The Conference Board of Canada

Intellectual Property in Canada

Technology Specialization and Competitive Advantage

Impact paper | August 25, 2025

Canadian Centre for the Innovation Economy

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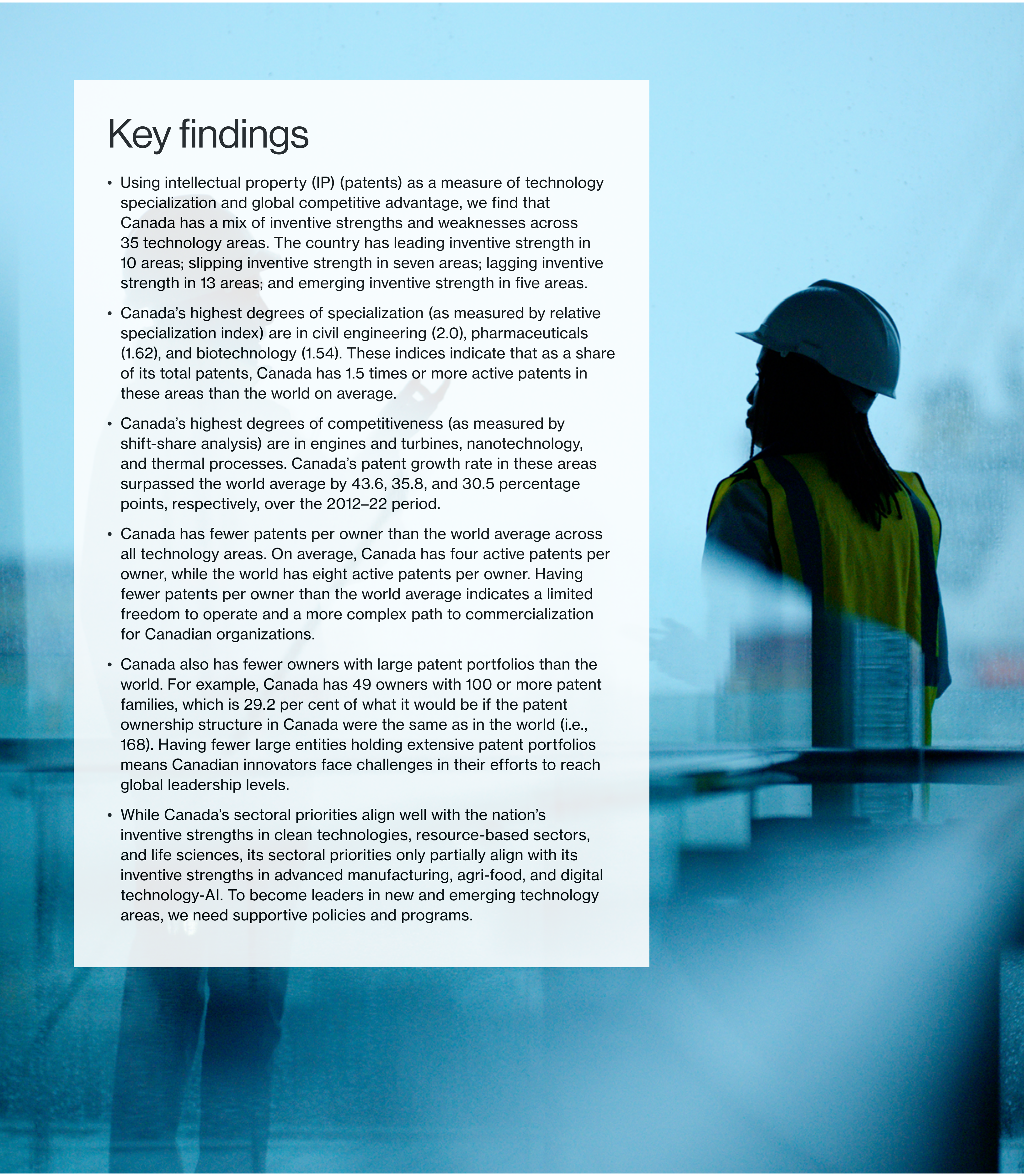


Key findings

- Using intellectual property (IP) (patents) as a measure of technology specialization and global competitive advantage, we find that Canada has a mix of inventive strengths and weaknesses across 35 technology areas. The country has leading inventive strength in 10 areas; slipping inventive strength in seven areas; lagging inventive strength in 13 areas; and emerging inventive strength in five areas.
- Canada's highest degrees of specialization (as measured by relative specialization index) are in civil engineering (2.0), pharmaceuticals (1.62), and biotechnology (1.54). These indices indicate that as a share of its total patents, Canada has 1.5 times or more active patents in these areas than the world on average.
- Canada's highest degrees of competitiveness (as measured by shift-share analysis) are in engines and turbines, nanotechnology, and thermal processes. Canada's patent growth rate in these areas surpassed the world average by 43.6, 35.8, and 30.5 percentage points, respectively, over the 2012–22 period.
- Canada has fewer patents per owner than the world average across all technology areas. On average, Canada has four active patents per owner, while the world has eight active patents per owner. Having fewer patents per owner than the world average indicates a limited freedom to operate and a more complex path to commercialization for Canadian organizations.
- Canada also has fewer owners with large patent portfolios than the world. For example, Canada has 49 owners with 100 or more patent families, which is 29.2 per cent of what it would be if the patent ownership structure in Canada were the same as in the world (i.e., 168). Having fewer large entities holding extensive patent portfolios means Canadian innovators face challenges in their efforts to reach global leadership levels.
- While Canada's sectoral priorities align well with the nation's inventive strengths in clean technologies, resource-based sectors, and life sciences, its sectoral priorities only partially align with its inventive strengths in advanced manufacturing, agri-food, and digital technology-AI. To become leaders in new and emerging technology areas, we need supportive policies and programs.

IP is a key driver of innovation and economic growth

Intellectual property (IP)[1] plays a vital role in fostering innovation and economic growth by giving businesses the freedom to compete, charge rents for their inventive assets, and protect their ideas globally. Among different forms of IP rights, patents stand out as one of the most important and widely used statistics.[2]

At the national and regional level, researchers use patents to understand innovation capacity of different jurisdictions.[3] At the firm level, patents measure firms' and individuals' ability to invent and seek protection for outputs from their research and development (R&D) activity. Additionally, a strong patent portfolio is an indication of businesses' ability to grow and gain market share with monopoly rights to their inventions.[4]

Despite the central role of patents in the innovation process, there remains a lack of clear insight into the technology areas where Canada holds specialization and competitive advantages. This research fills that gap by systematically analyzing patent data to 1) evaluate Canada's technological specialization, competitiveness, and freedom to operate, and 2) assess the extent to which these inventive strengths align with the federal government's sectoral priorities.[5]

1 "Intellectual Property means anything that may be protected by any Intellectual Property Right including, but not limited to, works, performances, discoveries, inventions, trademarks (including trade names and service marks), domain names, sectoral designs, trade secrets, data, tools, templates, technology (including software in executable code and source code format), Confidential Information as applicable, mask work, integrated circuit topographies, documents, or any other information, data, or materials and any expression thereof." Expert Panel on Intellectual Property, *Intellectual Property in Ontario's Innovation Ecosystem*, 38.

2 Furman and others, "Determinants of National Innovative Capacity."

3 Porter and Stern, *National Innovative Capacity.*

4 Organisation for Economic Co-operation and Development, *Competition and Innovation.*

5 There are other forms of specialization and competitiveness that are not based on patents, such as entrepreneurial and micro-level firm strengths or higher education research quality. The analysis here intentionally focuses on technological specialization and competitive advantage as measured through patents. This narrow scope offers a scientifically grounded and practically manageable lens to assess Canada's inventive strengths.

Mapping innovation advantage

Using both established and novel analytical approaches, we identify key technology fields and examine how well public policy is supporting or reinforcing these areas. Our analytical approach includes:

- **Relative Specialization Index (RSI):** Measures technological concentration in Canada compared with global and Organisation for Economic Co-operation and Development (OECD) averages, with values greater than 1 indicating specialization (expressed as ratios). Specialization indicates concentrated R&D capabilities with scientific and technical expertise in Canada that is less commonly found in other countries.
- **Shift-Share Analysis (SSA):** Isolates the National Shift (NS) in patent growth over time to identify competitive advantages unique to Canada, with positive values indicating stronger growth performance than global and OECD peers (expressed in percentage points). There are three potential sources of growth in patent grants: 1) overall increase in patent grants (global effect), 2) overall increase in patent grants in specific fields due to technological change (industry effect), and 3) increase in patent grants domestically (national shift, also known as the competitive shift or national effect). SSA allows us to quantify the portion of growth in patent grants attributable to each of the three components.
- **Freedom to operate (FTO):** Examines patent distribution by owners; lower values relative to global and OECD averages suggest Canadian organizations may face more constraints in using or commercializing patented technologies.
- **Policy alignment:** Assesses the overlap between Canada's inventive strengths and sectoral priorities, categorized as full alignment (RSI > 1 and NS > 0), partial alignment (RSI > 1 or NS > 0), or no alignment (RSI < 1 and NS < 0).

We conduct RSI and FTO analyses using 24,528,973 active patents with legally enforceable rights across 35 distinct technology areas as of 2022. These patents are protected in 90 countries.[6] We conduct SSA using patent grants in 2012 and 2022.[7] Through these complementary analyses,[8] we provide evidence-based insights to inform innovation policy and identify opportunities for enhancing Canada's global position in technological innovation.[9]

Canada's inventive strengths

We assess Canada's inventive strengths by combining RSI values (i.e., specialization) with NS values (i.e., competitiveness). This approach is novel and not only captures Canada's technological orientation and its growth trajectory in different technology areas simultaneously, but also systematically classifies all technology areas into four mutually exclusive categories that are insightful for innovation policy.

- Leading inventive strength = RSI > 1 and NS > 0
- Slipping inventive strength = RSI > 1 and NS < 0
- Lagging inventive strength = RSI < 1 and NS < 0
- Emerging inventive strength = RSI < 1 and NS > 0

Using Intellectual Property (patents) as a proxy for relative specialization and global competitive advantage, Canada has a variety of inventive strengths and weaknesses across 35 technology areas. (See Chart 1.)

The country has leading inventive strength in 10 areas; slipping inventive strength in 7 areas; lagging inventive strength in 13 areas; and emerging inventive strength in 5 areas. From a policy perspective, Canada has a favourable position in 15 areas (i.e. leading or emerging), while it has an unfavourable position in 20 areas (i.e., slipping or lagging).

6 European Patent Office, *Data Catalog PATSTAT Global*.

7 See Appendix A for methodological details.

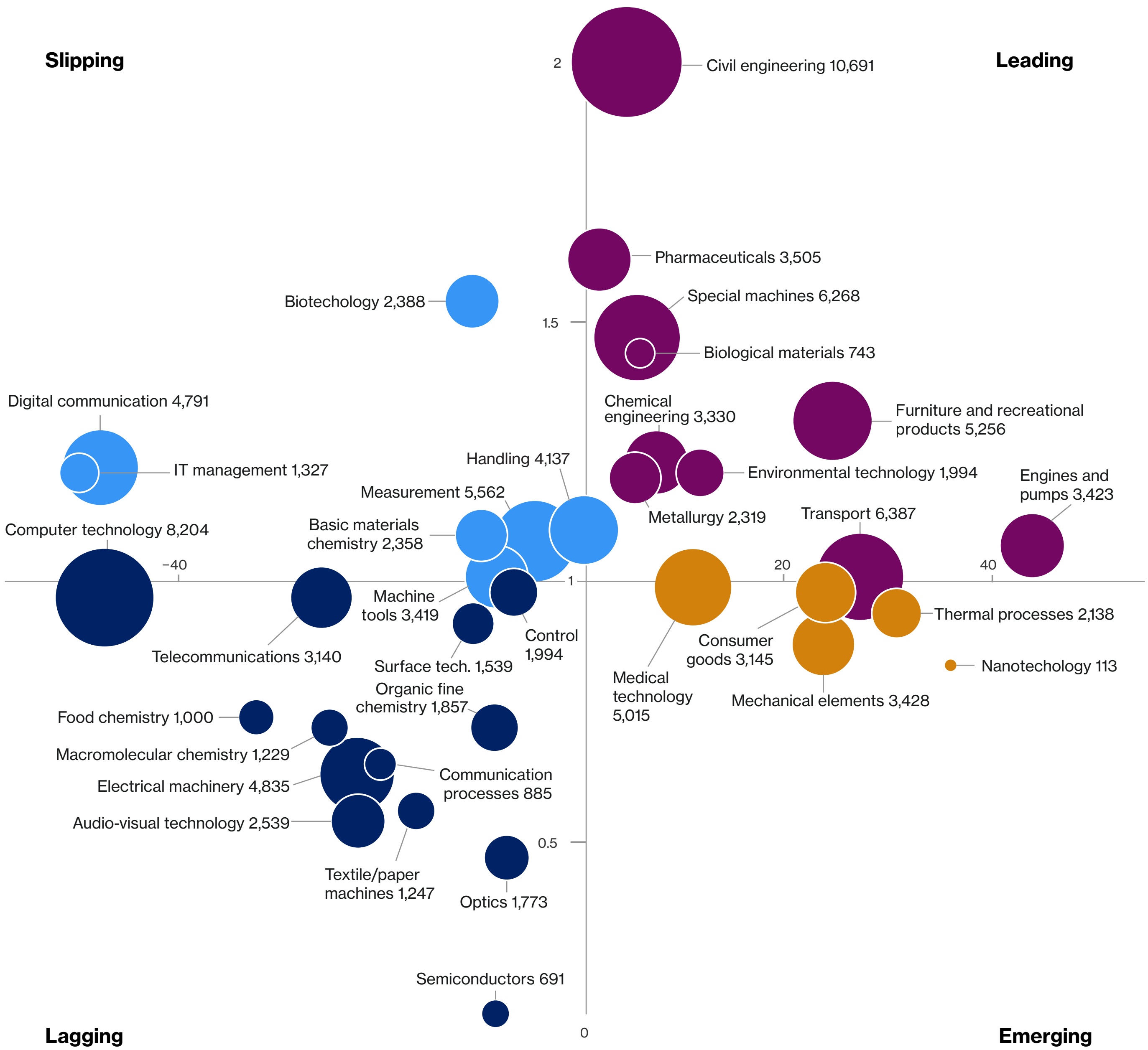
8 In all analyses, our focus is on patent ownership, not inventorship. Ownership is a more accurate indicator of innovation capability than inventor, as it reflects who holds the economic rights to the invention disclosed in patent documents.

9 In the main text, we provide results based on world as the reference region, while we present results based on OECD as the reference region in Appendix A.

Chart 1

Canada's innovation varies considerably across technology areas

(relative specialization index, vertical axis; national shift, per cent, horizontal axis; number of active patent families)



Note: The size of the bubbles is proportional to the number of active patent families. The technology class definition is based on World Intellectual Property Organization (WIPO) and European Patent Office (EPO). See Appendix A for definitions.
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Areas of slipping inventive strength reflect gaps in innovation capacity

Canada has slipping inventive strength in seven technology areas (RSI > 1 and NS < 0). These are areas in which Canada has current technological specialization, but not competitiveness, indicating that national factors—such as relevant talent, research capabilities, anchor firms, and capital—that supported growth in the past are no longer sufficient. Due to relatively low patenting growth rates, the country is at risk of losing its specialization position in these fields unless current trends are reversed. The mix of fields—ranging from knowledge-intensive areas such as biotechnology, digital communication, and information technology management to more conventional areas such as machine tools and handling—suggests structural gaps in the innovation ecosystem that cut across sectors.

Areas of leading inventive strength are conventional and knowledge-intensive

Canada has leading inventive strength in 10 technology areas (RSI > 1 and NS > 0). Given the combination of technological specialization and competitiveness, this is the most desirable quadrant for the country from an innovation policy perspective. These areas span both conventional and knowledge-intensive sectors. Conventional strengths include civil engineering, chemical engineering, furniture and recreational products, transport, special machines, and engines and turbines—fields often supported by either natural resource endowment[10] or established sectoral capacity (i.e., auto and aerospace manufacturing). On the other hand, Canada's position in pharmaceuticals, biological materials, and environmental technology reflects the country's research and innovation capabilities in more knowledge-intensive and emerging areas.

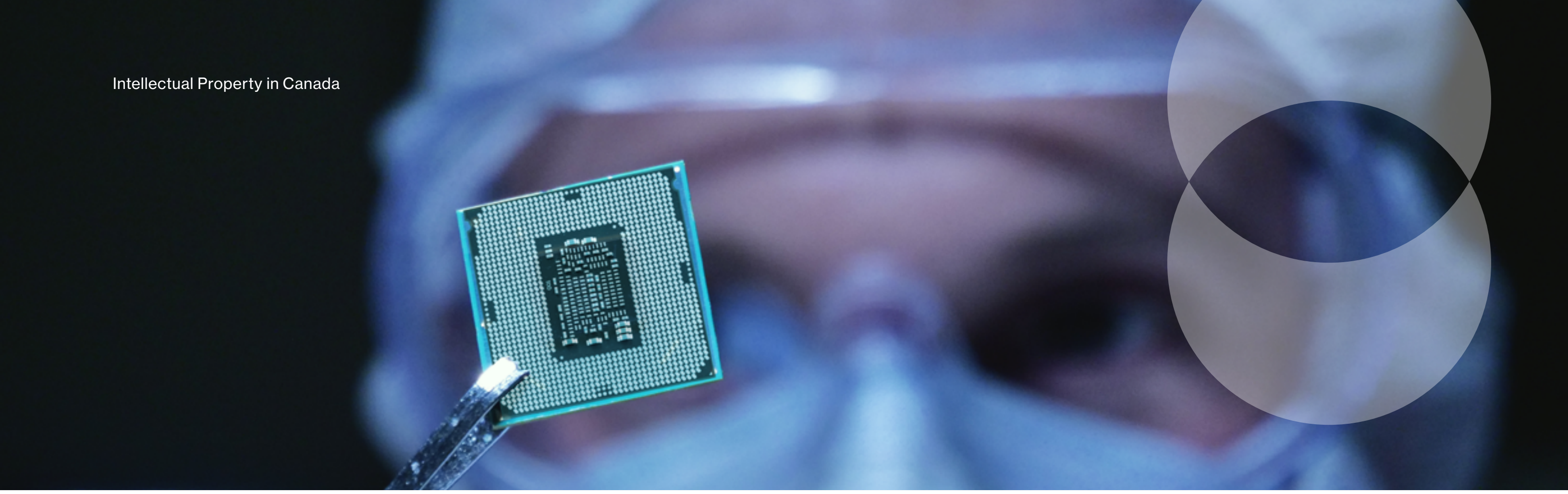
Areas of lagging inventive strength are diverse

Canada has lagging inventive strength in 13 technology areas (RSI < 1 and NS < 0), the largest group of the four categories. Given the lack of both technological specialization and competitiveness, this is the least-desirable quadrant from an innovation policy perspective. These lagging areas encompass digital infrastructure technologies (i.e., computer technology, telecommunications, semiconductors); advanced manufacturing (surface technology, electrical machinery); chemistry-based fields (i.e., food chemistry, organic chemistry, polymers); and communications technologies (communication processes, audio-visual technology). Given the diversity of technology areas in this category, it is difficult to pinpoint common factors that explain the country's lagging position in them collectively. However, Canada's lagging position in computer technology and communications could be explained by the fall of Nortel Networks in 2009[11] and the decline of BlackBerry in 2016.[12] It is surprising that Canada has lagging position in food chemistry, organic fine chemistry, and polymers given its leading position in chemical engineering and pharmaceuticals.

10 Most patents related to resource extraction are classified in civil engineering.

11 Calof and others, *An Overview of the Demise of Nortel Networks and Key Lessons Learned*.

12 Bhatt, "The Rise and Fall of BlackBerry Mobiles."



Areas of emerging inventive strength are conventional and knowledge-intensive

Canada has emerging inventive strength in five technology areas (RSI < 1 and NS > 0), the smallest group of the four categories. The country currently lacks specialization in these areas but shows competitiveness, suggesting potential for future growth if enabling conditions—such as talent, research capacity, and capital—are sustained. The group includes both conventional sectors, such as consumer goods, thermal processes, and mechanical elements, as well as more knowledge-intensive areas such as medical technology and nanotechnology, where Canada is showing signs of momentum (as evidenced by the relatively large positive national shift).

Nanotechnology[13] registers the second-highest growth rate among all 35 technology classes over the past decade (2012–22)—the engines and turbines technology area has the highest growth rate. While Canada currently does not have specialization in this field (RSI of 0.84 is slightly below the world average), the NS value of 35.8 percentage point indicates that Canadian nanotechnology invention is substantially outpacing its global peers. This competitive advantage based on patenting rate suggests Canada possesses national factors—such as relevant talent, research capabilities, and capital—driving nanotechnology advancement and presents an opportunity for targeted investment to further develop it.

Overall, Canada's varying inventive strengths and weaknesses relative to the world reflects its natural resource endowment, human capital, and the accumulated effects of research, innovation, and sectoral policies in the last three decades.[14] Given path dependency in a country's economic structure,[15] policy-makers can consider these patent-based technological specialization and competitiveness results in setting priorities (along with complementary analyses based on other forms of IP).

13 Nanotechnology involves manipulating materials at the nanoscale (1–100 nanometres) and has applications in medicine, aerospace, image processing, and high-performance materials. (See National Nanotechnology Coordination Office, "National Nanotechnology Initiative.") In medicine, it is used for diagnostics, cancer treatments, and nanodevices. It also enhances products in transportation, consumer goods, and biomedical fields. With its potential for atomic-level manipulation, nanotechnology is driving innovations in gene nanochips, nanotunnels, and advanced materials, and is expected to impact communications and transportation in the future. (See Organisation for Economic Co-operation and Development, *The Impacts of Nanotechnology on Companies*.

14 We say three decades because 81.2 per cent of the active patents have priority year between 1992 and 2022. Patents filed and granted in this period must have benefited from policies and programs either directly or indirectly.

15 De Lyon and others, "Enduring strengths."

A complex path to commercialization

Even in sectors where Canada has inventive strengths, limited freedom to operate—the ability to use a product or process without infringing on existing IP rights[16]—hampers commercialization. This happens because instead of a few large entities holding extensive patent portfolios, patents are spread across many smaller players, each with limited holdings. This makes it more difficult for companies to identify what technologies they can safely use without risking legal issues. Such a structure raises the cost and uncertainty of innovation for businesses, as they need to conduct extensive due diligence to avoid infringing on existing patent rights. For instance, a Canadian medical device company developing a new diagnostic device may find that different components—such as imaging software, sensor technology, and signal processing—are each patented by separate small entities. To bring the product to market, the firm must negotiate multiple licences, increasing cost, delay, and legal risk. A distributed invention ownership structure in Canada means that Canadian organizations must navigate a more complex path to commercialization than their global competitors.[17] Innovation Asset Collective is a good example to address this problem in clean technology. Canada can consider a similar approach in other technology fields.

Our analysis shows that inventive activity at the owner level in Canada is less concentrated than the world average. All technological fields have fewer patents per owner in Canada compared with world. (See Chart 2.) The gap is particularly large in key emerging technology fields such as semiconductors, optics, and digital communication. This suggests challenges in scaling innovation output in cutting-edge technologies in Canada.

In more established sectors, such as biological materials, chemical engineering, special machines, and pharmaceuticals, the patent ownership structure in Canada is closer to global levels. This indicates a relatively stable competitive position for Canada regarding other countries in these areas.

Canada also has fewer owners with large patent portfolios than the world. (See Chart 3.) For instance, the number of owners in Canada with 10 or more patent families is 1,721. That is 60.1 per cent of what it would be if the patent ownership structure in Canada were the same as in the world (i.e., 2,863).[18] The gap between Canada and the world widens as the size of patent portfolios increases. Looking at the top of the distribution, the number of owners with 100 or more patent families is 49 in Canada. That is 29.2 per cent of what it would be if the patent ownership structure in Canada were the same as in the world (i.e., 168).

These findings indicate that Canadian innovators face challenges in scaling up their patenting activity to reach global leadership levels.

Relatively low patent concentration in Canada impacts companies' ability to compete globally. A distributed ownership structure complicates firms' path to commercialization. Before pursuing a new idea, they must determine whether it is already patented to avoid legal and financial risks. With a complex path to scale, Canadian innovators will continue to struggle to turn invention into economic success.

16 World Intellectual Property Organization (WIPO), *Using Inventions in the Public Domain*.

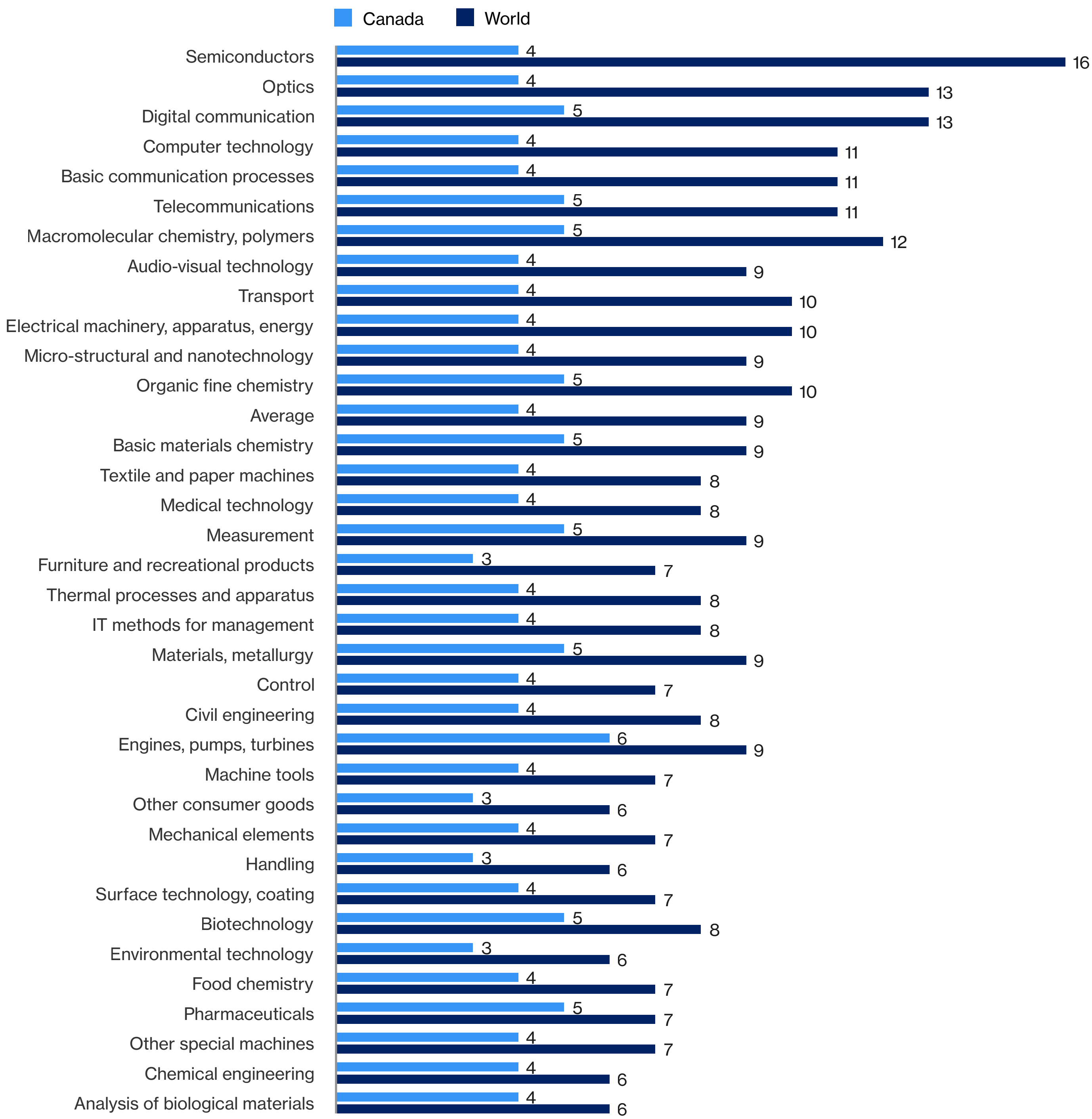
17 Gallini and Hollis, "To Sell or Scale Up."

18 We provide this counterfactual figure as a point of comparison instead of simply comparing Canada's figure with that of the world due to difference in sizes. See Appendix A for how it is calculated.

Chart 2

Canada has fewer patent families per owner than world average across all technological fields

(number of active patent families per owner)

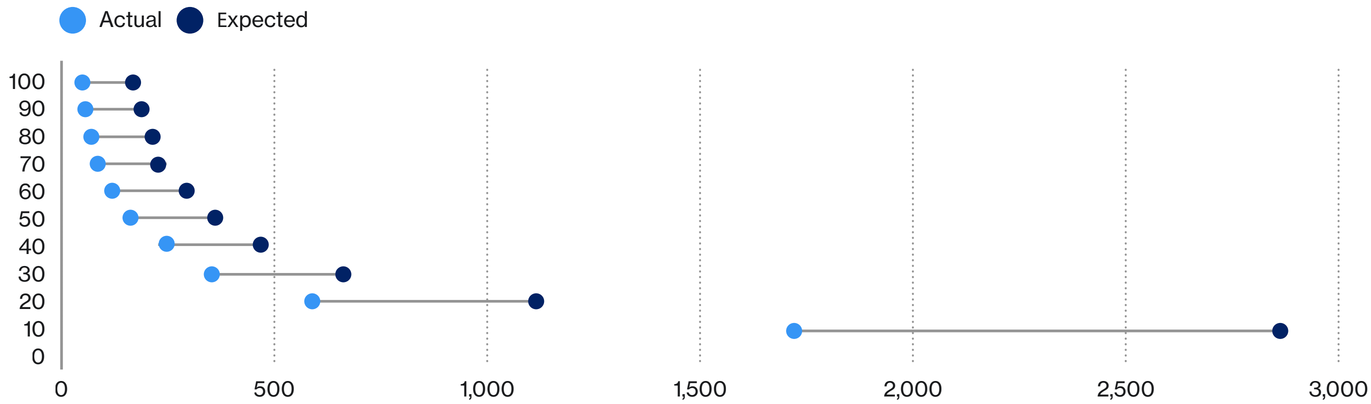


Note: Owners with a single patent family ownership (corresponding mostly to individuals) is excluded from both Canada and world counts; Technologies are sorted by the size of difference between Canada and world in descending order.
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 3

Canada has lower patent concentration than its global competitors

(vertical axis: number of patent families with at least one active patent; horizontal axis: number of owners)



Note: Expected number of owners is based on Canada's share of global patents averaged across 35 technology classes. Owner counts may be slightly underestimated due to variations or misspellings in patent database entries, which our algorithms interpret as distinct entities.
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Alignment of sectoral priorities

A review of major ongoing innovation and economic growth programs and policies targeted at specific sectors by Innovation, Science and Economic Development Canada (ISED), two Crown agencies (Export Development Canada [EDC] and Business Development Bank of Canada [BDC]), and Invest in Canada (an arm's-length government agency that helps attract and coordinate foreign direct investment [FDI] in Canada) reveals six areas for Canada's sectoral priorities.[19]

- advanced manufacturing
- agri-food
- clean technologies
- digital technology-AI
- life sciences
- resource-based sectors

But do these sector-specific innovation policies target and support technology areas that would maximize the impact of public policy?[20] The impact of public policy here is making Canada more specialized and competitive in technology areas that correspond to selected/prioritized sectors. For example, if Canada wants to be a global leader in advanced manufacturing, one of its public policies should help to produce more nanotechnology inventions than the rest of the world as a share of its total inventions.

We believe that Canada should focus sector-specific policies on technologies where it is already strong, because these areas have proven their value in the market and offer the highest potential return on investment.

19 See Appendix A for a list of these programs and policies. We focus on ISED, EDC, BDC, and Invest in Canada because they are the primary federal agencies shaping national innovation and sectoral strategies in the country. It is worth noting that what is prioritized for support via innovation programming is complex and includes multiple factors that may not show up in a macro-level analysis of four federal agencies. We hope that future work could expand this approach by engaging more systematically with broader policy instruments and programming. We collectively refer to these agencies as "federal government" in the following pages.

20 Balawejder and Monahan, *Effective Policy Approaches to Sectoral Issues*; De Lyon and others, "Enduring strengths."

We posit that technology areas where Canada has inventive strengths (i.e., technological specialization as measured by RSI and competitive advantage as measured by the national shift component of SSA) are where sector-specific policies would have the greatest return on investments because these technology areas have already passed a “market test”.[21]

Having passed this initial hurdle, further investment and support can be expected to accelerate the accumulation of physical and human capital in these areas.[22]

To determine how well Canada’s inventive strengths match its sectoral priorities, we analyzed two things: whether Canada is more active in certain technologies compared with the world (i.e., specialization via RSI), and whether it is competitive in those areas over time (differential growth rate in patenting via SSA).[23] If Canada is both specialized and growing in a technology area, we consider it a full alignment with related sectoral priority. If it has either specialization or growth—but not both—we call it partial alignment. If it has neither, we consider it no alignment. This helps identify where Canada is best positioned to lead and where more support is needed.

The results are surprising. While Canada’s sectoral priorities align well with the nation’s inventive strengths in clean technologies, resource-based sectors, and life sciences, its sectoral priorities only partially align with its inventive strengths in advanced manufacturing, agri-food, and digital technology-AI.

Canada’s potential to be a global leader in clean technologies

Canada is both specialized[24] and competitive[25] in clean technologies, with higher growth in patenting inventions compared with the world average. (See Table 1.) Canada currently ranks the number two most-represented country in Global Cleantech 100 companies[26] and it has 20 per cent of the world’s large-scale carbon capture, utilization, and storage projects (as of 2023).[27]

The federal government’s support for clean technologies sector in 2025 includes the following:[28]

- BDC provides capital support to clean technology companies to grow and scale through three channels: Sustainability Venture Fund ($150 million), Climate tech fund ($500 million), and Sectoral, Clean and Energy Technology (ICE) Venture Fund ($300 million).

Table 1

Governmental support for clean technologies shows full alignment with Canada’s inventive strengths
(clean technologies sector: BDC, Clean Growth Hub, EDC, Innovation Asset Collective, Invest in Canada)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Environmental technology	1,994	1.21	11	Full

Source: The Conference Board of Canada’s analysis of the European Patent Office’s PATSTAT Global patent dataset.

21 Porter, “Location, Competition, and Economic Development.”

22 Narassimhan and others, “Strategies for green sectoral and innovation policy.”

23 Patents are not the only type of IP, let alone the only source of technological specialization and competitive advantage. Cognizant of this limitation, we interpret results in this section with qualifications.

24 We consider Canada specialized in a technology area if the share of its patenting activity in that area is greater than the global share—meaning that, relative to its overall patent output, Canada produces more patents in that field than the world does on average.

25 We consider Canada competitive in a technology area if its patenting activity in that field is growing faster than the global average—measured by the national shift component of shift-share analysis—indicating that Canada is improving its position relative to other countries in that area over time.

26 Invest in Canada, “Industries: Cleantech.”

27 Global CCS Institute,” Scaling Up Through 2030.”

28 We did not include Sustainable Development Technology Canada’s (SDTC) as it is currently on hold due to investigation by ISED. Until 2025, SDTC was providing funding for pre-commercial cleantech development. Government of Canada provided funding of C$750 million over five years (2021–22 to 2025–26).

- Clean Growth Hub by ISED provides advice on federal funding for cleantech projects and a technology-readiness–level tool to assess technology's maturity of companies. In the 2024 federal budget, the government committed to providing $6.1 million over two years for the Clean Growth Hub.[29]
- EDC's Export Guarantee Program (EGP) provides guarantees of up to US$25 million to the financial institution of the program beneficiary company so the bank can extend the company's access to working capital; Account Performance Security Guarantee (APSG) is the only solution in Canada that gives the financial institution of the program beneficiary company a 100 per cent guarantee for standby letters of credit, and it also provides expert advice on financing complex projects.
- Innovation Asset Collective (IAC) provides tailored IP education, funding, and access to shared patent resources aimed at helping clean technology companies protect their inventions and scale globally. In the 2024 federal budget, the government committed to providing $14.5 million over two years to ISED for IAC.[30]
- Invest in Canada is focused on attracting foreign cleantech investment by providing personalized services to global cleantech companies.

Investments in resource-based sectors align well with Canada's strengths

Canada, widely recognized for its strength in natural resources,[31] also demonstrates specialization and competitiveness in the related technology area: civil engineering.[32] (See Table 2.) RSI value of 2.0 means inventive activity in civil engineering in Canada is twice as concentrated as the world. Canada's relatively strong position[33] highlights its potential to lead globally in innovative applications in this sector.

Canada is the largest producer of potash in the world (as of 2023)[34]; the second-largest producer of uranium globally[35]; the second-largest producer of hydroelectricity (as of 2022)[36]; and in the top five in oil and gas production (as of 2022).[37] Canada is a top destination for international mining finance—43 per cent of the world's public mining companies can be found on the Toronto Stock Exchange (TSX) and TSX Venture Exchange (TSX-V).[38]

Table 2

Governmental support for resource-based sectors shows full alignment with Canada's inventive strengths
(resource-based sectors: Ocean cluster, Invest in Canada, EDC, BDC, Natural Resources Canada)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Civil engineering	10,691	2.00	4	Full

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

29 BetaKit and others, "What's in #Budget2024 for Canadian tech?"
30 BetaKit and others.
31 "In 2023, natural resources directly and indirectly accounted for 1.7 million jobs and 19.2% of the nominal GDP." Leslie and others, "Sustaining Canada's natural resources for a safe, prosperous future."
32 We consider civil engineering as a technology area corresponding to resource-based sectors because patents related to mining, and oil and gas fields are classified here.
33 We consider RSI values of 1.25 or higher to be a strong position as long as NS value is positive.
34 Natural Resources Canada, "Potash facts."
35 Natural Resources Canada, "Uranium in Canada."
36 Natural Resources Canada, *Energy Fact Book 2024–2025*.
37 Natural Resources Canada.
38 Invest in Canada, "Industries: Mining."

The federal government supports its resource-based sectors through at least five programs:

- The $4-billion Canadian Critical Minerals Strategy by Natural Resources Canada (NRC) intends to make Canada a global supplier of critical minerals.
- BDC's Industrial Innovation Venture Fund ($250 million) targets legacy sectors (mining, and oil and gas is one of three sectors included) where there are enabling technologies that can help Canadian companies become global leaders.
- With $278-million funding, Canada's Ocean Cluster (OSC) helps Canadian ocean-based opportunities in energy transition, future of transport, and climate change scale-up and commercialization.
- Invest in Canada focuses FDI attraction in mining and hydrogen projects.
- EDC's role in the natural resources sector is limited to providing advice regarding export opportunities.

Investments in life sciences align well with Canada's pharmaceutical strengths

Canada has relatively strong inventive capabilities[39] in the life sciences sector—especially in pharmaceuticals and biological materials analysis. For example, an RSI value of 1.62 in pharmaceuticals means inventive activity in this technology area in Canada is 62 per cent more concentrated than the world. (See Table 3.) Similarly, an RSI value of 1.44 in biological materials means inventive activity in this technology area in Canada is 44 per cent more concentrated than the world. This inventive strength is also evident in Canada's clinical trial performance. Canada accounts for 4 per cent of all clinical trials worldwide and ranked fourth in the number of clinical trial sites in 2023.[40] Among G7 countries, it leads in clinical trial productivity, measured by the number of trials relative to population size. In the same year, Canada placed third globally for the number of new clinical trials launched and fourth for the total number of active trials.[41]

However, Canada's position in medical technology and biotechnology is mixed. Our analysis shows that, while Canada is competitive in medical technology (i.e., Canada increased its patents at a higher rate than the world from 2012 to 2022), it is in a neutral specialization state (i.e., it is just below the specialization cut-off point of 1). The neutral specialization state indicates that Canada's share of active patents in medical technology is exactly in line with the global average. To become a global leader in medical technology, Canada needs to move beyond this neutral position by growing its patent stock faster than other countries.

39 We consider RSI values of 1.25 or higher to be a strong position as long as NS value is positive.
40 Government of Canada, "Clinical trials environment in Canada."
41 Government of Canada.

Table 3

Governmental support for life sciences shows nearly full alignment with Canada's inventive strengths
(life sciences: BDC, Biomanufacturing and Life Science Strategy, Invest in Canada)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Pharmaceuticals	3,505	1.62	1	Full
Analysis of biological materials	743	1.44	5	Full
Medical technology	5,015	0.99	10	Partial
Biotechnology	2,388	1.54	–11	Partial
Total	**11,651**	**1.26**	**0**	**Full**

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

In biotechnology, we found that Canada has specialization, but it is not globally competitive. In the last decade (2012–22), inventive activity in biotechnology in Canada grew 11 percentage points less than the world average. This could be because this country's advantages (such as R&D spending or talent) that made biotechnology grow in Canada in the past are becoming less important or less competitive, as global peers are gaining ground. In fact, in 2021 biotechnology and pharmaceutical firms in the U.S. and the rest of the world spent considerably more on R&D than their counterparts in Canada. In that year, for every US$1,000 of GDP, U.S. firms spent US$5.90 while Canadian firms spent only US$0.49. The rest of the world averaged US$1.73 spent on R&D for every US$1,000 of GDP.[42]

To address this funding disparity and strengthen Canada's global position in biotechnology and life sciences, the federal government is supporting the sector through four major channels.

- The Government of Canada committed $2.2 billion in federal funding for Canada's Biomanufacturing and Life Science Strategy in the 2021 budget to support a domestic life sciences sector.
- Now closed to new investments, BDC's Healthcare Venture Fund allocated $270 million to develop innovations in precision medicine, biotech and medical imaging since its creation in 2013. This fund is now focused on supporting existing portfolio companies.
- The life sciences stream of the Venture Capital Catalyst Initiative from ISED invests up to $50 million in venture capital funds for technology companies in Canada's life sciences sector with high-growth potential.
- Invest in Canada focuses FDI attraction in life sciences projects.

These are complemented by the country's strong academic and research infrastructure, which is crucial for knowledge-intensive sectors such as life sciences.

Canada's innovation potential in manufacturing

When it comes to advanced manufacturing, Canada has mixed inventive strengths. (See Table 4.) Overall, it is in a neutral specialization state (i.e., it is just below the specialization cut-off point of 1) but it is not competitive. NS value indicates that in the last decade (2012–22), inventive activity in advanced manufacturing–related technology areas in Canada grew 11 percentage points less than the world average. At the technological level, Canada is particularly competitive in engines and turbines, nanotechnology, and transport but not in areas such as machine tools, coating technologies, and optics. For instance, NS value of 27 for transport means in the last decade (2012–22), inventive activity in ground vehicle and aerospace manufacturing in Canada grew 27 percentage points more than the world. Canada is a key global contributor to the aerospace industry and was the only country to place among the top five in 2024 across all major civil aerospace segments: flight simulators, engines, and aircraft components.[43]

42 Long and Atkinson, *Comparing Canadian and U.S. R&D Leaders in Advanced Sectors*.
43 Invest in Canada, "Industries: Advanced Manufacturing."

Table 4

Governmental support for advanced manufacturing shows partial alignment with Canada's inventive strengths
(advanced manufacturing: Advanced manufacturing cluster, EDC, BDC, NRC, Invest in Canada)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Special machines	6,268	1.47	5	Full
Materials, metallurgy	2,319	1.20	5	Full
Engines and turbines	3,423	1.07	44	Full
Transport	6,387	1.01	27	Full
Machine tools	3,419	1.01	–9	Partial
Nanotechnology	113	0.84	36	Partial
Surface technology, coating	1,539	0.92	–11	No
Optics	1,773	0.47	–8	No
Total	**25,240**	**0.99**	**–11**	**No**

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

The federal government supports its advanced manufacturing through at least five programs:

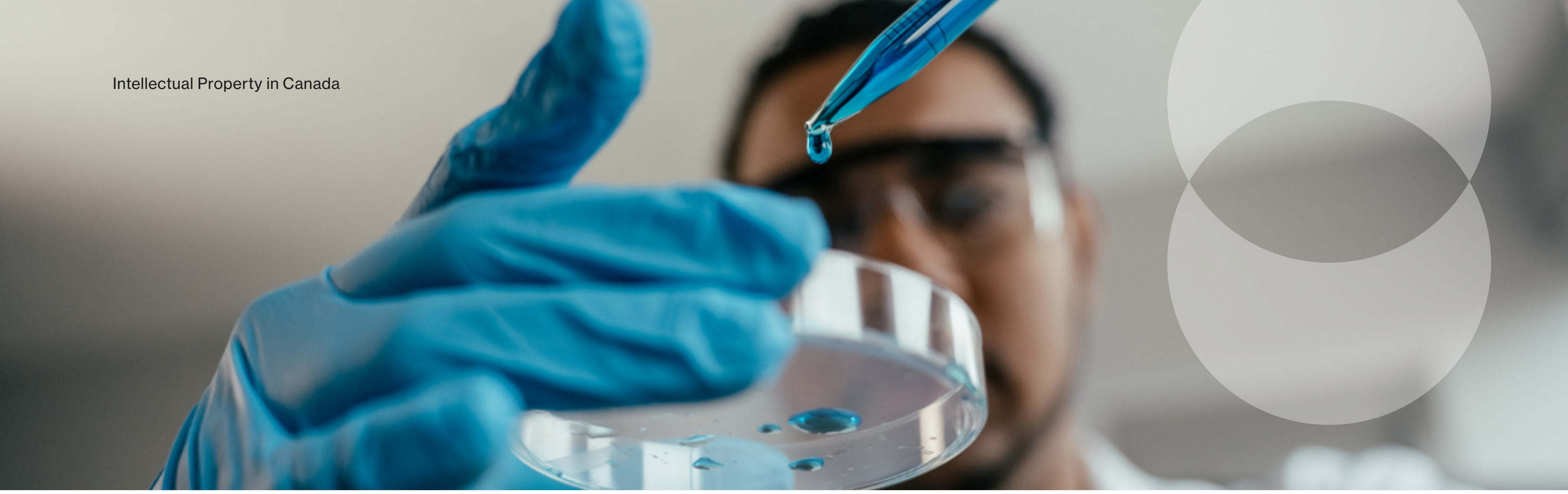
- With $427-million funding, ISED's Advanced Manufacturing Cluster (i.e., NGen) focuses on the development and deployment of automation, machine learning, cybersecurity, and additive manufacturing practices (i.e., 3D printing) in the Canadian manufacturing sector.
- BDC's Industrial Innovation Venture Fund ($250 million) targets Canadian companies in legacy sectors (Manufacturing 4.0 is one of three sectors included) working on innovations that can help Canadian companies become global leaders.
- The National Research Council of Canada's (NRC) Advanced Manufacturing program aims to reduce design, supply, processing, and assembly costs for transportation equipment manufacturers (i.e., aerospace and ground transportation such as light- and heavy-duty, train, mass transit, and recreational) by researching innovations in advanced manufacturing and collaborating with industry, academia, cluster groups, and other government departments and agencies.
- EDC's role in the advanced manufacturing sector is limited to providing advice regarding export opportunities related to automation, robotics, additive manufacturing, and the Internet of Things (IoT).
- Invest in Canada focuses FDI attraction in advanced manufacturing projects.

As transport has the largest number of patents among related technology areas, the trajectory of this field will determine Canada's position in advanced manufacturing. If current auto and related tariffs are resolved in a more comprehensive and permanent trade agreement, Canada can position itself as a leader in next-generation transportation innovations.

Agri-food investments are not aligned with food chemistry capabilities

Canada's agri-food sector—including everything from primary agriculture and aquaculture to food and beverage processing—is known for producing high-quality goods in a clean environment, offering a wide variety of food products.[44] Canada is the largest exporter of canola oil and pulses in the world[45] and it ranked number one in quality and safety on the Global Food Security Index in 2022.[46]

44 Invest in Canada, "Industries: Agribusiness."
45 Invest in Canada.
46 The Economist, "Global Food Security Index 2022."



Given the increasing global demand for food,[47] Canada is working to grow its agri-food sector, but the underlying technologies—such as biotechnology, food chemistry, and organic fine chemistry—aren't keeping pace. Canada shows only partial inventive strength in biotechnology and lacks both specialization and competitiveness in food chemistry and organic fine chemistry. (See Table 5.) The patent growth rate (NS value of -32) for food chemistry is much lower than the world average, meaning any degree of specialization that Canada currently has will be eroded in the future unless this is reversed.

The federal government's support for the agri-food sector covers the entire value chain from production to international market development.

The initiatives include:

- With $323-million funding, ISED's Protein Cluster focuses on the development and deployment of agri-food–enabling technologies, including genomics, processing, and on-farm sustainability.
- With $278-million funding, Canada's Ocean cluster (OSC) focuses on marine biotechnology.
- BDC's $500-million Growth Venture Fund provides scale-up funding to Canadian companies in areas, including the agri-food sector, that have received venture capital and use innovative technologies and business models.
- EDC's role in the agri-food sector is helping agri-food companies grow and find global opportunities and promoting Canada in the sector.
- Invest in Canada focuses FDI attraction in agribusiness projects.

Table 5

Governmental support for agri-food shows partial alignment with Canada's inventive strengths
(agri-food: Protein sectors and Ocean clusters, Invest in Canada, EDC, BDC)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Biotechnology	2,388	1.54	–11	Partial
Food chemistry	1,000	0.74	–32	No
Organic fine chemistry	1,857	0.72	–9	No
Total	**5,245**	**0.96**	**–18**	**No**

Note: Biotechnology is included under agri-food sector in addition to its inclusion in life sciences sector because it is a cross-cutting or generic technology that has applications both in agri-food and life sciences such as genetic engineering, sectoral enzymes, and biofuels.
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

47 Van Dijk and others, "A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050."

Given Canada's limited patent-based specialization and competitiveness in agri-food–related technologies, further research is needed to determine whether similar gaps exist in other forms of IP.

Businesses in agri-food may be protecting their inventions through alternative forms of IP, such as trade secrets or plant breeders' rights, or may rely on non-IP–based advantages such as supply chain control, brand reputation, or geographic indicators. It is also possible that Canadian firms are innovating but not consistently patenting, either due to cost, lack of awareness, or strategic choice. To ensure that public investments align with inventive strengths, Canada would benefit from a broader assessment of the agri-food sector's IP landscape.

Increasing the innovation gap in digital sectors

Canada is focused on growing its digital economy. It has two global innovation clusters (i.e., Digital Technology and Scale AI); it was the first country in the world to launch national AI strategy in 2017[48] with three regional AI institutes (i.e., Montreal Institute for Learning Algorithms [Mila], the Vector Institute, and the Alberta Machine Intelligence Institute [Amii]);[49] and the Canadian government allocated $2 billion in its 2024 budget to catalyze investment in AI infrastructure and adoption over five years.[50] However, when it comes to technologies behind it,[51] the picture isn't bright. Our assessment of technologies related to digital infrastructure and services finds the country specializes in only two out of the seven related technological areas—digital communication and IT management. (See Table 6.) More concerning, it is not competitive (i.e., lower patenting growth from 2012 to 2022 than the world average) in any of the related technological areas. For example, NS value of -48 for digital communication indicates that, in the last decade (2012–22), inventive activity in this area in Canada grew 48 percentage points less than the world average. If this trend continues, Canada will lose its specialization in this area.

Table 6

Governmental support for digital sectors-AI shows less than partial alignment with Canada's inventive strengths
(digital technology-AI: Digital technology and Scale AI clusters, AI institutes, EDC, BDC)

Technology area	Active patent families	RSI	NS (per cent)	Alignment
Digital communication	4,791	1.22	–48	Partial
IT methods for management	1,327	1.21	–50	Partial
Telecommunications	3,140	0.97	–26	No
Computer technology	8,204	0.97	–47	No
Control	1,994	0.98	–7	No
Audio-visual technology	2,539	0.54	–22	No
Semiconductors	691	0.17	–9	No
Total	**22,685**	**0.98**	**–37**	**No**

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

48 Invest in Canada, "Industries: Technology."

49 Canadian Institute for Advanced Research, "The Pan-Canadian AI Strategy."

50 Innovation, Science and Economic Development Canada, "Canadian Sovereign AI Compute Strategy"; The results for digital technology-AI should be interpreted with caution due to the different innovation and IP protection mechanisms employed by AI companies.

51 There are two types of technologies: 1) infrastructure and 2) digital services. Infrastructure encompasses the physical materials and their arrangements that allow computer networks to work—primarily information and communications technology goods and services. Digital services are computing and communication services that are performed for a fee charged to the consumer. Priced digital services products include cloud services, telecommunications services, internet and data services, and all other priced digital services.

The federal government supports digital technology-AI through at least six programs:

- With $298-million funding, the Digital Technology Cluster focuses on growing businesses and creating a digitally skilled workforce.
- With $284-million funding, Scale AI Cluster focuses on positioning Canada as a global leader in exports by enhancing industry performance through AI adoption, opening new market opportunities, and accelerating the launch of Canadian-made AI products and services.
- BDC's $500-million Growth Venture Fund provides scale-up funding to venture-backed Canadian companies in areas including AI and machine learning applications that have received venture capital and use innovative technologies and business models.
- The Pan-Canadian AI Strategy at the Canadian Institute for Advanced Research is working to build a national AI ecosystem of talent and partnerships to position Canada as a leader in the responsible development and use of AI.
- EDC's role in digital sectors is limited to helping digital technology companies scale up to seize global opportunities.
- Invest in Canada focuses FDI attraction in agribusiness projects.

Digital technology-AI shows the least alignment between Canada's inventive strengths and sectoral priorities, but this should be interpreted with caution. Patent data may not fully capture innovation in this sector, where firms often rely on non-patent IP such as trade secrets, proprietary algorithms, or data assets. A broader assessment of IP use in the digital sector is needed to ensure policy and investment decisions reflect the full scope of innovation activity in Canada.

Actionable insights

To position Canada as a global innovation leader, the federal government can consider the following actions:

- **Scale up federal and Crown corporation investment supports in clean technologies, resource-based sectors, and life sciences over the next three to five years where Canada has both specialization and competitiveness.**

This means scaling up existing programs such as ISED's clean growth hub, BDC's cleantech and healthcare funds, and EDC's export financing. It can also intensify FDI attraction efforts in these sectors through Invest in Canada, with specific targets for project volume and value by 2030.

- **Develop a targeted recruitment strategy focusing on attracting top medical scientists—particularly those facing job displacement in the U.S—to reverse the declining patenting activity in biotechnology.**

Biotechnology is the only life sciences field in which Canada's patent performance declined more than that of global peers. To help reverse this trend, the Canada Research Chairs Program—which invests $311 million annually to attract and retain top researchers—could be expanded to target scientists with a track record of generating IP or contributing to clinical trials.[52] Attracting top medical scientists requires more than salary support alone. High-profile researchers often come with established teams; therefore, recruitment packages should include provisions for relocating key team members as well. Access to wet-lab space is also critical, yet such facilities are often limited in universities and hospitals, and setting up new labs demands substantial infrastructure and equipment investment.

To ensure these inventions benefit Canada's innovation system, recruitment efforts should prioritize pathways that link researchers to Canadian institutions, so that resulting IP is more likely to be assigned domestically. Partnerships with life sciences businesses can help identify strategic gaps and align talent attraction with national priorities.

- **Prioritize nanotechnology by capitalizing on the recent growth in patenting.**

The Nanotechnology Initiative at the University of Alberta (started in 2002)[53] and Waterloo Institute for Nanotechnology (started in 2008),[54] which aim to expand Canadian nanotechnology capacity and foster breakthrough research, are important steps. Additionally, the federal government can establish targeted funding and incubator programs to help Canadian nanotech start-ups scale up and bring innovations to market. Facilitating collaboration between nanotech researchers and key sectors (e.g., healthcare, clean tech, and electronics) would also accelerate applied research and deployment. The federal government can match funding from companies that are financing academic research projects.

- **Conduct an assessment of the survival rate of companies and barriers to patenting in advanced manufacturing, agri-food, and digital technology-AI to determine why Canada has both weak specialization and competitiveness in these areas.**

Why does Canada have a weaker position in advanced manufacturing, agri-food, and digital technologies-AI? Given the public investments made in these sectors through multiple government programs—including global innovation clusters, ISED, BDC, EDC, Invest in Canada, and world-class talent in Canada—one wonders why our results are not better. A research project examining barriers to patenting would offer valuable insights. In parallel, a broader assessment of IP use across the agri-food, advanced manufacturing, and digital sectors is needed to ensure that policy and investment decisions reflect the full scope of innovation activity in Canada.

- **Close the patent ownership gap with other countries in all priority sectors where Canada has specialization within the next five years by strengthening patent ownership among Canadian firms.**

To close the gap in patent intensity and portfolio scale, Canada can build on existing initiatives such as the Global Hypergrowth Project (GHP)[55] and BDC's Growth Venture Fund[56] by introducing a dedicated funding mechanism to help high-potential firms acquire, consolidate, and protect valuable IP. This effort can be supported by the recently launched federal patent box regime,[57] which delivers preferential tax treatment of income from domestically developed IP. In addition to funding, the initiative can facilitate partnerships and licensing arrangements among Canadian firms with complementary patents to build stronger, more globally competitive portfolios.

52 Zhang, "Canada Should Hire Scientists Trump Fires."
53 University of Alberta, "The National Institute for Nanotechnology."
54 University of Waterloo, "Waterloo Institute for Nanotechnology."
55 Innovation, Science and Economic Development Canada, "Global Hypergrowth Project."
56 Business Development Bank of Canada, "Growth Venture Fund."
57 Department of Finance Canada, "Consultation Paper: Creating a Patent Box Regime."

Appendix A

Methodology

About the research

The problem that motivates this research is the lack of systematic knowledge regarding technology fields in which Canada has specialization and is competitive. Accordingly, this project addresses the following research questions:

1. What are the technology classes where Canada has strong specialization compared with the world/Organisation for Economic Co-operation and Development (OECD) countries based on patented inventions?
2. What are the technology classes where Canada has a competitive advantage compared with the world/OECD countries based on patented inventions?
3. What does the freedom to operate look like for Canadian organizations in different technology areas based on patented inventions?
4. What is the alignment between Canada's inventive strengths and the Government of Canada's sectoral priorities?

To answer questions 1 and 3, we calculated the relative specialization index (RSI) and freedom to operate (FTO) measures using 24,528,973 active patent families with legally enforceable rights across 35 distinct technology areas as of 2022. To answer question 2, we conducted shift-share analysis (SSA) using patent grants in 2012 and 2022. To answer question 4, we determined the Government of Canada's industrial priorities and examined the overlap between those priorities and Canada's inventive strengths, which we identified through answering questions 1 and 2.

Data source

We used PATSTAT Global Database, 2024 autumn edition, to assess Canada's technological specialization and competitiveness. This database has an 18-month lag, meaning that we observe 2023 partially and 2022 is the latest year with complete observation. PATSTAT links related patents from different countries and offices around the world into patent families. This helps identify multiple patents related to the same invention across different jurisdictions, eliminating duplication. You can see coverage detail in the European Patent Office's *Data Catalog PATSTAT Global*.

Table 1

Technology classification of patents

Code	Technology	Description
1	Electrical machinery, apparatus, energy	The non-electronic part of electrical engineering; for instance, the generation, conversion and distribution of electric power, electric machines but also basic electric elements such as resistors, magnets, capacitors, lamps, or cables.
2	Audio-visual technology	Largely equivalent to consumer electronics.
3	Telecommunications	A variety of techniques and products including wireless communication devices, network infrastructure, signal processing technologies, data transmission system
4	Digital communication	A self-contained technology at the border between telecommunications and computer technology. A core application of this technology is the internet.
5	Basic communication processes	Basic technologies such as oscillation, modulation, resonant circuits, impulse technique, coding/decoding. These techniques are used in telecommunications, computer technology, measurement, control.
6	Computer technology	Mainly electrical digital processing (i.e., arrangement for program control, methods and arrangements for data conversion), but also includes separate specific application fields such as image data processing, recognition of data, or speech analysis.
7	IT methods for management	Data processing methods, specially adapted for administrative, commercial, financial, managerial, supervisory, or forecasting purposes. This field represents software for these special purposes. In most countries, business methods are not patentable, but if they are admitted,they are registered in this class.
8	Semiconductors	Semiconductors, including methods for their production. Integrated circuits or photovoltaic elements belong to this field.
9	Optics	All parts of traditional optical elements and apparatus, but also laser beam sources.
10	Measurement	A broad variety of different techniques and applications related to the measurement of mechanical properties (e.g., length, oscillation, speed).
11	Analysis of biological materials	The analysis of blood for medical purposes. In many cases, biotechnological methods are addressed.

(... continued)

Table 1 (cont'd)

Technology classification of patents

Code	Technology	Description
12	Control	Elements for controlling and regulating electrical and non-electrical systems and referring test arrangements, traffic control, or signalling systems.
13	Medical technology	Generally associated with high technology items such as medical imaging device, surgical instruments and robotics, diagnostic and monitoring equipment, and therapeutic devices, but also low technology items such as as operating tables, massage devices, bandages, etc.
14	Organic fine chemistry	Chemicals related to pharmaceuticals (nearly half of the applications have an additional code in pharmaceuticals) such pesticides and herbicides, dyes and pigments, flavours and fragrances.
15	Biotechnology	Such as organic chemistry or computer technology, biotechnology is a cross-cutting or generic technology. Mainly genetic engineering, sectoral enzymes, and biofuels.
16	Pharmaceuticals	This field refers to an area of application, not a technology. Medicinal preparations containing inorganic active ingredients.
17	Macromolecular chemistry, polymers	The chemical aspects of polymers.
18	Food chemistry	Represent food additives, preservation methods, flavour enhancers, nutritional supplements. Machines for food production are not included but classified as part of field 29 (other special machines).
19	Basic materials chemistry	Typical mass chemicals such as herbicides, fertilizers, paints, petroleum, gas, detergents, etc.
20	Materials, metallurgy	All types of metals, ceramics, glass, or processes for the manufacture of steel.
21	Surface technology, coating	The coating of metals, generally with advanced methods, represents the core of this field. It also covers electrolytic processes, crystal growth, and apparatus for applying liquids to surfaces.
22	Nanotechnology	Micro-structural devices or systems, including at least one essential element or formation characterized by its very small size. It includes nano-structures having specialized features directly related to their size.
23	Chemical engineering	Technologies that are at the borderline of chemistry and engineering. It refers to apparatus and processes for the sectoral production of chemicals. Some of these processes may be classified as physical ones.
24	Environmental technology	A variety of different technologies and applications, in particular filters, waste disposal, water cleaning (a quite large area), gas-flow silencers and exhaust apparatus, waste combustion, or noise absorption walls.
25	Handling	Comprises elevators, cranes, or robots, but also packaging devices.
26	Machine tools	Referring to turning, boring, grinding, soldering, or cutting with a focus on metals.
27	Engines and turbines	This field covers non-electrical engines for all types of applications. In quantitative terms, applications for automobiles dominate.
28	Textile and paper machines	The fields 27 and 28 cover machines for specific production purposes. Textile and food machines represent the most relevant part of these machines and are classified separately.
29	Special machines	Areas not covered in fields 26, 27, 28 such as 3D printing.
30	Thermal processes and apparatus	Steam generation, combustion, heating, refrigeration, cooling, or heat exchange.
31	Mechanical elements	Fluid-circuit elements, joints, shafts, couplings, valves, pipe-line systems, or mechanical control devices. The focus is on engineering elements of machines such as joints or couplings.
32	Transport	All types of transport technology and applications with dominance of automotive technology.
33	Furniture and recreational products	Consumer products such as adjustable ergonomic office chairs, modular transformable furniture, interactive gaming tables.
34	Other consumer goods	Primarily represents less research-intensive products such as kitchen appliances, personal care products, household cleaning devices.
35	Civil engineering	The construction of roads and buildings as well as elements of buildings such as locks, plumbing installations, or strongrooms for valuables. A special part refers to mining which is important for Canada.

Source: Schmoch, *Concept of a Technology Classification for Country Comparisons*.

Determination of priority sectors for Canada

We scanned websites of federal ministries and Crown agencies to identify major innovation and economic growth programs and policies targeted at specific sectors. To manage the scope of the study, we limited the list to those programs that are ongoing. Focusing on only ongoing government support mechanisms allows us to assess the overlap between current government sectoral priorities and Canada's current inventive strengths. The following is the list of Government of Canada programs or policies that we included in the analysis.

- Global Innovation Clusters, Innovation, Science and Economic Development Canada (ISED)
  - Digital technology
  - Protein sectors
  - Advanced manufacturing
  - Scale AI
  - Ocean

- AI Institutes, Innovation, Science and Economic Development Canada (ISED)
  - AMII
  - MILA
  - Vector Institute

- Priority sectors for trade competitiveness, Export Development Canada (EDC)
  - Agri-food
  - Clean technologies (Cleantech)
  - Advanced manufacturing
  - Digital sectors
  - Resource-based sectors

- Priority sectors for Foreign Direct Investment (FDI) in Canada, Invest in Canada
  - Agribusiness
  - Advancing manufacturing
  - Cleantech
  - Electric vehicle supply chain
  - Life sciences
  - Natural resources (mining and hydrogen)
  - Technology

- Funding programs for priority sectors, Business Development Bank of Canada (BDC)
  - Sustainability Venture Fund
  - Climate tech fund
  - Industrial, Clean and Energy Technology (ICE) Venture Fund
  - Healthcare venture fund
  - Industrial Innovation Venture Fund (Manufacturing 4.0, Agri-tech and Food-tech, Extractive sectors (mining, and oil and gas, etc.)
  - Growth Venture Fund (Artificial intelligence (AI) and machine learning (ML) applications for eCommerce, AgTech, EdTech, HealthTech. Blockchain technology for Fintech, Cybersecurity, Insurtech. TravelTech, MarTech

- Innovation Asset Collective (IAC)
- ISED Clean Growth Hub
- ISED Venture Capital Catalyst Initiative
- National Research Council advanced manufacturing program

Analytical methods

Historical performance in patenting

We conducted trend analyses of patenting for Canada relative to OECD and the world by calculating the compound annual growth rate (CAGR) of patent applications and grants. The period of performance covers 1970 to 2022. In addition to calculating CAGR for individual years, we examined it at 10-year cohorts to show acceleration/deceleration or changes in rankings over time. The formula for calculating CAGR is as follows:

Where:

$$\boldsymbol{CAGR} = \left(\left(\frac{V_{ending}}{V_{beginning}} \right)^{\frac{1}{n}} - 1 \right) x\ 100$$

V_{ending} = ending value in the time series,

$V_{beginning}$ = beginning value in the time series,

n = number of years in the time series.

Relative Specialization Index for measuring technological specialization

RSI measures the concentration of a particular technological or sectoral activity in a region or a country compared with its concentration at a higher geographical level (OECD or world). A value greater than 1 indicates specialization, and a value less than 1 indicates no specialization. We recognize that this binary categorization somewhat oversimplifies the country's position and therefore RSI values close to 1 should be interpreted with caution.[1] In practice, RSI values between 0.75 and 1.25 indicate a neutral position for Canada relative to OECD or world. While we initially experimented with three RSI categories—specialized, neutral, and non-specialized—we reverted to a two-category approach to keep the alignment analysis clear and manageable. Using three RSI categories and two national shift (NS) categories would have produced six combinations, requiring ambiguous alignment labels such as "less than partial" or "greater than partial". In contrast, a binary RSI classification paired with two NS values produces four distinct combinations, enabling a simpler and more consistent alignment framework (i.e., full, partial, or no alignment) that is easier to communicate.

In terms of calculation and interpretation, RSI is similar to Revealed Comparative Advantage (RCA) in the economics literature, which is used to identify the relative advantages or disadvantages that a country or region has in producing and exporting specific goods or services compared with other countries. Both measures help understand a country's specialization in particular technology fields or sectors in the global market. The formula for calculating RSI is as follows:

$$\boldsymbol{RSI} = \left(\frac{p_i}{p_t}\right) \div \left(\frac{P_i}{P_t}\right)$$

Where:

p_i = national patenting in technology i (200),
p_t = total national patenting (1,000),
P_i = reference region (OECD) patenting in technology i (5,000),
P_t = total reference region (OECD) patenting (50,000).

Example: [(200/1,000) / (5,000/50,000)] = (0.2) / (0.1) = 2.0.
Interpretation: Patenting activity in technology X in Canada is twice as concentrated as the reference region, OECD. Based on this relative concentration, we say Canada is specialized in this field.

Shift-Share Analysis (SSA) for measuring technological competitiveness

SSA disaggregates the influence of global trends versus sectoral or national factors affecting growth in patenting activity in different technology fields in Canada. Theoretically, there are three sources of growth in patent applications in technology fields for any country or region:

1. Global effect/shift captures the overall increase in patent applications. As we know, patenting rate is influenced by major economic and scientific forces that affect inventive activity to some degree in all countries.
2. Industry mix effect captures the increase in patent applications in specific fields due to technological change. In any given period, patenting rate is higher in certain technology areas than others.
3. National shift (NS), also known as the competitive shift or national effect, refers to an increase in patent applications domestically that is due to factors unique to Canada. For example, the collective impact of university research, talent pool, government policies, etc.

Among these three components, NS is the most important component for our purposes. It is expressed in percentage points and ranges from any negative value to any positive value. Theoretically, values larger than 0 indicate competitiveness, while values smaller than 0 indicate no competitiveness. In practice, values around 0 (i.e., –5 or 5 percentage points) indicates neutral position. The formula for conducting SSA is as follows:

$$\Delta \boldsymbol{N_i} = GS_i + IM_i + NS_i$$

$$\boldsymbol{GS_i} = \frac{G_A^t - G_A^{t-1}}{G_A^{t-1}}$$

$$\boldsymbol{IM_i} = \left(\frac{G_i^t - G_i^{t-1}}{G_i^{t-1}} - \frac{G_A^t - G_A^{t-1}}{G_A^{t-1}}\right)$$

$$\boldsymbol{NS_i} = \left(\frac{N_i^t - N_i^{t-1}}{N_i^{t-1}} - \frac{G_i^t - G_i^{t-1}}{G_i^{t-1}}\right)$$

1 A similar approach is taken by the Canadian Intellectual Property Office (CIPO), *Processing Artificial Intelligence*.

Where:

ΔN = actual change in patenting in Canada,
GS = global (reference region-OECD) shift,
IM = industry (technology field) mix term,
NS = national (competitive) shift,
i = industry (technology field),
A = all of economy,
t = current time period,
$t-1$= previous time period.

SSA deals with patenting growth over time; therefore, a time frame (start year and end year) is required to perform the analysis. Because our goal is to understand long-term trends and structural changes in Canada's patenting activity to assess whether that long-term direction is desirable, we selected a relatively long-time interval of 10 years. We want our findings to be as current as possible; thus, we focus on the last decade for which we have complete data: 2012–22.

RSI and SSA are complementary statistical techniques or analyses.[2] They are simple to apply yet produce insightful results in describing structure and evaluation of an economy over time.[3]

Distribution of patents by owners

This formula is applied across all patent family thresholds (x = 10, 20, 30, ..., 100) and for all 35 World Intellectual Property Office (WIPO) technology classes. The reported figures for Canada are the averages of these expected values across all technology classes.

$$\boldsymbol{E}_{x,a} = A_{x,a}^{World} \; x \; \frac{P_a^{CAN}}{P_a^{World}}$$

Where:

$\boldsymbol{E}_{x,a}$	Expected number of owners with x or more patent families in Canada in technology class a,
$A_{x,a}^{World}$	Number of owners with x or more patent families in the world in technology class a,
P_a^{CAN}	Number of patent families in Canada in technology class a,
P_a^{World}	Number of patent families in the world in technology class a.

2 Blakely and Leigh, *Planning Local Economic Development*.

3 They are used by Statistics Canada, U.S. Bureau of Labor Statistics (BLS), and Regional Economic Analysis Project.

The unit of analysis and other statistical considerations

Observations in these analyses are simple patent families (i.e., European Patent Office worldwide bibliographic data [DOCDB]). A patent family is "a collection of patent documents that are considered to cover a single invention. The technical content covered by the applications is identical. Members of a simple patent family have the same priorities."

RSI values presented in the text are calculated using the active patent families as of autumn 2024. NS values presented in the text are calculated using patent families (granted) from 2012 to 2022. Patent families are organized by the first priority year. That means, in the case of multiple patents applied in different years, we assign the priority year for the first patent application to the family.

It is important to note that extreme fluctuations or outliers can impact the robustness of the analysis results (both RSI and SSA). To reduce noise and highlight underlying trends, we smoothed the data by using five-year moving averages in both analyses. That ensures that the data is statistically stable within the selected time interval.

To check how Canada's technological specialization and competitiveness changed over the years, we also calculated these measures for the previous four decades (available upon request). The following section presents Canada's historical performance in patenting activity compared to the world.

Additional findings with world as the reference region

Canada's shrinking innovation footprint in the world

Patent application

Table 2

Patent applications slowed substantially in Canada compared with world in the last two decades

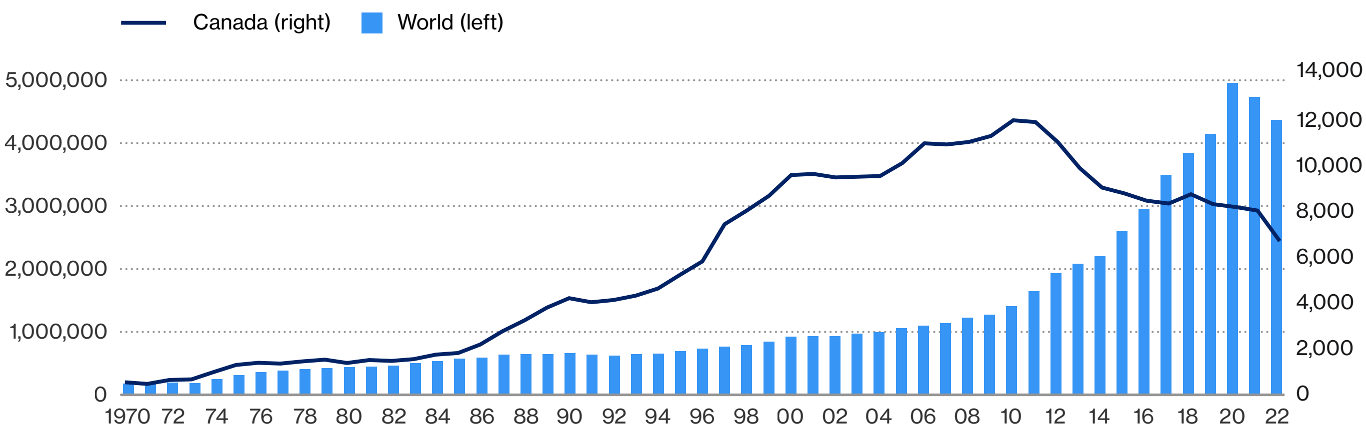
	1970–80	1980–19	1990–20	2000–10	2010–22
Canada patent application, CAGR	10.3	12.0	8.6	2.3	–4.7
World patent application, CAGR	9.5	4.2	3.4	4.3	9.9
Canada's share of world patent applications	0.35	0.39	0.80	0.97	0.30

CAGR = compound annual growth rate, per cent
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 1

Canadian patent applications grew faster than the rest of the world until 2010

(right: number of applications by patent family for Canada; left: number of applications by patent family for the rest of the world)



Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Patent grants

Table 3

Patent grants slowed substantially in Canada compared with world during the last two decades

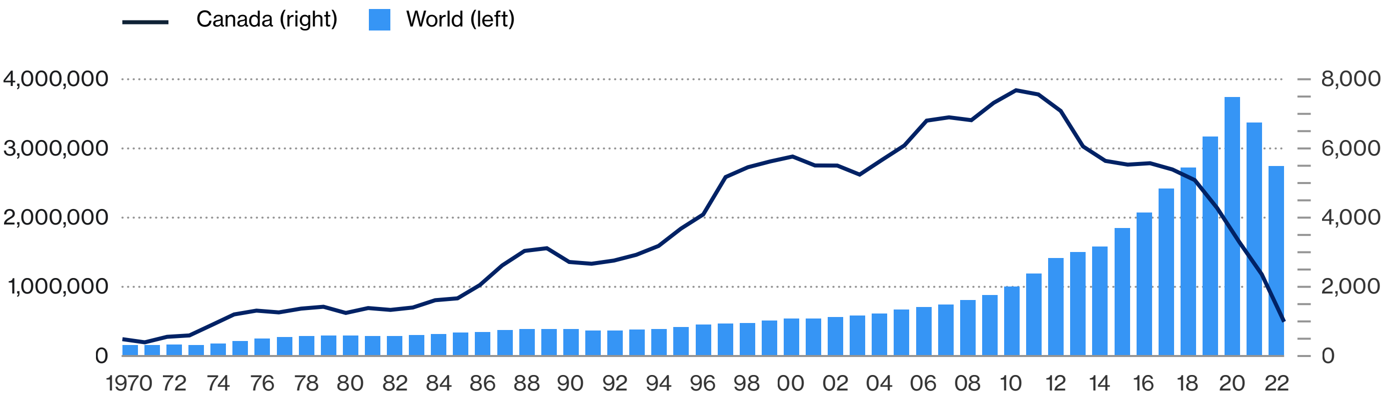
	1970–80	1980–19	1990–20	2000–10	2010–22
Canada patent application, CAGR	9.8	8.1	7.8	2.9	–15.7
World patent application, CAGR	6.5	2.8	3.4	6.4	8.8
Canada's share of world patent applications	0.45	0.59	0.91	0.93	0.23

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 2

Canadian patent grants grew faster than the rest of the world until 2010

(right: number of patents granted by patent family for Canada; left: number of patents granted by patent family for the rest of world)



Note: Decline in recent years (i.e., 2020, 2021, 2022) is partly due to the time lag between patent applications and grants, as it typically takes several years for a patent application to be processed and approved. This creates a right-censoring effect, where more recent data appears incomplete because many applications from those years are still pending.

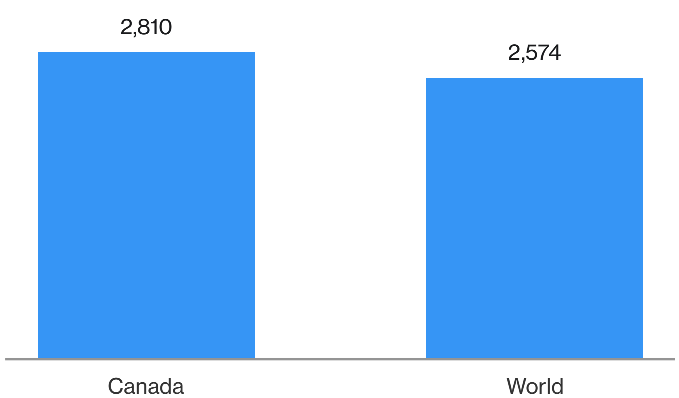
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Active patents

Chart 3

Canada has slightly more active patents per capita than the world average

(number of active patent families per 1,000,000 population)



Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Appendix B

Sensitivity analysis

Findings with OECD as the reference region

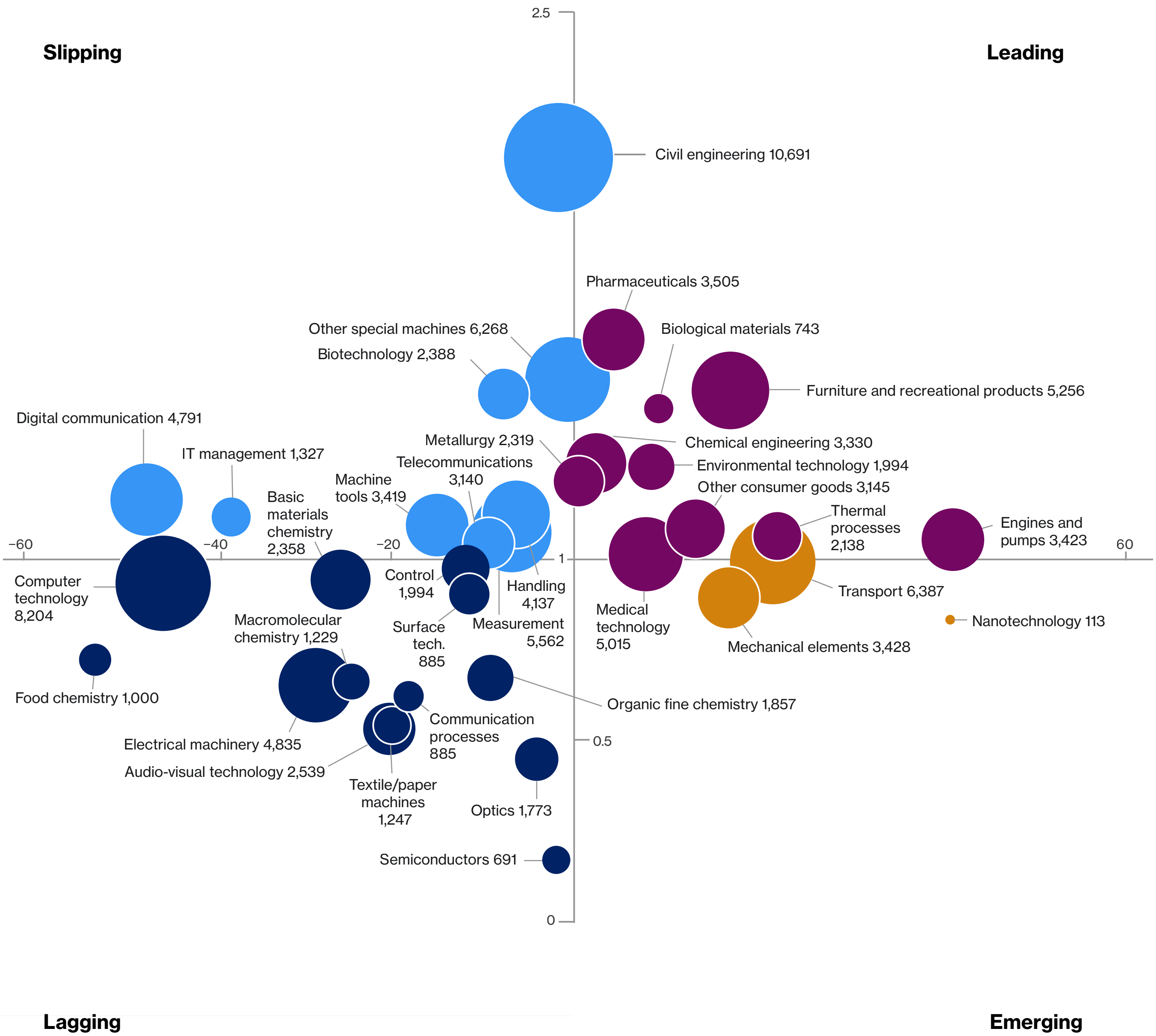
Our primary reference region in this research is the world, and consequently the findings we presented in the main text are based on this designation. However, to test the sensitivity of our findings to the reference region, we also repeated all analyses designating OECD as the comparator region. Using OECD as reference region allows us to account for relatively low-quality patents from non-OECD countries. We observe two major differences in results. First, there is partial alignment between Canada's resource-based sector's priority and its inventive strength in the related technology area of civil engineering (instead of full alignment as we saw in the text based on world as the reference region). Second, there is full alignment between Canada's advanced manufacturing priority and its inventive strengths in related technology areas (instead of partial alignment as we saw in the text based on world as the reference region).

These two variations aside, results are mostly the same as those presented in the text. Overall, that makes us confident in the robustness of our findings and insights.

Chart 4

Canada's innovation varies considerably across technology areas

(relative specialization index, vertical axis; national shift, per cent, horizontal axis; number of active patent families)

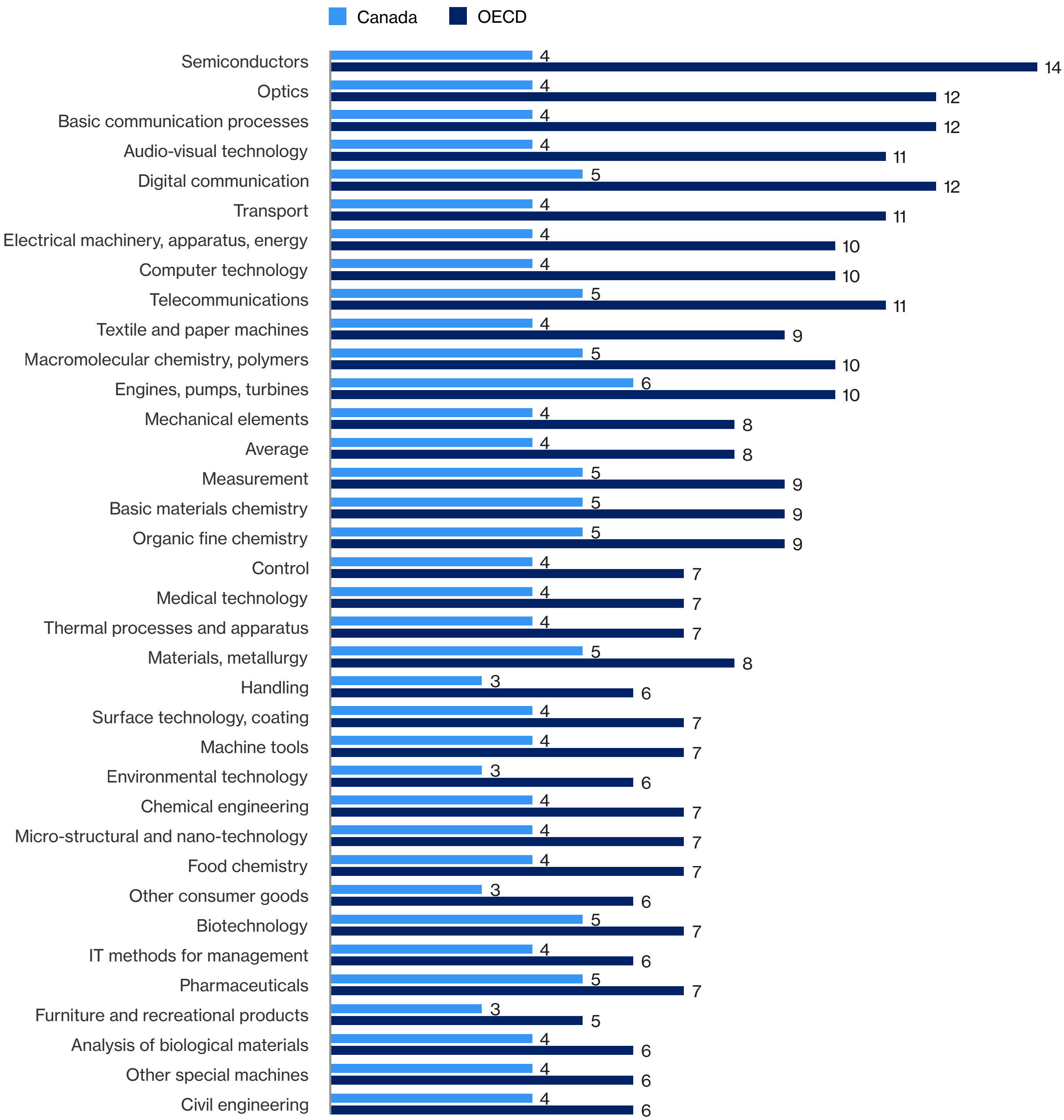


Note: The size of the bubbles is proportional to the number of active patent families. The technology class definition is based on World Intellectual Property Organization (WIPO) and European Patent Office (EPO). See Appendix A for definitions.
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 5

Canada has fewer patent families per owner than the OECD average across all technological fields

(vertical axis: number of active patent families per owner)



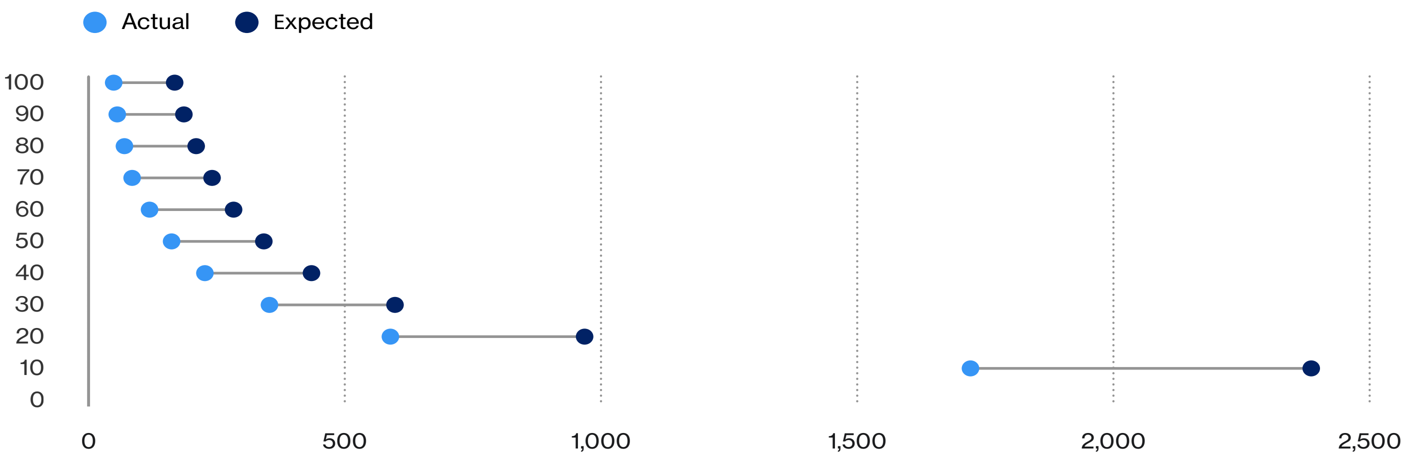
Note: Owners with a single patent family ownership (corresponding mostly to individuals) are excluded from both Canada and OECD counts. Technologies are sorted by the size of difference between Canada and OECD in descending order.

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 6

Canada has lower patent concentration than its OECD peers

(vertical axis: number of patent families with at least one active patent; horizontal axis: number of owners)



Note: Owner counts may be slightly underestimated due to variations or misspellings in patent database entries, which our algorithms interpret as distinct entities. However, since this issue also affects OECD data, it is unlikely to substantially impact the results.

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Table 4

Partial alignment between Canada's inventive strengths and sectoral priorities (OECD as reference region)

Clean technologies: BDC, Clean Growth Hub, EDC, Innovation Asset Collective, Invest in Canada

Technology area	Active patents	RSI	NS (per cent)	Alignment
Environmental technology	1,994	1.25	8	Full
Resource-based sectors: Ocean cluster, Invest in Canada, EDC, BDC, Natural Resources Canada				
Civil engineering	10,691	2.10	–2	Partial
Life sciences: BDC, Biomanufacturing and Life Science Strategy, Invest in Canada				
Pharmaceuticals	3,505	1.60	4	Full
Analysis of biological materials	743	1.41	9	Full
Medical technology	5,015	1.01	8	Full
Biotechnology	2,388	1.45	–8	Partial
Total	**11,651**	**1.25**	**0**	**Full**
Advanced manufacturing: Advanced manufacturing cluster, EDC, BDC, NRC, Invest in Canada				
Materials, metallurgy	2,319	1.21	1	Full
Engines and turbines	3,423	1.05	41	Full
Other special machines	6,268	1.49	–1	Partial
Machine tools	3,419	1.09	–15	Partial
Transport	6,387	0.99	22	Partial
Nanotechnology	113	0.83	41	Partial
Surface technology, coating	1,539	0.90	–11	No
Optics	1,773	0.45	–4	No
Total	**25,240**	**1.02**	**8**	**Full**

(...continued)

Table 4 (cont'd)

Partial alignment between Canada's inventive strengths and sectoral priorities (OECD as reference region)

Technology area	Active patents	RSI	NS (per cent)	Alignment
Agri-food: Protein sectors and Ocean clusters, Invest in Canada, EDC, BDC				
Biotechnology	2,388	1.49	–8	Partial
Food chemistry	1,000	0.72	–52	No
Organic fine chemistry	1,857	0.67	–9	No
Total	**5,245**	**1.09**	**–22**	**Partial**
Digital technology-AI: Digital technology and Scale AI clusters, AI institutes, EDC, BDC				
Civil engineering	10,691	2.10	–2	Partial
IT methods for management	1,327	1.10	–37	Partial
Digital communication	4,791	1.16	–47	Partial
Audio-visual technology	2,539	0.53	–20	No
Control	1,994	0.97	–12	No
Telecommunications	3,140	0.94	–25	No
Computer technology	8,204	0.93	–45	No
Semiconductors	691	0.17	–2	No
Total	**22,685**	**0.79**	**–34**	**No**

Notes: RSI stands for Relative Specialization Index. NS stands for national shift. Full alignment: Canada has RSI > 1 and NS > 0. Partial alignment: Canada has RSI > 1 or NS > 0. No alignment: Canada has RSI < 1 and NS < 0. 3). Priority sectors are ordered based on their degree of alignment with Canada's inventive strengths in related technology areas.
Source: Conference Board of Canada's analysis of European Patent Office PATSTAT Global patent dataset.

Canada's shrinking innovation footprint in OECD

Patent applications

Table 5

Patent applications slowed substantially in Canada compared with OECD in the last decade

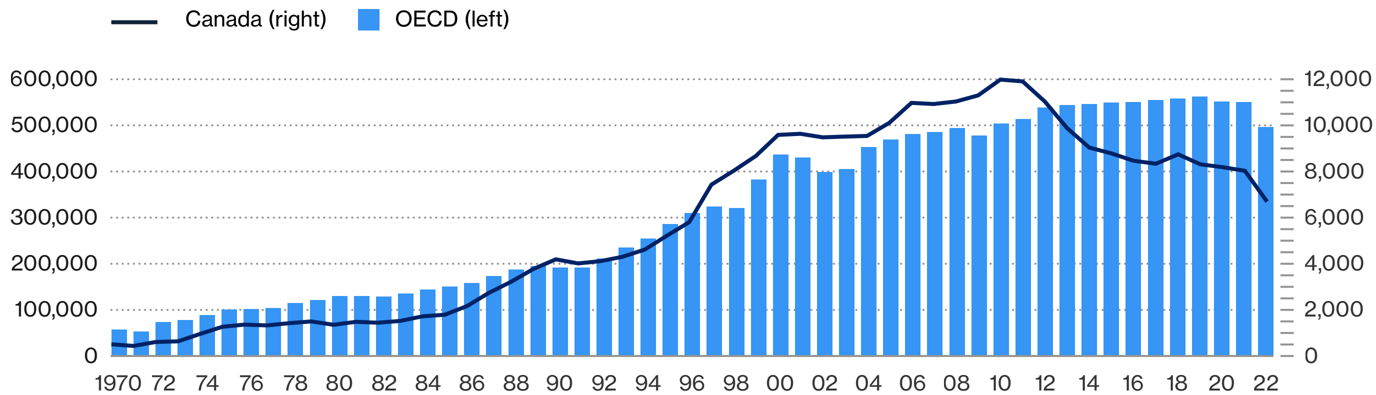
	1970–80	1980–19	1990–20	2000–10	2010–22
Canada patent application, CAGR	10.3	12.0	8.6	2.3	–4.7
OECD patent application, CAGR	8.5	4.0	8.6	1.4	–0.1
Canada's share of OECD patent applications	1.13	1.39	2.09	2.25	1.70

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Chart 7

OECD has mostly outperformed Canada in patent applications but that accelerated in recent years

(right: number of applications by patent family for Canada; left: number of applications by patent family for the rest of OECD)



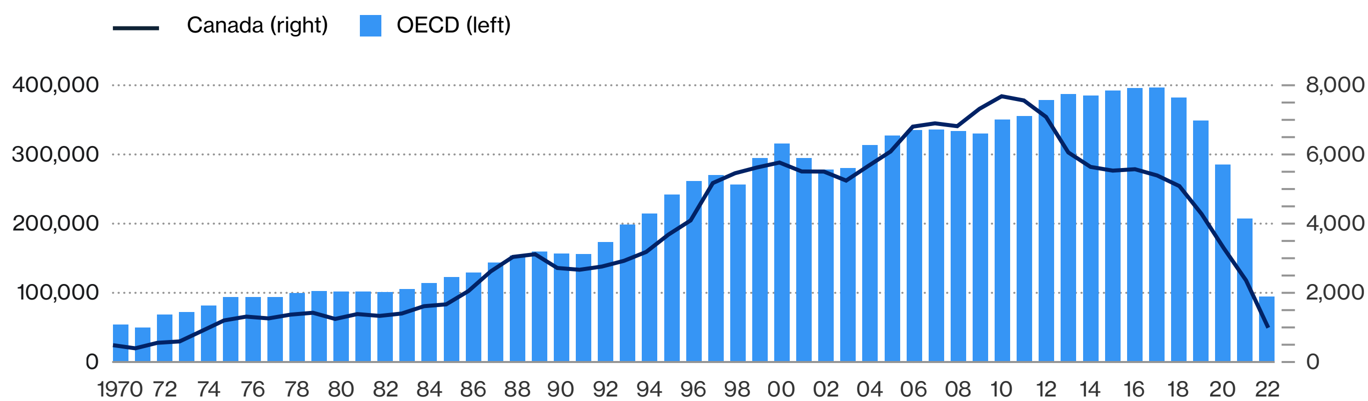
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Patent grants

Chart 8

OECD has always outperformed Canada in patent grants, but that accelerated in recent years

(right: number of patents granted by patent family for Canada; left: number of patents granted by patent family for the rest of OECD)



Note: Decline in recent years (i.e., 2020, 2021, 2022) is partly due to the time lag between patent applications and grants, as it typically takes several years for a patent application to be processed and approved. This creates a right-censoring effect, where more recent data appears incomplete because many applications from those years are still pending.

Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Table 6

Patent grants slowed substantially in Canada compared with OECD in the last decade

	1970–80	1980–19	1990–20	2000–10	2010–22
Canada patent grants, CAGR	9.8	8.1	7.8	2.9	–15.7
OECD patent grants, CAGR	6.6	4.4	7.3	1.1	–10.3
Canada's share of OECD patent grants	1.18	1.58	1.72	1.96	1.53

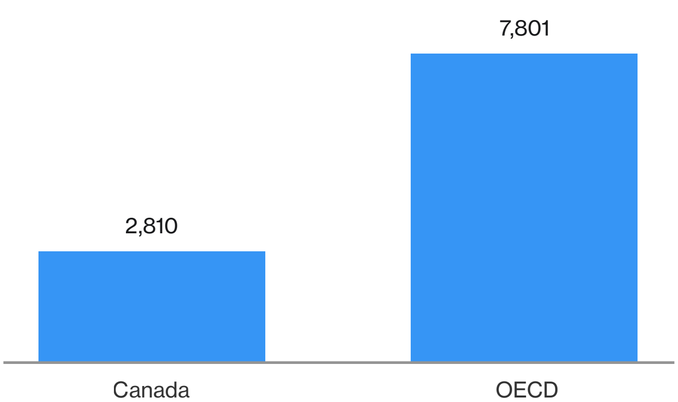
Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

Active patents

Chart 9

Canada has fewer active patents on a per capita basis than the OECD average

(number of active patent families per 1,000,000 population)



Source: The Conference Board of Canada's analysis of the European Patent Office's PATSTAT Global patent dataset.

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Acknowledgements

This impact paper was prepared with financial support from the Canadian Centre for the Innovation Economy (CCIE). For further information visit the Centre's website.

The underlying research was conducted, and the report was written by Zafer Sonmez, PhD, Lead Research Associate. Erin Rose, Senior Research Associate, contributed by editing it and structuring the sections. The following members of The Conference Board of Canada's team reviewed this briefing: Reetika Rana, PhD, Associate Director of Innovation and Technology, Alain Francq, Director of Innovation and Technology, and Dianne Williams, Vice-President, BComm. This impact paper was designed by Mallory Eliosoff, Senior Graphic Designer.

We also thank the members of the Research Advisory Board who supported this research:

- **Jim Hinton,** Founder, Own Innovation – Senior fellow at Centre for International Governance Innovation
- **Warren Clarke,** Senior Strategic Analyst, National Research Council
- **Derek Newton,** Assistant Vice-President, University of Toronto, Innovation, Partnerships and Entrepreneurship
- **Jesse Vincent-Herscovici,** CEO, Axelys
- **Mike McLean,** CEO, Innovation Asset Collective
- **Kurtis McBride,** CEO, Miovision

Intellectual Property in Canada: Technology Specialization and Competitive Advantage
Zafer Sonmez

To cite this research: Sonmez, Zafer. *Intellectual Property in Canada: Technology Specialization and Competitive Advantage.* Ottawa: The Conference Board of Canada, 2025.

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