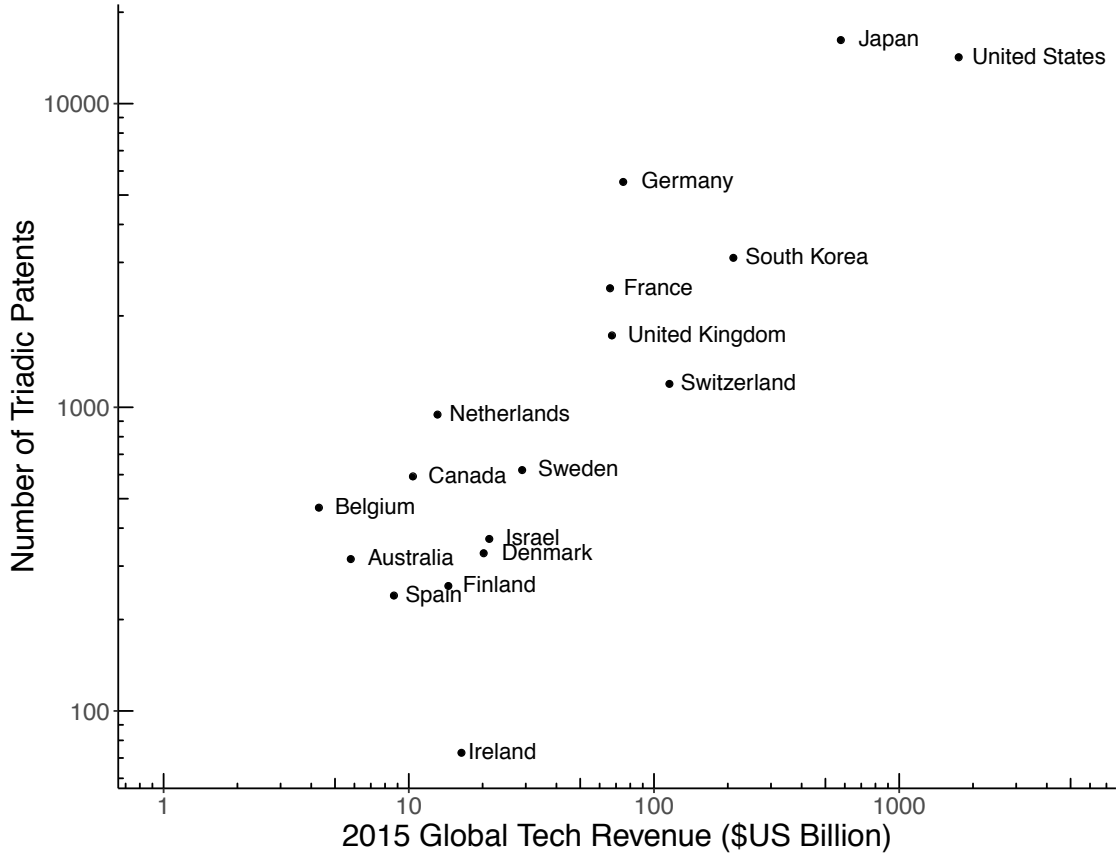
To answer this question, we turned to the Forbes listing of the "Global 2000", the world's 2000 largest public businesses in 2015. The Global 2000 provides additional information on each company such as country of origin, sales, profits, and market value (www.forbes.com/global2000). For each OECD country, we tabulated the total revenue of Global 2000 firms in biotechnology, ICT, nanotechnology, medical technology, and pharma. We then calculated this revenue as share of GDP of the country in which the firms operate.

Our hypothesis was that the share of the GDP of firms identified in each of these sectors would show a correlation with the number of triadic patents attributed to each country; i.e., the higher the concentration of Global 2000 firms in a particular nation, the larger the number of triadic patents. Figure 2 shows the results of our analysis. We have only included countries that have companies listed on the Forbes' Global 2000 list and operating in our five key technology sectors.

Switzerland, which had the highest per-GDP concentration of Global 2000 companies in our target technology sectors, was second in triadic patents. Israel, which ranked fifth in the concentration of companies, ranked fourth on patents. Canada has a significantly smaller number of Global 2000 tech companies; it was ranked 15th on this metric, and 14th on patents.

Although this approach may have some shortcomings, there is still a correlation of .7 between a country's ranking in Global 2000 companies and its ranking in triadic patents. This means that 70% of the patent results are explained by the heft of the multinational corporations headquartered in a country, a satisfyingly high correlation between these factors.

Relationship between Triadic Patents and
Revenue of Global Technology Companies
Figure 2



Based on this analysis, it is clear that triadic patent filings do not accurately reflect innovativeness. They only provide an indirect measure of the composition of the economy and the structure of firms.

Although we do not advocate for the use of patents as an authoritative metric for innovation, it is interesting to note that the current analysis brings us back to the issue of "scaling". Triadic patents favour countries with large resident technology companies. Hence, if we wish to develop our economy to a point where it can compete in triadic patents, we will need a significantly higher concentration of large, world-class companies that have the resources and the need for triadic patents. Some countries, like the US, Japan, South Korea, and Switzerland, have a remarkably high concentration of multinational corporations that have naturally followed this patenting path. This suggests that since a more balanced economy such as Canada will not be able to compete on these rankings unless we improve our ability to scale technology companies, we should, in the interim, turn to measures that better reflect our innovation capacity given the current state of our economy.

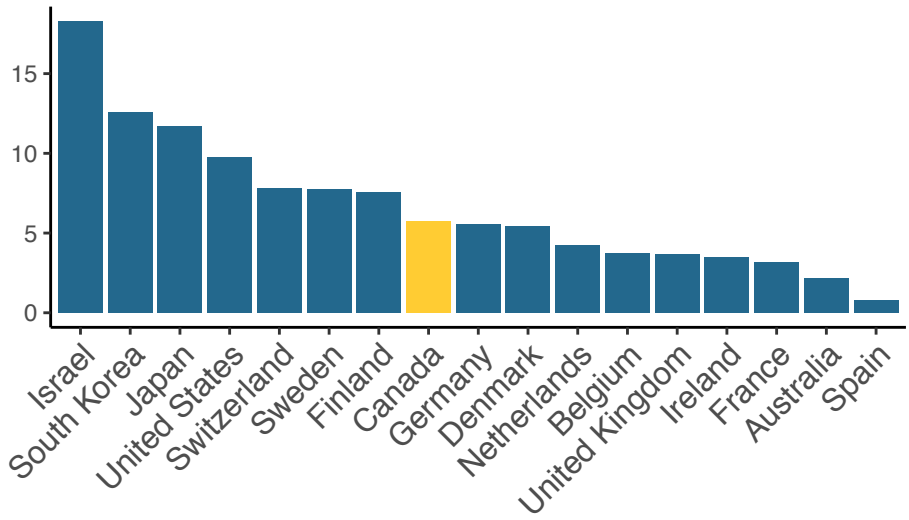
Canadian Patents in the US

One way of assessing Canada's capacity to innovate is to look at our ability to file patents in countries where we actually have large numbers of customers; and the US has historically been the primary market for Canadian goods and services. In 2015, Canadian inventors were granted 2,882 patents in Canada (up 5.4 times since 2005.) But this pales in comparison to the 8,903 patents issued to Canadian inventors in the US.

Patents by Inventor

A popular way to dissect patents is by country of invention, which is an indirect measure of the R&D output of a specific country. Figure 3 provides a summary of the number of US patents granted to each country in 2015. We then computed a country's ranking in this particular market by calculating the number of US patents issued relative to the GDP for each country.

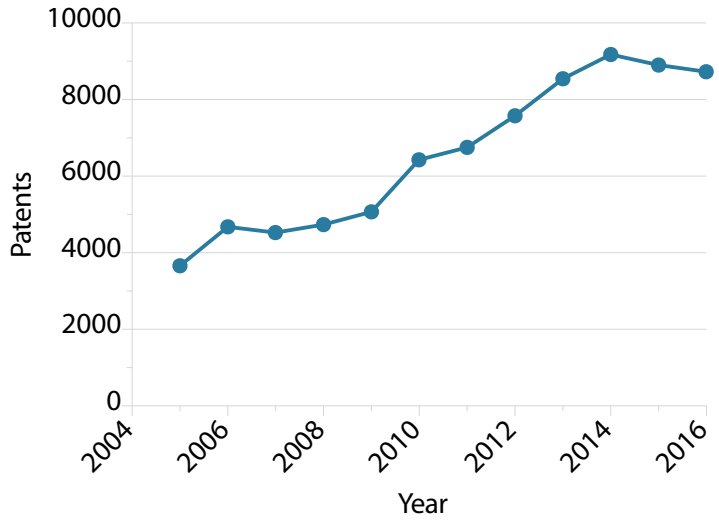
US Patent Grants by Country of Invention
Number per $million of GDP (Source: USPTO)
Figure 3



In what we perceive to be our long-standing primary market, we sit in the middle of the pack (eight out of seventeen countries) in terms of our ability to produce a novel invention per dollar of GDP. If we wish to move up in standing and match Israel, for example, we will need to increase our patenting output by 237% (or nearly 12,200 more patents per year). Since our analysis included all patents where at least one inventor is located in Canada, this rank effectively measures Canada's ability to conduct R&D that results in patents in the US market.

Another approach to look at our ability to innovate is to track how the number of patents granted to Canadians in the US has increased over the last decade. This number has climbed from 3,661 patents in 2005 to 8,903 patents in 2015; a staggering 143% increase (Figure 4). This growth not only places us in eighth place among competing countries, but also, shows that our ability to compete internationally has kept pace with other nations.

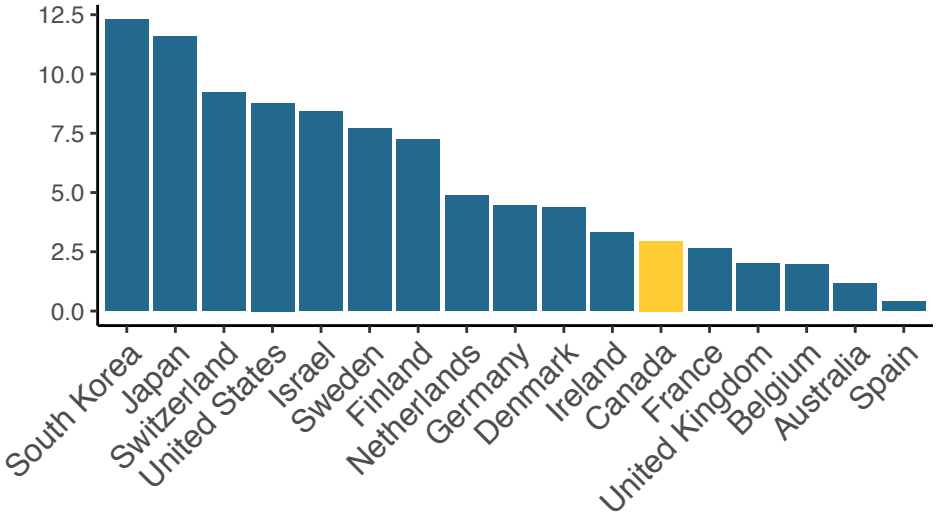
Number of Canadian Inventions Granted Patents in the US
Figure 4



Patents by Assignee

While measuring patents by country of invention helps our understanding of the research output, we can also rank patents by country of assignment; this offers insights into who derives benefits from the ownership of an invention. To this end, we looked at corporate assignees of US patents domiciled in a particular country. We then calculated a country's US ranking by calculating the number of US patents issued as a share of GDP for each country (Figure 5).

US Patent Grants by Country of Assignment
Number per $million of GDP (Source: USPTO)
Figure 5



Using this approach to analysis, we found a glaring gap between invention and ownership. Canada is ranked 12th out of 17 nations in terms of our ability to capitalize on and earn a return from the patents issued as a result of R&D conducted here. What this means is that while we may have done work to develop the science behind a patent, the company or inventors that carried out the work have either sold the patent to a company in another country or assigned it during the registration process to an office or business headquartered outside of Canada.

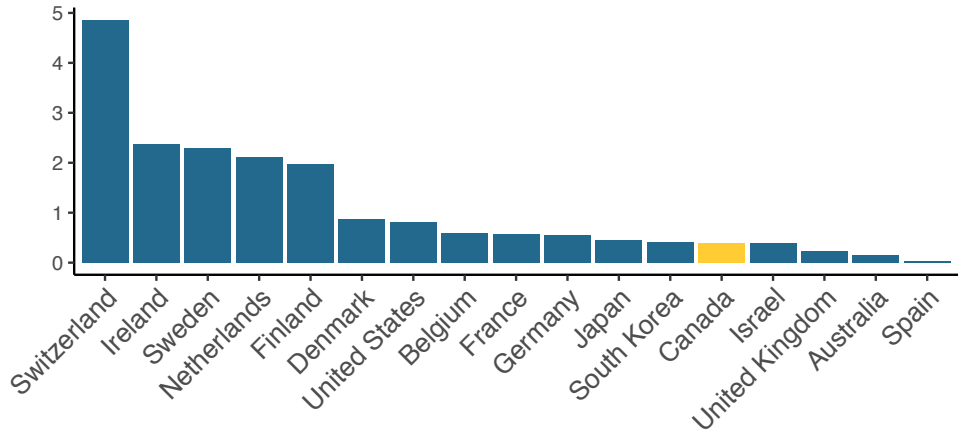
Beneficiary Assignments

In the world of patents, companies frequently conduct work in one country and assign their patent to a head office in another country. They also sell patents to companies in other nations. But has Canada benefitted from either purchasing or receiving assignment in cases where the inventors were not working in Canada?

Figure 6 indicates that the answer is no. In this ranking, our results slip even further. Canada is ranked 13th out of 17 countries in terms of our ability to purchase patents or receive assignments of research conducted outside of Canada. Switzerland (ranked first), Ireland, and Sweden are the largest beneficiaries from this practice. Other countries that one would not expect to carry out significant R&D or to file for patents—including the Cayman Islands, Bermuda, and Barbados that are not listed in Figure 6—are the real beneficiaries of patent assignments.

US Patent Grant Beneficiary by Country
Number per $million of GDP (Source: USPTO)

Figure 6

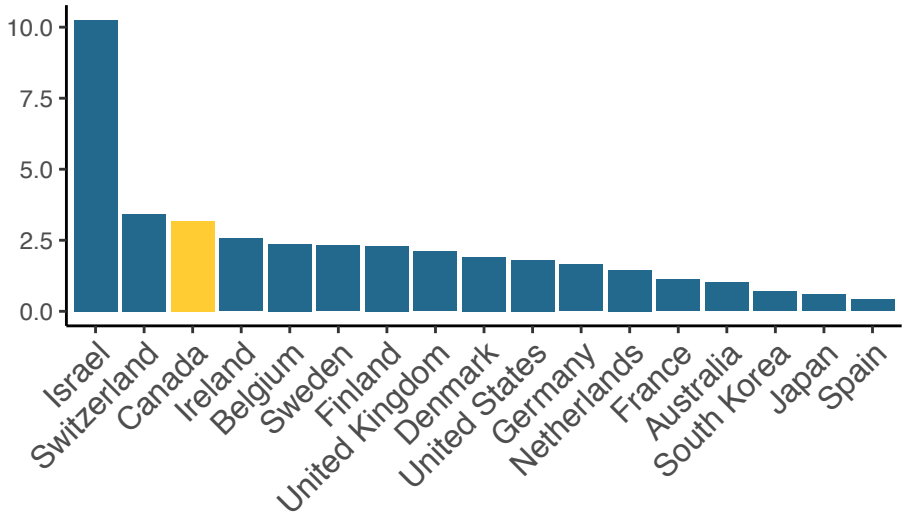


Patents Assigned or Sold Outside Canada

If Canada's future depends on our ability to conduct research locally and benefit from its eventual commercialization, then the final ranking in Figure 7 points to a disturbing trend. This provides insights into the number of patents that were invented in one country but were assigned to another.

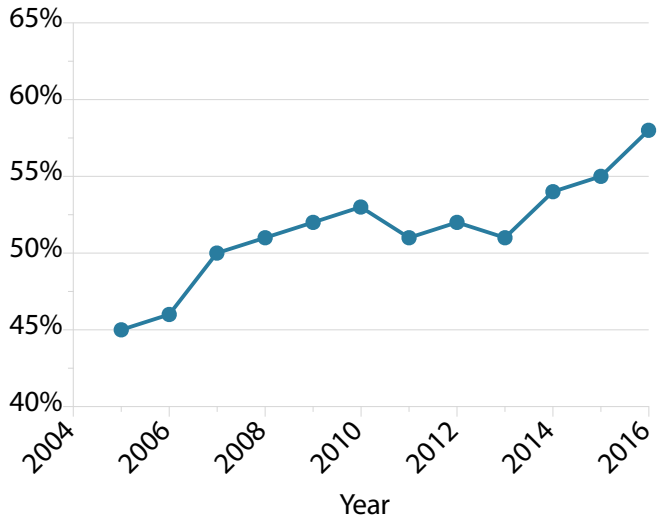
Surprisingly, Canada sits near the top in this measure: we rank third in the number of patents where the underlying research was done in Canada but where the patent was assigned to another country. Of all the patents that were issued in the US in 2015 for inventions made in Canada, 55% were assigned to another country. That means that in more than half of the cases, the benefits of Canadian R&D are transferred to another jurisdiction.

US Patent Grants by Country for Inventions
not Assigned to the Country of Origin
Number per $million of GDP (Source: USPTO)
Figure 7



In fact, when we look at the trend in patent assignments, it becomes clear that Canada has a commercialization problem that is not fully understood. The percentage of US patents with Canadian inventors that were eventually assigned to other countries has grown from 45% in 2005 to 58% in 2016 (Figure 8).

Percentage of Canadian Inventions Assigned to Another Country (Source: USPTO)
Figure 8



Understanding the derivation of this 58% figure is important. Our searches returned thousands of patent citations so we were unable to look at each one and determine its eventual disposition. Tests that we performed on the underlying data indicated that two things may be influencing the results we found. In many cases, a Canadian inventor is one of many inventors from multiple countries who is listed on the patent. In these situations, it may be totally reasonable to assign the patent ownership to a company in another country. In other cases, we noted problems with the database in that the country of assignment is not listed. We were unable to determine the magnitude of this issue.

One would presume though that every country is experiencing similar issues and that the issues we noted have occurred for many years. What is important then is not specifically whether we lose exactly 58% of the patents we are granted but that we lead the world in the loss of patents and that this problem has been getting worse for over 10 years.

While the entire discussion in Canada has focused on our inability to patent in general, these statistics point to a more nuanced issue. While we rank in the middle of the pack in generating inventions that are patentable in our primary export market, we rank near the bottom in terms of ability to gain commercial benefit from them. **Therefore, Canada's critical challenge is not a failure to turn invention into innovation. Our challenge is to ensure that Canada retains some of the economic and social benefits from our innovation activities.**

The Role of Leading Canadian R&D Firms

To look at the patenting practices of leading Canadian firms, we consulted publications by Research Infosource Inc., a research, consulting, and publishing firm that specializes in policy, Canada's R&D ecosystem, and related topics. Research Infosource publishes an annual list of the top 100 R&D spenders in Canada. Collectively, these companies spent C$12.5 billion in 2015 on R&D (Canada's Top Corporate R&D Spenders 2016, November 2016).

Our analysis identified 1625 US patents taken out by these firms based on their Canadian work. This represents 18% of the total number of patents taken out by Canadian firms in the US.

(Please note that the C$12.5 billion spent on R&D by the highest R&D spenders in Canada is out of a total of C$15 billion recorded by Statistics Canada for R&D in the entire country. Therefore, while the leading 100 firms in Canada represent 83% of the total R&D expenditure, they only account for 18% of the patents issued. Although not all R&D funds will translate directly into a patent, such a significant discrepancy suggests that either the patent numbers derived from the USPTO or the total BERD claimed by Statistics Canada is incorrect. Even with the tremendous growth rate in patents at home and abroad as discussed in a previous section, Canada's federal government claims that Canadian business enterprise expenditure on research and development [BERD] is declining. These facts simply do not tally. Please refer to our April 2016 Impact Brief, Losing Count, for a more detailed discussion of our criticism of Canada's BERD calculation. We will continue to operate under the assumption that the BERD calculation is incorrect.)

Our analysis shows that a notable fraction of the large international firms with a subsidiary in Canada do not assign their US patents to their Canadian offices. Foreign subsidiaries like Ericsson, IBM, Cisco, and PMC-Sierra undertake a substantial amount of R&D in Canada. These four companies capture 20% of the total funds spent on R&D and 32% of the patent grants among the top 50 firms. But, in almost all cases, they assign their patents to the parent business located in other regions of the world. In fact, 96% of the patents granted and R&D undertaken by the 17 leading foreign subsidiaries will benefit another country when commercialized.

Table 2 shows the number of patents granted in 2015 for each of the top 15 R&D spenders along with how many of these were assigned to a company in Canada. A full list of the top 50 R&D spenders is available as Supplementary Figure 6.

R&D Expenditures and US Patent Grants by Company 2015
(Sources: Research Infosource Inc. and USPTO)
(fs = foreign subsidiary)
Table 2

	Company	Expenditures on R&D ($C)	Total # of US Patents	# of Patents Assigned to CAN company
1	Bombardier Inc.	2,293,988	37	30
2	Magna International Inc.	639,350	10	10
3	Blackberry Limited	599,710	851	816
4	BCE Inc.	530,300	17	17
5	Canadian Natural Resources	527,000	0	0
6	Pratt and Whitney Canada Corp. (fs)	518,000	87	70
7	IBM Canada Ltd. (fs)	477,000	230	0
8	Valeant Pharmaceuticals International, Inc.	427,597	3	2
9	Rogers Communications	425,287	9	9
10	Constellation Software Inc.	349,325	n/a	n/a
11	Ericsson Canada Inc. (fs)	316,000	111	0
12	Apotex Inc.	274,505	4	4
13	CGI Group Inc.	257,177	0	0
14	Open Text Corporation	251,253	4	1
15	Telus Corporation	206,000	1	1

To us, this is clear evidence that the problem is not in the performance of R&D in Canada or in the number of patents issued. The problem is in our inability to commercialize the results of the R&D done here, particularly when it is performed by subsidiaries of foreign companies.

Implications for the Scientific Research and Experimental Development (SR&ED Program)

This patenting problem exposes a troubling repercussion for policy instruments such as SR&ED tax incentives that have been used for decades as an indirect tool to encourage business investment in R&D. Subsidiaries of foreign companies conducting R&D in Canada are eligible for a SR&ED credit at a rate of 15% of eligible expenditures. But if in many cases, rights to the outputs of Canadian R&D flow to another country, then the question that arises is whether Canadian taxpayers are, or should be, subsidizing research that ultimately benefits non-Canadian businesses.

If the purpose of SR&ED program is to create R&D employment in Canada, then allowing foreign subsidiaries to collect the benefit through the tax system is acceptable. However, if the purpose of the SR&ED program is to help the Canadian technology industry with expenditures that will create export growth, then this is an abject failure.

Patents as a Metric

In assessing the ability of Canada to compete in the innovation economy, three commonly used metrics include:

1. expenditures on research and development,
2. the number of patents granted, and
3. multifactor productivity.

These indicators have had a profound impact on Canada's strategy and policy conversation for decades. When blended with other metrics, patents are thought to be an effective measure of the ability of countries to convert knowledge into novel inventions that allow them to reap the commercial benefits of the IP. Triadic patent counts are generally considered the gold standard for IP-related metrics and continue to be used abundantly. But there are five significant shortcomings in using them as a measurement of innovation:

Patents are an input metric

The first problem with patents as a measure of the innovativeness of a country is that patents are fundamentally an input metric. Although they require approval from an examiner who judges on their novelty, usefulness, and non-obviousness, a patent office cannot measure the impact of the invention. We believe that the purpose of corporate R&D is to generate beneficial inventions, but the novelty and non-obviousness of a technology do not guarantee its usefulness or impact in the field.

Patents do not correlate well with results-oriented measures such as revenue

If patent results were an ideal input metric or measure of the innovation capacity of a firm, region, or country, we would expect to see causality, or at least a correlation, between inputs and outputs. We could trace the interrelationships between the number of patents issued and the level of firm profitability, country productivity, or new product sales—and eventually economic impact. This would enable us to review our progress and predict future outcomes based on the level of current inputs. But there is no conclusive evidence that patents correlate well with outcomes such as revenue.

Patents range significantly in the quality and impact of the underlying invention

In many cases, it is impossible to predict the long-term impact of a patent. Some patents earn a superb return for their inventors but most earn nothing throughout the lifetime of the IP. (The author would like to state that when it comes to patents, he would rather be the holder of the patent for the transistor than the patent for a wheel chock for an inline skate, for which he is a co-inventor and patent holder. Refer to Canadian patent number 2189810). Large companies have the resources to file patents when needed, for a range of operational or strategic reasons, resulting in a potentially large number of patents that occupy patent databases but have little to no commercial value. On the other hand, smaller companies struggle to pay their filing and defense costs and often have to make hard choices about

when to patent. As a result, large corporations are favoured in indicators related to triadic patents, while small firms look less productive.

Indicators do not take into account the breadth of possible product and process patents

We have not covered the purpose of patents in this analysis (but plan to do so in a future Impact Brief). Companies use patents to protect both processes and products, but IP-related metrics do not differentiate between them. When companies choose one approach over another, they do so after careful deliberation and strategic planning. Arguably, the end result of a process patent is improved productivity or product quality, and the outcome of a product patent is a new or improved product. Using a single measure—the number of patents—to measure both activities is unsound. And, certainly, basing an entire industrial strategy on a single indicator is fundamentally flawed. To be more effective in our analysis, patents should be divided into categories that more accurately reflect the underlying business activities.

Patenting is an international, not a local activity

Our analysis stresses just how internationalized business R&D has become. Where R&D is concerned, borders are now irrelevant, and companies conduct R&D where they see talent. But interestingly, this internationalization has not translated to patenting; subsidiaries still assign patents to the country where their head office is located or to a location that rewards them with a low tax rate, effectively shifting the benefit of conducting R&D locally and spreading the commercial gains internationally. The nuances of the process must be considered before the numbers are aggregated into a single indicator for the purpose of policy making.

Conclusions

Although using patents as a metric for how well we are performing internationally may have worked in the industrial economy, it does not work in an internationalized knowledge economy. For too long, Canada has crafted policy and programs in response to aggregate macroeconomic indicators. For example, in response to Canada's consistently low BERD numbers, countless R&D programs have been fashioned at all levels of government to encourage businesses to invest in research and innovation that would eventually lead to more commercialization, patents, and improved productivity.

But, this Impact Brief has demonstrated that we must move beyond macroeconomic assumptions and look at firm level behaviour to arrive at metrics that properly capture the realities of innovation and Canada's performance. Not only do we need new measures that reflect the new economy that we are part of, but we also have to continuously challenge our approaches to analyzing Canada's record in R&D and innovation. We have to look at the underlying assumptions and data to understand how we can derive actionable items that improve our standing in innovation. That way we can mount initiatives and programs that make a meaningful difference to Canada's technology sector.

Methodology

Our study looked at economic, patenting, and company data from the following sources:

- Organisation for Economic Co-operation and Development (OECD) – Gross Domestic Product (data.oecd.org)
- OECD – Triadic Patent Families (stats.oecd.org)
- Forbes – Global 2000 List (www.forbes.com/global2000)
- Research Infosource – Canada's Top 100 Corporate R&D Spenders 2016, November 2016

Please note that different dates were chosen throughout this report as a result of the availability of data.

Please also note that differences between the data in this report and the data on the OECD site result from differences in reporting methodologies and differences between data sources from different portions of the OECD site.

Data from the USPTO was obtained by searching their patent database. We noted in conducting searches that not all fields of data in the database are complete or accurate. Thus there are problems with data quality that could be affecting the results of our searches. We intend to do further research in the future to produce more in-depth analysis through an examination of individual patent grants.

This study was not intended to be academically rigorous; nor was it intended to be all encompassing about the topic of patenting in the tech industry. It was designed only to add to the conversation on innovation and highlight areas worthy of future research by looking at data available from publicly available sources. We plan to continue exploring and developing research on the subject in future Impact Briefs.

Supplemental Data

Relationship between Triadic Patents and Revenue of Global Technology Companies
(Data for Figure 2)
Supplemental Table 1

	2013 Number of Triadic Patents	Ranking of Triadic Patents as a % of GDP	Revenue of Global 2000 Technology companies ($US B)	Ranking of Global Tech Companies as a % of GDP
Australia	316	16	5.8	17
Belgium	467	10	4.3	14
Canada	593	14	10.4	15
Denmark	331	7	20.2	6
Finland	258	9	14.5	9
France	2,466	11	66.2	11
Germany	5,525	5	74.9	12
Ireland	73	15	16.4	7
Israel	369	4	21.3	5
Japan	16,197	1	578.2	3
South Korea	3,107	3	210.7	2
Netherlands	947	8	13.1	13
Spain	240	17	8.7	16
Sweden	621	6	29	8
Switzerland	1,195	2	115.6	1
United Kingdom	1,726	13	67.4	10
USA	14,211	12	1,748	4

US Patent Grants by Country of Invention 2015
(Data for Figure 3)
Supplemental Table 2

Country	Number of US Patents by Inventor	Rank by Number of US Patents as a % of GDP
Australia	2,349	16
Belgium	1,814	12
Canada	8,903	8
Denmark	1,423	10
Finland	1,702	7
France	8,315	15
Germany	20,157	9
Ireland	778	14
Israel	4,336	1
Japan	55,449	3
South Korea	20,696	2
Netherlands	3,456	11
Spain	1,194	17
Sweden	3,386	6
Switzerland	3,771	5
United Kingdom	9,131	13
USA	162,969	4

US Patent Grants by Country of Invention 2015
(Data or Figure 5)
Supplemental Table 3

Country	Number of US Patents by Assignee	Rank by Number of US Patents by Share of GDP
Australia	1,294	16
Belgium	953	15
Canada	4,582	12
Denmark	1,148	10
Finland	1,628	7
France	6,908	13
Germany	16,179	9
Ireland	735	11
Israel	1,995	5
Japan	54,766	2
South Korea	20,231	1
Netherlands	3,988	8
Spain	585	17
Sweden	3,374	6
Switzerland	4,466	3
United Kingdom	4,999	14
USA	146,499	4

US Patent Grants by Country of Invention 2015
(Data for Figure 6)
Supplemental Table 4

	Number of US Patents Assigned to but not Invented in Specific Country	Rank by Number of US Patents by Share of GDP
Australia	165	16
Belgium	285	8
Canada	605	13
Denmark	227	6
Finland	442	5
France	1508	9
Germany	2007	10
Ireland	527	2
Israel	92	14
Japan	2142	11
South Korea	685	12
Netherlands	1725	4
Spain	31	17
Sweden	1002	3
Switzerland	2353	1
United Kingdom	588	15
USA	13631	7

US Patent Grants by Country of Invention 2015
(Data for Figure 7)
Supplemental Table 5

	Number of US Patents Not Assigned to Country of Origin	Rank by Number of US Patents Not Assigned by Share of GDP
Australia	1,120	14
Belgium	1,146	5
Canada	4,926	3
Denmark	502	9
Finland	516	7
France	2,915	13
Germany	5,985	11
Ireland	570	4
Israel	2,433	1
Japan	2,825	16
South Korea	1,150	15
Netherlands	1,193	12
Spain	640	17
Sweden	1,014	6
Switzerland	1,658	2
United Kingdom	5,270	8
USA	30,101	10

R&D Expenditures and US Patent Grants by Company 2015
Sources: Research Infosource Inc. and USPTO
(fs = foreign subsidiary)
Supplemental Table 6

	Company	Expenditures on R&D ($C)	Total # of US Patents	# of Patents Assigned to CAN company
1	Bombardier Inc.	2,293,988	37	30
2	Magna International Inc.	639,350	10	10
3	Blackberry Limited	599,710	851	816
4	BCE Inc.	530,300	17	17
5	Canadian Natural Resources	527,000	0	0
6	Pratt and Whitney Canada Corp. (fs)	518,000	87	70
7	IBM Canada Ltd. (fs)	477,000	230	0
8	Valeant Pharmaceuticals International, Inc.	427,597	3	2
9	Rogers Communications	425,287	9	9
10	Constellation Software Inc.	349,325	n/a	n/a
11	Ericsson Canada Inc. (fs)	316,000	111	0
12	Apotex Inc.	274,505	4	4
13	CGI Group Inc.	257,177	0	0
14	Open Text Corporation	251,253	4	1
15	Telus Corporation	206,000	1	1
16	Suncor Energy Inc.	200,000	7	7
17	Imperial Oil Limited	195,000	0	0
18	General Motors of Canada (fs)	190,000	13	0
19	AMD Canada (fs)	185,422	23	16
20	Mitel Networks	168,021	10	10
21	BRP Inc.	164,400	8	3
22	CAE Inc.	138,900	2	2
23	Sanofi (fs)	133,300	2	1
24	Hydro-Quebec	130,000	6	6
25	MDA	129,266	6	6
26	Cisco Canada (fs)	114,926	40	0
27	Sierra Wireless, Inc.	95,390	9	9
28	Pfizer Canada Inc. (fs)	95,185	2	0
29	Huawei Canada (fs)	93,840	13	0
30	Cenovus Energy Inc.	91,000	2	2

	Company	Expenditures on R&D ($C)	Total # of US Patents	# of Patents Assigned to CAN company
31	PMC-Sierra Ltd. (fs)	87,781	55	0
32	Bayer Inc. (fs)	84,300	5	4
33	GlaxoSmithKline Inc. (fs)	80,907	6	0
34	Janssen Inc. (fs)	74,749	0	0
35	Amgen Canada Inc. (fs)	72,800	8	0
36	Linamar Corporation	71,937	0	0
37	Amaya Inc.	68,312	0	0
38	Westport Innovations Inc.	67,761	0	0
39	Arbutus Biopharma Corporation	65,859	0	0
40	Evertz Technologies Limited	64,332	2	2
41	EXFO Inc.	64,124	6	6
42	Novelis Inc. (fs)	63,935	6	0
43	Atomic Energy of Canada Limited	63,800	3	3
44	Redknee Solutions Inc.	61,416	1	1
45	Syncrude Canada Ltd.	58,698	5	5
46	SMART Technologies Inc.	55,759	14	14
47	Novartis Pharmaceuticals Canada Inc. (fs)	53,000	4	1
48	Shell Canada Limited (fs)	52,427	0	0
49	Shopify Inc.	52,145	0	0
50	ProMetic Life Sciences Inc.	51,570	3	3

About the Impact Centre

Science to Society

We generate impact through industry projects and partnerships, entrepreneurial companies, training and research.

We bridge the gap between the university and industry to accelerate the development of new or improved products and services based on physical technologies. We work with graduate students and researchers to help them commercialize their discoveries. We provide undergraduate education and training for students at all levels to ease their transition into future careers.

The Impact Centre conducts research on all aspects of innovation, from ideation and commercialization to government policy and broader themes such as the connection between science and international development. We study how companies of all sizes navigate the complex path between a discovery and its market and how their collective innovations add up to create a larger socioeconomic impact.

Our objective is to understand how we can improve our ability to create world-class technology companies, how governments, companies, and academia can identify and adopt best practices in technology commercialization.

Impact Briefs

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