

ECONOMIC VIEWPOINT

Quebec Exports: Does Technology Have a Bigger Role?

Is there more technology in Quebec's exports than in the past? This is what we want, at a time when technology is getting into every sphere of activity and is often presented as a clear asset for governments that want to be leaders. According to the available data, it seems that Quebec is doing better than before. Note that the aerospace sector has a big weight in this. However, it would be reductive to boil the province down to a single sector with a high-tech content, no matter how important it is. The data shows that a lot of progress has been made in Quebec and elsewhere in Canada in a few decades. Seeing the factors that played a role shows that we must keep up our effort, because competition is lively. Research and development (R&D) efforts must be increased and lead to patents and commercial innovations. The science and technical professions must also be appealing to young people. Quebec needs graduates who are experienced with the new technologies. Quebec's future as a high-tech exporter is not the sole prerogative of goods production. On the service side, a lot remains to be showcased and exported.

Technological Quebec from the End of the 20th Century to the Start of the 21st

In 1982, the Quebec government published an economic action program; its title, *Le Virage technologique*, attested to the hopes new technologies were raising for stimulating and steering economic development. It wasn't that the existing technologies no longer had any appeal, but that the emerging technologies held out the promise of opportunities so enormous they were inevitable.

In the early 1980s, the new technologies primarily consisted of what were called micro electronics and biotechnology. The multitude of applications for information and communications technologies (ICTs) followed, including the Internet, social networks, and artificial intelligence, to name a few. There were many developments in the pharmaceutical and agri-food industries, among others, and a growing array of products that drew on biological processes. Major technological advances also revolutionized the materials and energy sectors.

Quebec's technological capability expanded over time, helped by the investments in equipment, machinery and production infrastructure. There were also a number of government policies, a higher education level with a concomitant increase in the number of skilled workers, and the spur provided by competition. Each of these factors helped, in its own way, to get Quebec's economy to where it is now.

In terms of technology exports, Quebec had a long way to go, as shown by this example. Of the 25 main products exported at the end of the 1970s, the "aircraft engines and parts" category is the only category that could be characterized as high-tech. It ranked 7th, behind printing paper, motor vehicles and various mineral products (iron, asbestos, aluminum, copper).¹ In 1976, it represented 3.9% of Quebec's exports. In contrast, Ontario's exports in the "motor vehicles, trucks, trains and other vehicles and parts" category accounted for 49.9% of the total.²

Over time, it became clear that specialized knowledge was playing an increasingly large role in the goods and services produced here, and in those exported. Although it is hard to pin down the contribution of knowledge statistically, the evidence is there in the efforts and technological investments made in all sectors, even some that are characterized as traditional, such as farming, food, wood, paper, printing, etc.

At first glance, Quebec has minimally increased the technological content of its industrial output since the end of the 20th century. This is what is shown by prior studies. The progress is not the sole prerogative of Quebec and Canada. It is similar to industrialized and emerging economies elsewhere in the world.

¹ Pierre FRÉCHETTE, Roland JOUANDET-BERNADAT and Jean-Paul VÉZINA, *L'économie du Québec*, 2nd edition, Laval HRW, 1979, p. 336.

² Carmine NAPPI, *La structure des exportations au Québec*, C.D. Howe Research Institute, 1958-1996, p. 20.

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NOTE TO READERS: The letters k, M and B are used in texts and tables to refer to thousands, millions and billions respectively.

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What remains to be seen is how much the technology content of its exports has increased, which we will cover in the next few sections.

Some Methodological Considerations

How do we measure technology intensity? Do we need to look at how much technology is used? Does the key lie in analyzing the technological sophistication of products and services, or of production and research equipment? Do we have to try to calculate the R&D effort or assess the higher education of staff? This information does not specifically exist for each sector of the economy. Moreover, the way some of the data is recorded has changed, making it difficult or even impossible to compare over time.

Little work has been done on this area. The Organisation for Economic Co-operation and Development (OECD) has looked at the matter. It took into account R&D efforts in 12 countries, solely in the manufacturing sector. The technology content of economic activities is a relatively new area for research and analysis, which is why the topic does not yet seem to have been the focus of extensive methodological development. In fact, the only work that seems to garner some consensus is the work done by the OECD Secretariat at the end of the 1990s.

The OECD Secretariat's approach involves classifying manufacturing industries according to the magnitude of resources they dedicate to R&D. The exercise was done for 12 OECD member nations, including Canada, resulting in four categories of industries, ranging from high to low technology intensity (box 1). The classification represents the average situation for the 12 countries analyzed. Of course, a different industry classification could be obtained for individual countries, and for countries not analyzed.³ The advantage is that the OECD's classification is used by various bodies, making it easier to compare countries. The OECD's approach and classification underlie the tables published by the World Bank and, in Quebec, the Institut de la statistique du Québec (ISQ) and Ministère de l'Économie et de l'Innovation (MEI).

We quickly realized that it was hard to isolate each country's contribution, because of value chains, in particular. Moreover, the value of exports is an imperfect reflection of a country's technological capacity, given that its exports of tech goods may result from assembling components that are produced in another country with a process and technology that are also designed abroad.⁴ This is true for the large majority of or even all exporting countries, given that globalization has resulted in production now

BOX 1

Classification of Manufacturing Industries Based on R&D Intensities

- ▶ High
 - Aircraft and spacecraft
 - Pharmaceuticals
 - Office, accounting and computing machinery
 - Radio, TV and communications equipment
 - Medical, precision and optical instruments
- ▶ Medium-high
 - Electrical machinery and apparatus, n.e.c.
 - Motor vehicles, trailers and semi-trailers
 - Chemicals excluding pharmaceuticals
 - Railroad equipment and transport equipment, n.e.c.
 - Machinery and equipment, n.e.c.
- ▶ Medium-low
 - Building and repairing of ships and boats
 - Rubber and plastics products
 - Coke, refined petroleum products and nuclear fuel
 - Other non-metallic mineral products
 - Basic metals and fabricated metal products
- ▶ Low
 - Manufacturing, n.e.c.; recycling
 - Wood, pulp, paper, paper products, printing and publishing
 - Food products, beverages and tobacco
 - Textiles, textile products, leather and footwear

Sources: *ISIC REV. 3 Technology Intensity Devinition*, OECD, 2011

³ Karine ST-PIERRE, *Classification par niveau technologique du secteur manufacturier*, Institut de la statistique du Québec, February 2002, 44 p.

⁴ *The Evolution of Global Value Chains and Their Economic Implications*, Desjardins, Economic Studies, *Economic Viewpoint*, May 14, 2019, 4 p.

being handled through value-added chains that involve goods and services suppliers located in several different countries. The numbers published by the World Bank clearly show that the gross value of exports is not very useful in reaching firm

conclusions about a country's real technological capacity. The data allows us to compare the performances of many countries by means of an indicator: the ratio of high-tech goods exports to all exports of manufactured goods. Table 1 presents the indicator's values for Canada and a few other countries in 2017. The much stronger performance of some countries, like Singapore and Vietnam, suggests that their high-tech exports are largely based on the assembly of imported components.

The highly variable results by country shown in table 1 suggest that an indicator that is based on value added rather than on the gross value of exports could yield different results, while better reflecting those national economies' true technological capacity. Unfortunately, publication of data on exports' value added is relatively recent in Canada and other countries. For Canada, moreover, the data is only published for 2007 to 2015; provincially, the data does not provide a breakdown by industry.

In light of these observations, the data on the value of gross exports has been retained for this analysis. As we saw earlier, the value of technology exports is an observation whose scope is limited. That is why we opted to expand on it by looking at it with two other parameters: total exports and real GDP. Technology exports will thus be compared based on total goods exports (excluding services) and in relation to the total value of the economy's output.

TABLE 1
Ratio of high-tech exports to exports of manufactured goods

IN %	2017
World	16
OECD countries	14
Singapore	49
Hong Kong	30
Vietnam	29
France	24
China	24
United States	14
Germany	14
Japan	14
Canada	13
Sweden	13
Belgium	9
India	7

Source: World Bank

These are the results that will be produced for Quebec and the rest of Canada between the end of the 20th century and 2019. A few dates will act as reference points. 1988 will act as the anchor; it is prior to the 2000s and thus the accelerated deployment of new technologies. 2004 has been selected as the high point of the surge in globalization, and 2019 is the latest year. Box 2 contains more detailed explanations.

BOX 2
Benchmark Years
► 1988

- This year is the reference point because it precedes the rapid development of the new information and communications technology, and the fall of the Berlin Wall, and thus the rapid increase in global trade that ensued. Aerospace was well entrenched in Quebec with Bombardier, United Technologies (now Pratt & Whitney), CAE, Héroux Devtek and Bell Helicopter. Montreal was the main Canadian centre for biopharmaceutical production and could count on new shoots like Biochem; the sector also had a presence in Toronto. Ontario benefited from the presence of several electronics and communications companies, including Northern Telecom (which became Nortel in 1999).

► 2004

- This year represents the approximate peak of the surge in globalization around the turn of the millennium, after the BRIC⁵ emerged, including China, which joined the World Trade Organization (WTO) in 2000, and before the 2008 financial crisis and resulting slowdown in growth in many countries. The loonie had just started to rise against the U.S. dollar, a rise that lasted until 2012 and caused major problems for Canadian manufacturers and exporters.

► 2019

- This is the latest year for which data is available. It makes it possible to track the changes that have occurred over the last 15 years in Quebec and the other provinces, and over the last three decades for Canada.

⁵ Brazil, Russia, India and China.

We had to deal with methods for recording technology exports that varied over the period of time considered (1988 to 2019). Three broad “generic” categories were formed in order to be able to make comparisons: electronics, aerospace and healthcare. Box 3 sets out the details on each category.

Canada’s Exports of High-Tech Goods

Table 2 shows Canada’s high-tech goods exports in 1988, 2004 and 2019. Note that these exports’ share of GDP has increased, rising from 1.8% to 2.2% from 1988 to 2019. The relative weight of high-tech goods exports in overall exports has also risen, but the growth primarily materialized between 2004 and 2019. Lastly, the high-tech share of Canadian exports went from 6.8% to 8.4% over the last 30 years. In short, these two indicators show that the relative importance of Canada’s high-tech exports increased by about one quarter from 1988 to 2019.

TABLE 2
Exports of high-technology goods in Canada

IN G\$	1988	2004	2019
Total exports of high-technology (HT) goods	11.1	27.6	49.8
Total exports of goods (X)	162.8	435.4	592.6
GDP	626.9	1,241.1	2,303.9
HT/X (%)	6.8	6.3	8.4
HT/GDP (%)	1.8	2.2	2.2

Sources: Statistics Canada and Desjardins, Economic Studies

BOX 3

Breakdown of Three Broad Categories of Technological Exports

- ▶ Electronics
 - Devices and components for computing, telecommunications, instrumentation and consumer goods
- ▶ Aerospace
 - Aircraft (airplanes and helicopters), aircraft engines and other equipment and parts for air navigation
- ▶ Healthcare
 - Pharmaceutical products and medical instruments and equipment

Sources : Statistics Canada and Desjardins, Economic Studies

Table 3 reveals major changes in the relative importance of three broad technology sectors in Canada over the last 30 years. During this period, the share of aerospace goods in high-tech exports rose from 26.0% in 1988 to 42.5% in 2019, putting them in first place. Conversely, electronics, which had ranked first in 1988, fell to the third place in 2019; their share in the total dropped from 71.6% to 28.2%. The plunge is no doubt largely due to the problems at Nortel and Blackberry,⁶ and competition from Asia. The biggest change over the period, however, is the change in healthcare goods, which made a prodigious leap that took them from 2.3% to 29.3% of total high-tech exports, putting them in a position comparable to electronics.

TABLE 3
Distribution of Canada’s high-technology goods exports by sector

IN %	1988	2004	2019
Electronics	71.6	47.3	28.2
Aerospace	26.0	36.2	42.5
Healthcare	2.3	16.5	29.3
Total	100.0	100.0	100.0

Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

Exports of High-Tech Goods from Quebec and the Rest of Canada

Quebec’s exports of high-tech goods stood at \$20.3B in 2019 (table 5 on page 5). They represented just over one fifth (21.7%) of all Quebec exports, a substantial gain from the 15.8% recorded in 2004 (table 4). The ratio between the value of Quebec’s high-tech exports and GDP posted a more modest increase between these two years, going from 4.2% to 4.4%.

TABLE 4
High-technology goods exports by Quebec and the rest of Canada in 2004

	QUEBEC \$B	ROC \$B	QUEBEC/ROC %
High-technology exports (HT)	10.7	16.9	63.6
Total exports of goods (X)	67.6	367.8	18.4
HT/X (%)	15.8	4.6	---
GDP	252.0	989.2	25.5
HT/GDP (%)	4.2	1.7	---

ROC: Rest of Canada

Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

⁶ The flagship product of Research in Motion.

TABLE 5
High-technology goods exports by Quebec and the rest of Canada in 2019

	QUEBEC	ROC	QUEBEC/ROC
	\$B	\$B	%
High-technology exports (HT)	20.3	29.5	68.8
Total exports of goods (X)	93.5	499.1	18.7
HT/X (%)	21.7	5.9	---
GDP	458.7	1,845.2	24.9
HT/GDP (%)	4.4	1.6	---

ROC: Rest of Canada
Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

Quebec's performance on the high-tech share of exports is much better than the rest of Canada. In both 2019 and 2004, Quebec exports represent about two thirds of those of the other provinces, whereas the GDP ratio is only one quarter. Similarly, high-tech goods only represent 5.9% of total exports from the rest of Canada in 2019 (4.6% in 2004), much less than Quebec's 21.7% (15.8% in 2004). Comparing the ratio between high-tech exports and GDP yields the same findings. Lastly, in Quebec as in the rest of Canada, the relative importance of high-tech exports in total exports increased between 2004 and 2019, but the increase was bigger in Quebec. In both cases, the ratio of high-tech exports to GDP has not changed much between the two years.

The appendix (tables A and B on page 7) sets out the detailed breakdown of high-tech exports according to product category for 2004 and 2019. Tables 6 and 7 were developed by grouping these categories according to the three broad tech sectors selected earlier. Extraordinarily, the data available for 2004 included numbers for all global exports. This makes it possible to see how Quebec's economy stood out from the rest of the world in terms of high-tech exports, particularly in aerospace.

TABLE 6
Sector breakdown of high-technology goods exports in 2004

IN %	QUEBEC	ROC	WORLD
Aerospace	68.0	16.1	10.2
Electronics	24.9	61.4	58.3
Healthcare	7.1	22.5	31.5
Total exports	100.0	100.0	100.0

ROC: Rest of Canada
Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

TABLE 7
Sector breakdown of high-technology goods exports in 2019

IN %	QUEBEC	ROC
Aerospace	67.9	24.8
Electronics	18.7	34.8
Healthcare	13.4	40.4
Total exports	100.0	100.0

ROC: Rest of Canada
Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

An initial observation is that aerospace clearly dominated Quebec's exports of high-tech goods. In 2019, this sector accounted for 67.9% of Quebec's exports of high-tech products. Electronics (18.7%) and healthcare products (13.4%) were well behind. The main changes that occurred between 2004 and 2019 were an increase in the healthcare sector's share (from 7.1% to 13.4%) and a decline by electronics (24.9% to 18.7%).

The distribution of high-tech exports is more balanced in the rest of Canada. For example, in 2019, the three broad sectors' respective shares ranged from 24.8% to 40.4%, much less dispersion than in Quebec (from 13.4% to 67.9%). Between 2004 and 2019, aerospace increased its relative share of high-tech goods exports (from 16.1% to 24.8%) while, as in Quebec, electronics lost importance (from 61.4% to 34.8%) to the benefit of Asian countries, in particular. The biggest gain was recorded by the healthcare products sector in Canada; its share increased from 22.5% to 40.4% and it now leads the high-tech goods export sectors.

Table 6 shows that, in 2004, the distribution of Quebec high-tech exports diverged substantially from that of total global exports of the same goods. Proportionally speaking, exports of aerospace products were in fact seven times higher in Quebec than they were elsewhere in the world. Divergences from the structure of global exports were much smaller in the rest of Canada.

Main Destination Countries

Each year, the MEI publishes data on Quebec's main export products and their primary destination countries. The data provides a good snapshot of the destination countries for Quebec's exports in the aerospace sector, i.e. products in the following categories for 2018:

- ▶ Airplanes, helicopters and other aircraft or spacecraft (\$7.7B in exports)
- ▶ Turbo-jets, turbo-propellers and other gas turbines (\$5.1B)
- ▶ Flight simulators and parts thereof (\$1.1B)
- ▶ Airplane, helicopter and other aircraft parts (\$0.9B)

Table 8 shows the breakdown of exports by destination country for 2018, the latest year for which the information has been published. However, it only covers \$13.1B of these exports' total of \$14.9B. The difference stems from the fact that the data published by the MEI only covers the main products exported. Despite this shortcoming, table 8 demonstrates that the United States is clearly the main destination for products from the aerospace sector.

TABLE 8
Quebec exports of aerospace products by destination country in 2018

DESTINATION	\$B	%
United States	6.9	46.3
European Union	3.3	22.1
Asia	1.6	10.7
Latin America	0.5	3.4
Middle East	0.5	3.4
Africa	0.1	0.7
Oceania	0.2	1.3
Unspecified	1.8	12.1
Total	14.9	100.0

Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

The sources available do not make it possible to get similar data for the other high-technology goods exported.

In Light of These Observations...

Based on the analysis above, we drew the following conclusions:

- ▶ Quebec's performance in the area of high technology in goods exports seems to be much stronger than the rest of Canada for 2004 to 2019.
- ▶ For Quebec and the rest of the provinces, the relative weight of high-tech exports in total exports increased between 2004 and 2019, but the increase was sharper in Quebec.
- ▶ In Quebec, aerospace clearly dominates high-tech goods exports.
- ▶ Exports of high-tech goods are more evenly distributed in the rest of Canada.
- ▶ The United States is the main destination for products from aerospace sector, and for all Quebec exports.

Other Avenues to Explore

The analysis of the technology content of exports could be done differently. The OECD's technology intensity methodology, mentioned on page 2, could be applied. However, it would be a time-consuming, meticulous job. We could also expand the

study to activities other than manufacturing, such as exportable services that employ highly skilled workers or offer innovative, distinctive products. Note that the export of services is especially interesting because it adds more value than do exports of material goods.

For now, the work on the technology intensity of exports is relatively recent and imprecise, which does not allow for a very in-depth historical analysis. The available data indicates an increase in high-tech goods' share of total Quebec exports since 2004.

We saw that, over the last few decades, in Canada, aerospace and healthcare products have taken over from electronics. In Quebec, high-tech exports are mainly concentrated in aerospace. This sector includes about 200 businesses in Quebec, including 4 major prime contractors associated with the large global builders. The pace of output is tied to the global market's output. Quebec has a skilled workforce. The Greater Montreal area, where much of Quebec's industry is concentrated, remains a major hub and production centre for North America. Insofar as global demand for all types of aerospace products holds up, the exceptional situation caused by the coronavirus notwithstanding, exports of aerospace products should remain high and continue to colour the Quebec picture of high-tech exports in the years to come.

Other opportunities to export high technology seem to be shaping up. This is the case, in particular, for services. The global trade in services that rely on expertise, knowledge and creativity is increasing. For Quebec to carve out its space without necessarily abandoning goods production, we will have to increase the R&D effort and ensure it results in patents and commercial innovations. The science and technical professions must also be appealing to young people. Quebec needs graduates who are experienced with the new technologies. Quebec's future as a high-tech exporter is not the sole prerogative of goods production. On the service side, a lot remains to be showcased and exported.

Appendix

Detailed Breakdown of High-Tech Exports in 2004 and 2019

TABLE A
Breakdown of high-technology goods exports in 2004

IN %	QUEBEC	ROC	WORLD
Instrument for air navigation	68.0	16.1	10.2
Parts for radios, televisions, telephones, etc.	13.8	31.0	27.9
Electrical and electronic measuring devices	4.6	11.0	7.1
Medications	4.4	17.8	16.5
Line telephony equipment	3.1	4.4	3.6
Data processing machines	3.0	12.3	23.9
Medical or surgical	1.6	4.1	5.1
instruments and apparatus, n.e.c.	1.1	0.6	0.7
Pharmaceutical goods	0.3	0.9	1.0
Microphones, speakers, amplifiers	0.1	1.7	2.4
Photographic and cinematographic equipment	0.0	0.2	1.6
Total	100.0	100.0	100.0

ROC: Rest of Canada

Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies

TABLE B
Breakdown of high-technology goods exports in 2019

IN %	QUEBEC	ROC
Aircraft	39.4	3.0
Aircraft engines	17.0	5.0
Aircraft parts and other aerospace equipment	11.4	16.8
Pharmaceutical and medicinal products	8.7	35.6
Printed and integrated circuits, semiconductors and printed circuit assemblies	7.8	2.6
Medical and laboratory equipment	4.7	4.7
Electronic equipment parts, n.e.c.	3.7	7.4
Computers and computer peripherals	2.9	7.0
Switchgear, switchboards, relays and industrial control apparatus	1.8	5.7
Televisions and other audio and video equipment, and unrecorded media, n.e.c.	0.9	3.0
Broadcast, studio, alarm, and signalling equipment	0.7	3.6
Motor vehicle electrical and electronic equipment	0.5	2.5
Other electronic components	0.3	1.4
General application software (except online and game software) and software licensing	0.1	0.2
Telephone and data communications equipment	0.1	1.5
Total	100.0	100.0

ROC: Rest of Canada

Sources: Statistics Canada, Databank of Official Statistics on Québec and Desjardins, Economic Studies