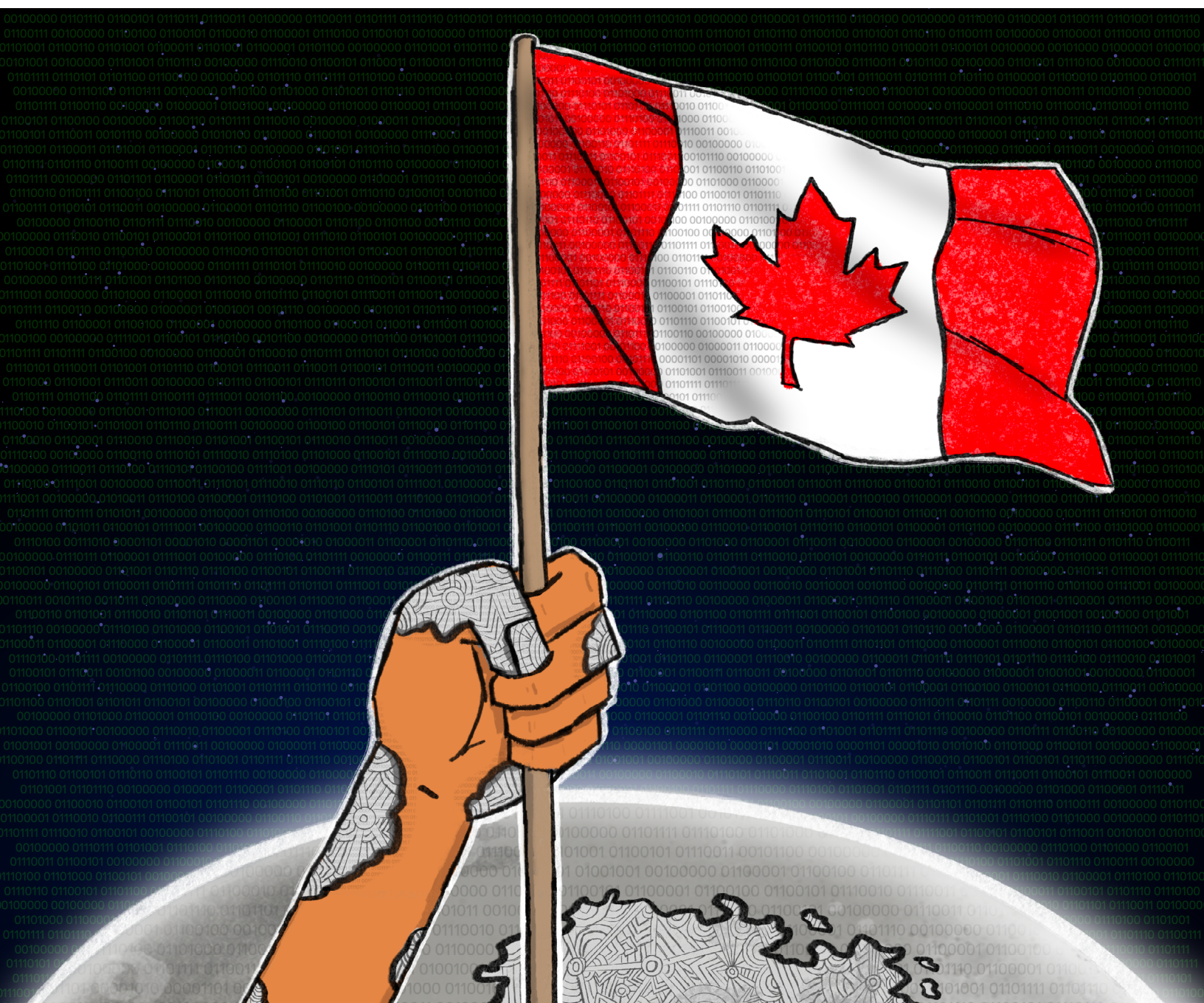


Automation Nation?

AI Adoption in Canadian Businesses

Angus Lockhart | September 2023



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The Dais is Canada's platform for bold policies and better leaders. We are a public policy and leadership institute at Toronto Metropolitan University, connecting people to the ideas and power we need to build a more inclusive, innovative, prosperous Canada.

For more information, visit dais.ca
20 Dundas St. W, Suite 921, Toronto, ON M5G 2C2



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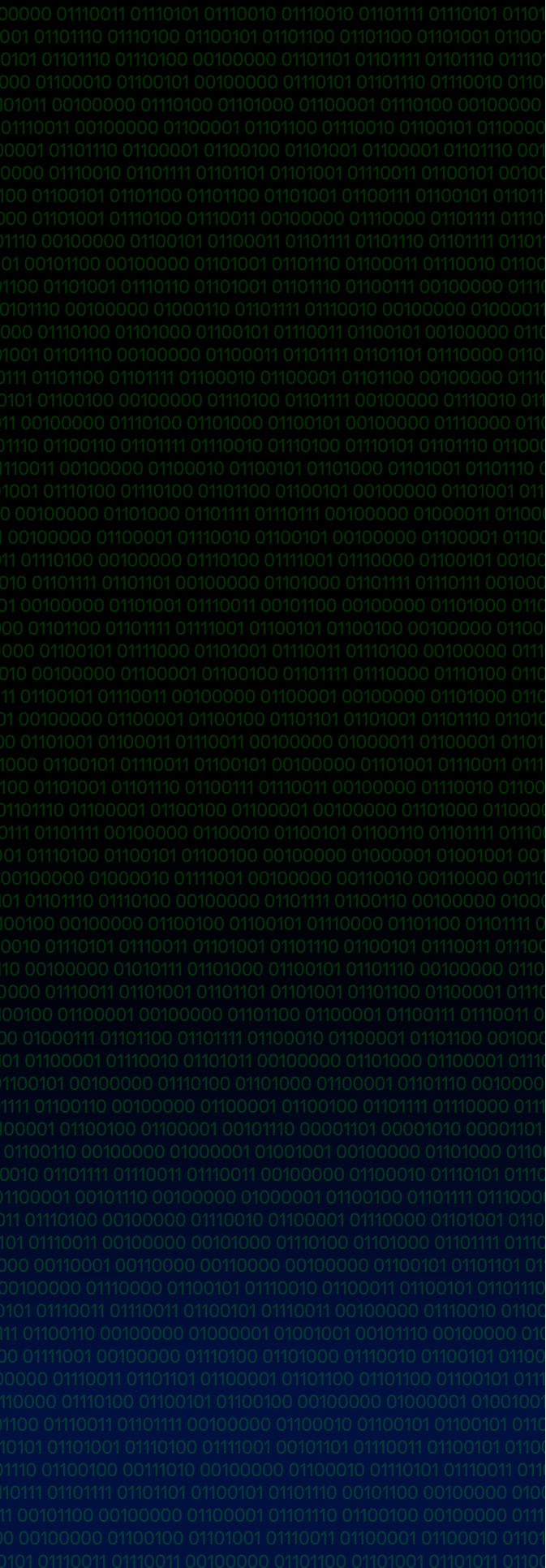
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Design and Illustration

Mariana Rodrigues

Copy-Editing

Suzanne Bowness

Translation

Ubiquis Translation Services

Contributors

Dr. Ebrahim Bagheri

Sarah Gagnon-Turcotte

Dr. Tom Goldsmith

Lilia Jemai

Ryan Khurana

François Labonté

David Nolet

Marc-Etienne Ouimette

Peter Severinson

Craig Stewart

Ed Teather

Viet Vu

Nina Rafeek Dow

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Business Data Lab

Canadian Chamber of Commerce

Author



Angus Lockhart
Senior Policy Analyst

Angus Lockhart is a Senior Policy Analyst at the Dais. Angus researches the adoption of innovative technologies in both the public and private sectors and the role policy can play in accelerating uptake. Angus holds a Bachelor of Arts in Political Science from the University of British Columbia, and a Master of Arts in Political Science from Simon Fraser University.

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Executive Summary

With all the breathless news coverage and raging debate surrounding artificial intelligence (AI) in recent months, it would not be unreasonable to think that the age of AI has already arrived for Canadian businesses. The promise of artificial intelligence has long been its potential to make an economy more productive, increasing wages and living standards for all. For Canada to realize these benefits and remain competitive with our global peers, we will need to responsibly harness the potential of AI. Unfortunately, Canada lags behind.

And yet, little is understood about how Canadian businesses are adopting this newest type of technology, from how prevalent its use is, how it is being deployed and what barriers exist to prevent further adoption. This study uses a high quality survey administered by Statistics Canada to look at these issues. Our key findings reveal that:

1. Canada has a long way to go before we have integrated AI into our economy. By 2021, only 3.7 percent of Canadian firms had deployed AI in their business in any capacity. When compared to other similar countries, Canada lags in AI adoption. Global leaders like Denmark have so far had more than double the rate of adoption of AI as Canada.

2. The adoption of AI has been uneven across businesses in Canada. Adoption has been most rapid among large firms (those with more than 100 employees), with 20 percent of these businesses reporting the use of AI. Comparatively, only three percent of the smallest firms have adopted AI. Adoption has also been leaving some equity-seeking groups behind: businesses owned by women, Indigenous peoples, and people living with disabilities are far less likely than other businesses to currently be using AI.

While business adoption of AI has been slow, Canada has a long history as a leader in AI research and development. With deliberate effort, Canada has the potential to be a leader in AI adoption. Specifically, we recommend that:

1. Federal and provincial governments need to work with industry partners to actively build demand for AI. Most Canadian businesses have not been able to make a business case for AI, and many don't know what AI tools are available on the market. Governments in Canada need to work with their existing partners in the AI ecosystem to develop new and scale up existing programs designed to help business leaders make the case for AI in their workplace.

2. Governments and industry need to promote internal upskilling. Businesses that invest in their existing workforce and develop their skills are far more likely to have adopted AI tools. Scaling programs that support upskilling will help empower workers who already know the needs of their firm and the existing technological environment the firm operates in. For Information and Communication Technology (ICT) workers, upskilling the internal workforce means giving employees who are already familiar with the firm's data infrastructure the capacity to implement new AI tools, and for the rest of the workforce it means giving workers the knowledge and understanding of what the AI tools are to successfully use them as part of their day to day work.

3. Any action should be taken within a framework of responsible AI adoption. While Canada does need to accelerate AI adoption, we can't do so at the expense of a focus on ethical and responsible use of the technology. With the current pace of AI development, governments at all levels have struggled to keep up with the current speed of development. As we promote the adoption of new and existing AI tools, we need to simultaneously make sure they are being used safely and responsibly.

2

Introduction

With artificial intelligence (AI) now at the forefront of many discussions about innovation, it's more important than ever to understand the true extent of its use and rate of adoption in Canada.

AI has the potential to dramatically alter the Canadian economy, a boost that Canada desperately needs. Canada has fallen behind our peers in productivity over the last decades and efforts to reverse this trend have not yet been successful. Beyond this, AI also has the potential to accelerate innovation and scientific discovery if fully embraced and to help resolve ongoing labour shortages caused by shifting demographics in Canada.

Globally, AI has not yet become pervasive in the economy, but studies suggest that AI has the

potential to dramatically improve worker productivity, from automating production lines in factories, to increasing efficiency at routine office tasks and beyond. Taking swift action will be essential for Canada to overcome our historical weakness in the adoption of emerging technologies. Leveraging AI offers yet another chance to remain competitive with our peers.

This report discusses the current state of AI adoption in Canada with a focus on the characteristics that define firms that have already adopted AI. We will also discuss what commonalities exist between firms that have not yet adopted AI, and what Canada should be doing to help them adopt these new and powerful tools.

What is Artificial Intelligence?

Whether you take a definition from [Britannica.com](https://www.britannica.com), such as “the ability of a computer or computer-controlled robot to perform tasks commonly associated with intelligent beings,” or IBM’s “artificial intelligence is a field, which combines computer science and robust datasets, to enable problem-solving”, there are a range of ways of describing artificial intelligence (AI).

Recently, the conversation surrounding AI has become more focused on responsible adoption and development. Tools like ChatGPT have drawn significant public attention to AI and the speed of new developments have led to increased calls for responsible use of AI tools. Regulatory frameworks also need to keep up.



Recent public conversation regarding AI tools has focused on those that fall under the broad category of generative artificial intelligence. Generative AI is a newer type of artificial intelligence that generates new content by calling on examples of an input (for instance text samples).¹ This can range from text, to images, to video content and beyond.

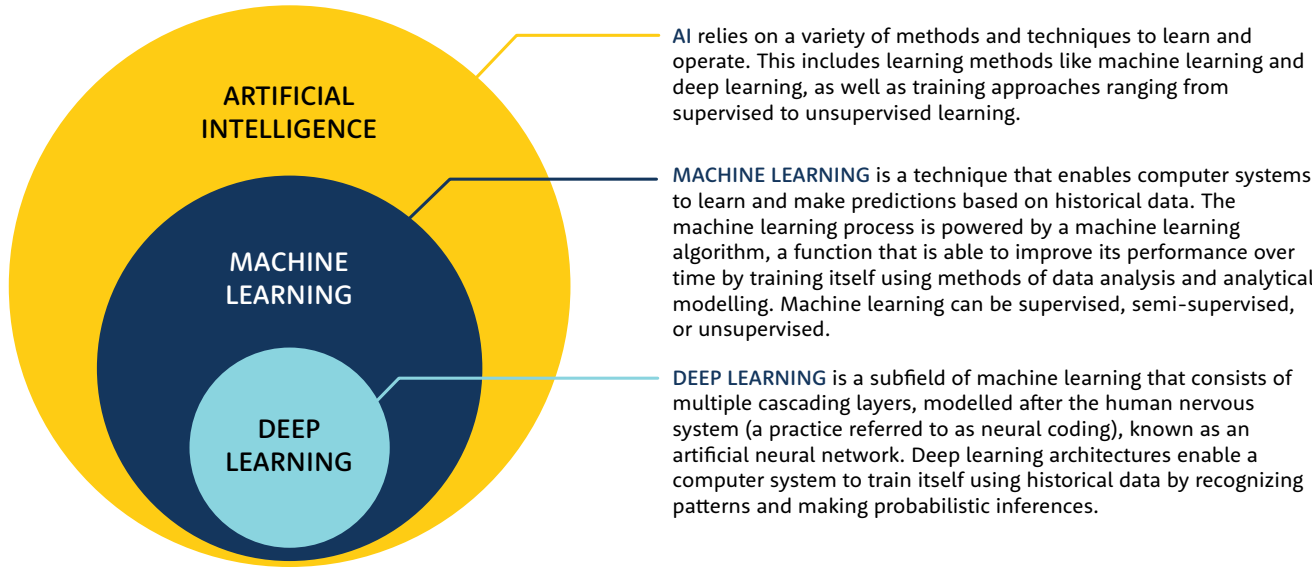
But AI by definition is a much larger grouping of technologies, many of which have been in use in a variety of sectors for many years. Other AI applications familiar to the average consumer now include:

- Virtual agents, used to augment customer support capabilities for firms both online and over the phone
- Automatic speech recognition, used for a wide range of tasks from smartphone personal assistants to assistive typing software
- Computer vision software, used for tasks from smartphone security to border control
- Machine learning, used in many ways including helping improve navigation by apps like Google Maps

These are only some of the many ways that AI is already in use in Canada and globally. At their core, these technologies all use a range of techniques to identify patterns, produce insights, enhance knowledge-based work, and automate routine tasks.

It is these non-generative, more difficult tools that this report focuses on. Technology like image recognition has been in use in Canada for years now and the risk in adoption of these technologies is far better understood.

HIERARCHIES



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3

Motivation for Adopting AI in Canada

Productivity

Canada has suffered from sluggish economic growth throughout the twenty-first century. Our productivity since 2000 has slipped by 5.6 percent when compared to the United States. This is more than most of our peer countries.² As productivity is directly tied to higher wages and higher standards of living, keeping pace and closing this gap matters for Canada.³



We are falling behind when it comes to economic productivity. Productivity matters because it is what guarantees the dream of every parent—that our children will be more prosperous than we are. This is a well-known Canadian problem—and an insidious one. It is time for Canada to tackle it.

Chrystia Freeland, Budget Speech, 2022

For decades, the rise of digital technologies has been heralded as a potential solution to slow growth.⁴ However, the link between new technologies and productivity growth has remained a matter of debate.

Economists have long discussed this in terms of the Solow paradox, which notes that investments into IT technologies failed to yield the predicted increase in worker productivity, and in some cases resulted in productivity declines.⁵ Yet there is also significant evidence that new technologies have led to real economic growth.⁶

This debate continues with regards to artificial intelligence. Studies have shown that artificial intelligence has real potential to increase productivity in specific industries. For example, Besiroglu et al (2023) suggest that artificial intelligence could significantly increase the impact of research and development.⁷ Similarly, a firm-level analysis of AI patent activity found a positive relationship between patent activity and firm productivity.⁸

Another recent study of firm-level data in the manufacturing sector found that a one-percent increase in the penetration of AI across businesses resulted in a corresponding 14.2 percent increase in total factor productivity (the total economic output that can be generated with a given set of inputs).⁹

However, evidence at the level of national economies is more mixed. A study by Parteka and Kordalska (2023) suggests that AI has not yet contributed to country-wide economic growth.¹⁰ They assess the relationship between AI patents and economic growth, finding no strong macroeconomic link between the development of artificial intelligence and economic growth.

This difference is potentially attributable to the low levels of widespread AI adoption. Brynjolfsson et al (2019) describe the current state as “forward-looking technological optimism and backward-looking disappointment.”¹¹ As this report discusses, only a small share of firms have adopted AI, and among those that have, adoption is not always deeply ingrained. It’s therefore unlikely that the impact of AI on productivity will yet be measurable looking at the scale of the entire economy.

This aligns with findings by the Organisation for Economic Co-operation and Development (OECD) that suggest that the slow economic growth from new technologies has been driven not by slow adoption among frontier firms (firms that are the most productive relative to their industry), but rather slow diffusion from those firms to non-frontier firms.¹² For Canada to fully take advantage of the potential benefits of artificial intelligence, we will need to make sure that diffusion of the technology goes beyond the leading adopters and reaches into the wider market.

Canada’s AI Strategy

Historically, Canada has been a leader when it comes to artificial intelligence research, with many early pioneers like Geoffrey Hinton, Yoshua Bengio, and Richard Sutton working in Canada throughout the AI winter in the 1980s and 1990s, giving Canada a scientific edge as computing power caught up to the early research.¹³

As AI capabilities continued to improve, Canada launched the Pan-Canadian AI Strategy in 2017,

which was the first strategy of its kind and built on the existing history of AI investments.¹⁴ With a long record as a leading centre for AI research, the Canadian Institute for Advanced Research (CIFAR) was assigned to lead the strategy, and three new AI research institutions were created in Edmonton (Alberta Machine Intelligence Institute), Toronto (the Vector Institute), and Montreal (Mila - originally Montreal Institute for Learning Algorithms).

The first five-year period of the strategy, focused on the development of new AI technologies, was largely successful in maintaining Canada’s reputation as a leader in research. Aggregate rankings from Tortoise Media place Canada fifth globally in a ranking of investment, innovation, and implementation of AI (with Québec placing seventh globally in their 2021 regional analysis).¹⁵ Similarly, Canada was ranked sixth by the Global AI Talent Report and remains a top producer of AI research publications.¹⁶

While these investments were successful in supporting Canada’s research efforts, the strategy has only recently shifted its focus to supporting AI diffusion. Following the first five years of the strategy, a new phase adds a focus on commercialization alongside existing focuses on research and development.¹⁷ The new phase now includes \$185 million in spending commitments over five years, provided in the 2021 federal budget. Driven by a belief that Canada is falling behind on the commercialization side, this shift is essential for Canada to reap the benefits of our historic efforts with artificial intelligence. While the new technologies can contribute, it’s the cross-sector adoption of new tools that will result in real economic growth.

Many parties have argued that firm-level data is needed to better understand the state and impact of AI adoption.¹⁸ Canada has been fortunate that multiple sources have collected firm-level data over the last few years. These allow us to understand the state of adoption here. In this report, we gather these sources to draw the first accurate picture of the state of AI adoption in Canada, and discuss what can be done to move it further forward.

4

The State of AI Adoption in Canada

The Survey of Digital Technology and Internet Usage (SDTIU) provides the best data nationwide to understand how many firms have adopted AI and who those firms are. The SDTIU is a bi-annual survey of Canadian enterprises conducted by Statistics Canada, evaluating firm use of digital tools and emerging technologies.

In conducting the survey, Statistics Canada employs a two-stage process. First, it contacts the firms to identify the correct person to fill out the survey (in this case, someone in charge of making Internet communication technology decisions for the firm). Second, it contacts that person directly to complete the survey. Response to the survey was mandatory, and Statistics Canada was able to achieve a response rate of 73 percent, far above standard response rates.¹⁹

In all businesses with five or more employees, as of the end of 2021, only 3.7 percent of firms say they had adopted artificial intelligence in any way (Figure 1).

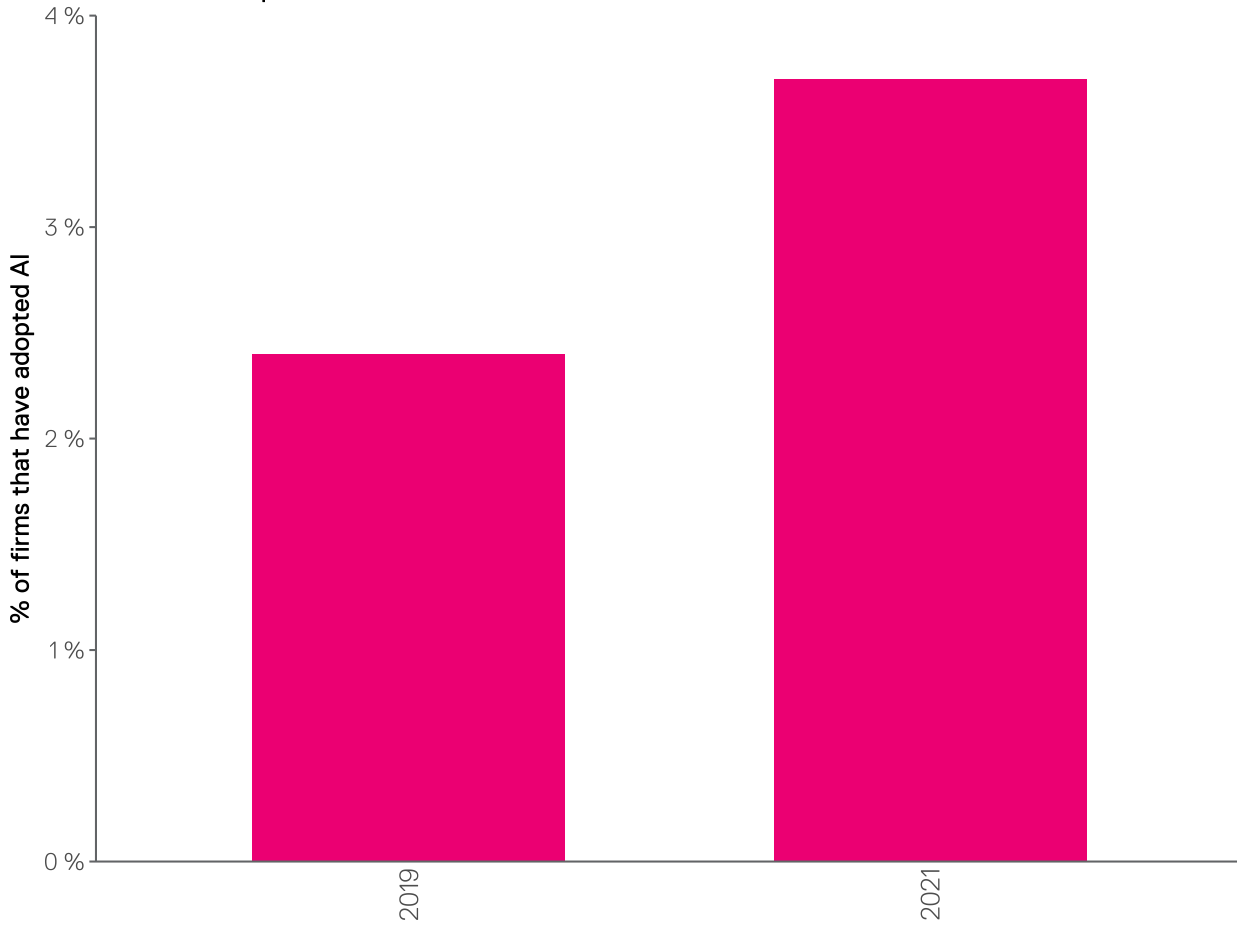
This figure is consistently lower than other surveys report. IBM Global AI Adoption Index²⁰ suggests that 28 percent of firms in Canada have adopted artificial intelligence as of 2021 (Figure 2), while in 2019 Deloitte found that 19 percent of Canadian firms had already adopted artificial intelligence.²¹

We can compare the results of the Statistics Canada survey to those done in other countries by their national statistical agency. Comparing results for firms with 10 or more employees, the share in Canada is 4.7 percent, in twentieth position of 35 countries. Additionally, four of the countries trailing Canada in this overview have data collected before 2021. If those countries experienced even modest growth in AI adoption between when their surveys were conducted and when the Canadian data was collected, Canada would trail even further behind.



Figure 1

Overall AI Adoption in Canada



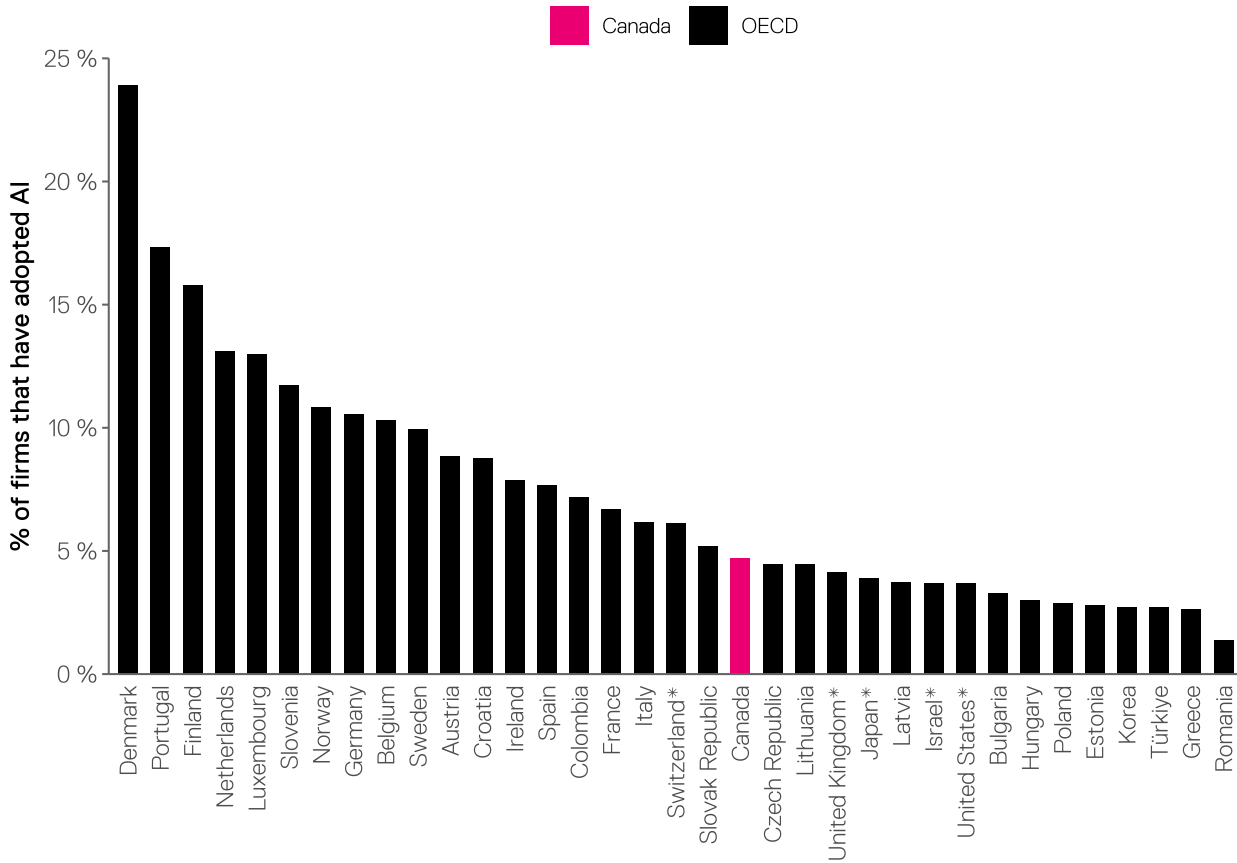
Source: Survey of Digital Technology and Internet Usage. Among all firms with 5 or more employees



In all businesses with five or more employees, as of the end of 2021, only 3.7 percent of firms say they had adopted artificial intelligence in any way.

Figure 2

Firm Level AI Adoption in OECD Countries



Source: OECD. Among all firms with 10 or more employees. * indicates data collected before 2021.

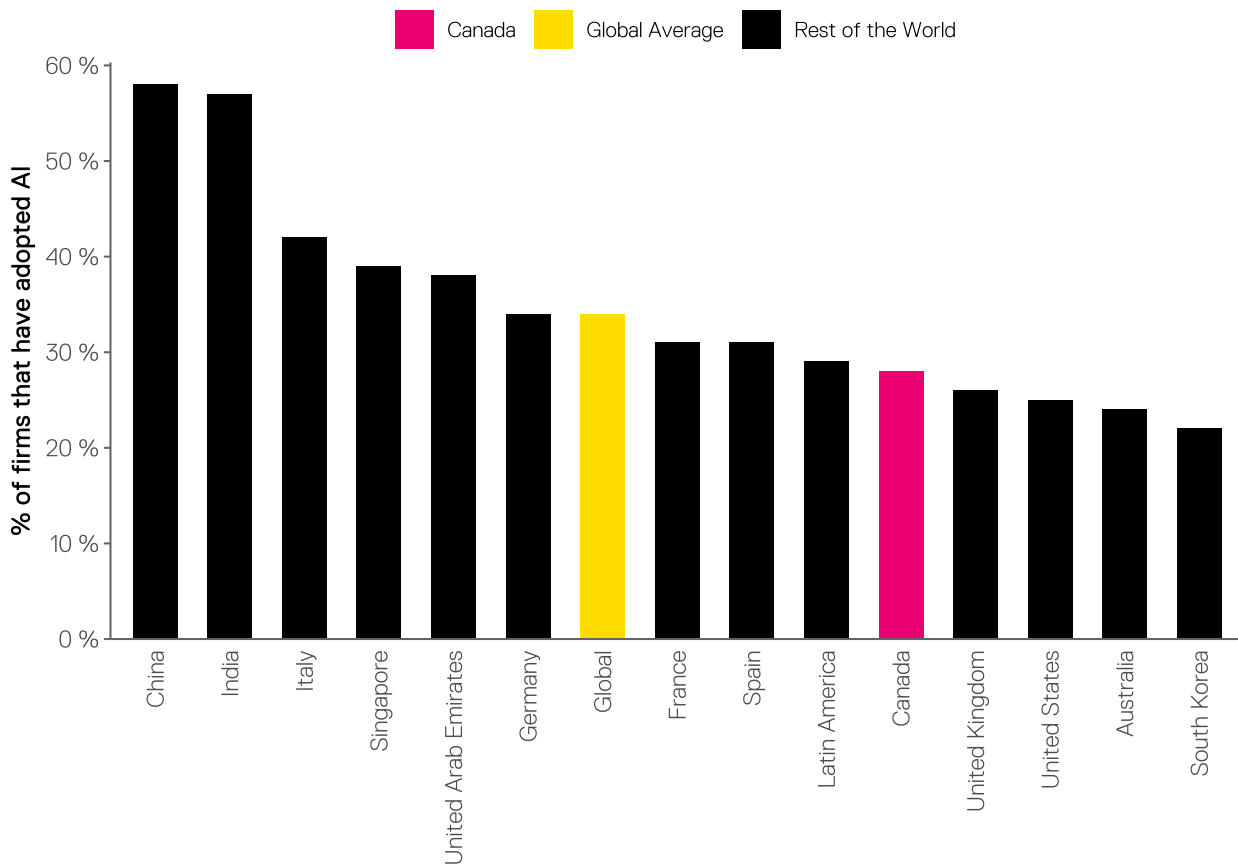
IBM's Global AI Adoption Index puts Canada in a similar position. Although the numbers are significantly higher, Canada ranks tenth of the countries/regions included, six points below the average of all included countries. This discrepancy is likely due to a difference in the types of firms that make up the two surveys.

Given the higher profile of the IBM Index, it is likely that many people within the AI ecosystem are aware of Canada's relative position on AI adoption compared to our global peers, but are unaware of how far behind AI Canada truly lags.

While the SDTIU makes an effort to weight its survey according to the breakdown of businesses in the Canadian economy, IBM's survey is disproportionately composed of large businesses (those with 100 or more employees). The relationship between size and likelihood of having adopted AI will become clear in the next section.

Figure 3

IBM Global AI Adoption Index



Source: IBM

5

Correlates of AI Adoption

Regression Model

That 3.7 percent adoption of AI is not distributed evenly across Canadian firms. We can use a regression model, combined with additional data, to better understand what types of firms have been most successful adopting AI to date. A regression model helps us understand the specific relationship between different factors and AI adoption, while holding the other factors constant. In particular, we start in Model 1 by understanding the impact of fundamental firm characteristics (such as company sector, or age) helps us set a baseline. We then further take into account more specific firm behaviours, including whether they engage in research and development (R&D) activity, or what their Information and Communication Technology (ICT) employee investment looks like in Model 2.

This analysis is meant to capture the unique effect that each of these factors have on the rate of AI adoption. That is, when we're understanding the first model (that only includes firm fundamentals), we can interpret the effect firm age has by imagining a situation where a company gets older without changing anything else (staying at the same size, no change in real compensation and in industry) on how maturity impacts the chance a firm has adopted AI. To do this, we created two models to help understand the relationship between AI adoption and firm characteristics. The first model is adapted from Acemoglu et al (2022, working),²² and models the following:

Model 1:

Firm Adoption = Size + Age + Wages + Industry

This model depicts adoption as a function of the number of employees in a firm, the length of time the business has been operating, the average wages at the firm, and the industry that the firm belongs to (as defined by the North American Industry Classification System - NAICS). We code industries at their most aggregated level, differentiating between the service and goods producing industries. The count of employees in a firm and its years in operation are modelled as percentiles relative to their industry.

These represent fundamental firm characteristics. While they are not immutable, they are difficult to change intentionally over the short term. However, the SDTIU includes additional information related to active business choices we can include to further differentiate firms. The second model expands this as follows:

Model 2:

Firm Adoption = Size + Age + Wages + Industry + ICT Workers + Upskilling for ICT Work + Upskilling for non-ICT Workers + R&D Spending

This model includes some additional, less stable features of Canadian firms. We now include measures for

- the presence or absence of ICT workers
- provision of ICT upskilling to ICT workers
- provision of ICT upskilling for non-IT workers
- firms reporting spending on R&D.

We do not account for the amount of spending on R&D, only the presence or absence of any spending. See Appendix A for full model details.

	Model 1	Model 2
	Dependent variable: % AI Adoption	Dependent variable: % AI Adoption
Goods industry (compared to the services industry)	-1.9%***	-1.6%***
Age (10th to 50th percentile)	-0.05%	-0.1%
Age (50th to 75th percentile)	-0.7%	-0.7%
Age (75th to 90th percentile)	-2.2%***	-1.7%**
Age (90th to 95th percentile)	+0.3%	+0.8%
Age (95th to 99th percentile)	-3.8%***	-4.4%***
Age (99th percentile and above)	-3.8%	-3.0%
Employee Count (50th to 75th percentile)	+4.0%***	+2.5%***
Employee Count (75th to 90th percentile)	+8.5%***	+4.2%***
Employee Count (90th to 95th percentile)	+15.4%***	+9.2%***
Employee Count (95th to 99th percentile)	+24.4%***	+16.4%***
Employee Count (99th percentile and above)	+28.6%***	+21.8%***
Mean Wage (Logged)	+2.5%***	+1.2%***
ICT Workers		+1.8%**
Upskilling for ICT Workers		+16.0%***
Upskilling for non-ICT Workers		+3.1%***
R&D Spending		+6.8%***
Constant (Baseline adoption)	+21.3%***	-9.6%***
Observations	10,355	10,355
R2 (goodness of fit)	0.030	0.075
Adjusted R2	0.029	0.074

Note: *p<0.1; **p<0.05; ***p<0.01

Table 1. Results of the regression models described above. Values show how much more or less likely a firm is to have adopted AI if they have each characteristic.

The results of these models are discussed below, along with the direct relationships between adoption and other firm characteristics. While this analysis does not show any causal relationships, it does provide a picture of Canada's leading adopters so far.

Firm Size

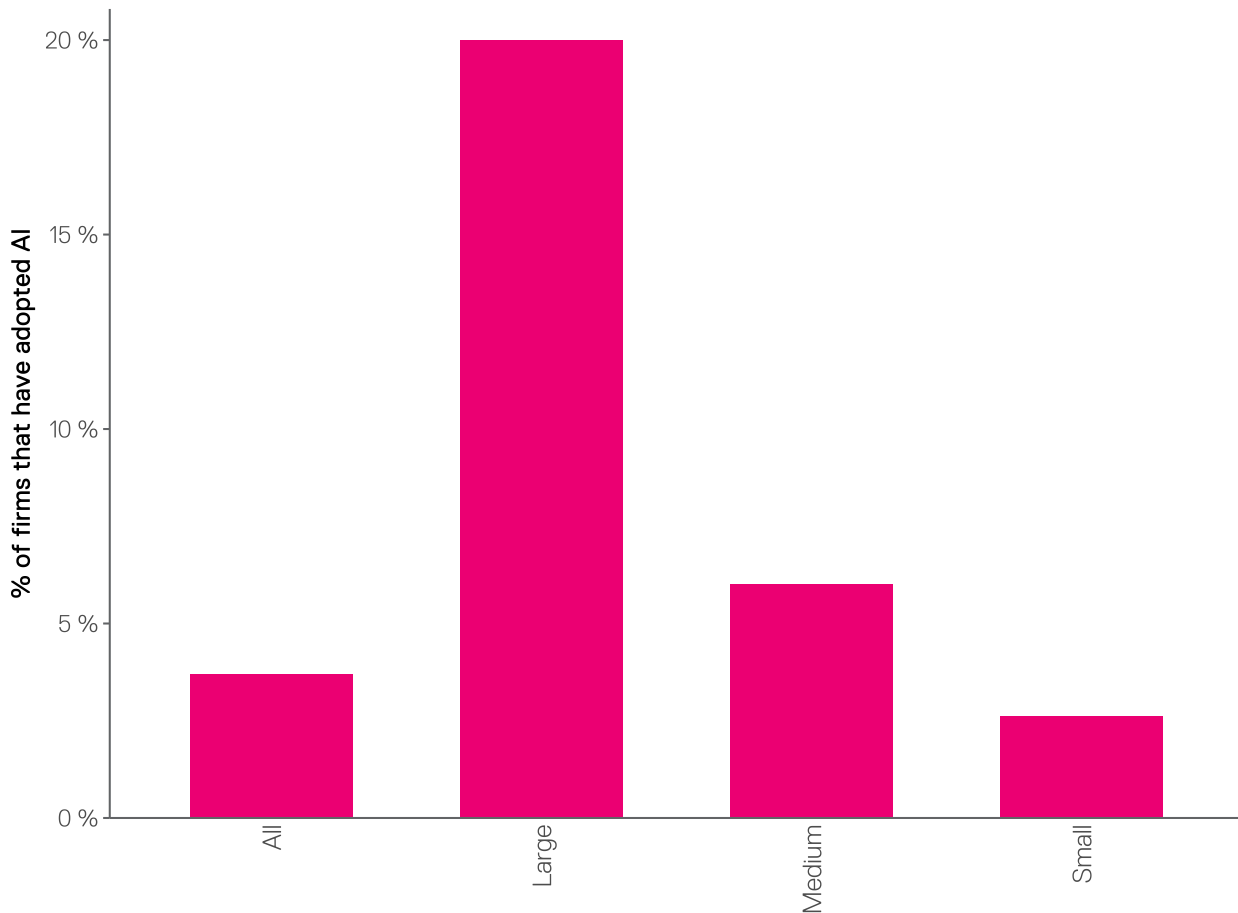
Firm size has a strong correlation with AI adoption rates. Larger firms are far more likely to have adopted AI in some capacity. While only three percent of the smallest firms with between 5 and 19 employees have adopted AI, 20 percent of firms with 100 or more employees have already started to use this technology.



Larger firms are far more likely to have adopted AI in some capacity.

Figure 4


AI Adoption by Firm Size



Source: Survey of Digital Technology and Internet Usage

Size is similarly related to AI adoption in both regression models presented above. The very largest of firms are far more likely to have adopted AI than their smaller counterparts, and this remains true holding other factors consistent.

However, this also means that the overall estimate of 3.7 percent understates the total share of *workers* at a firm that has adopted AI.



Firm Size	Employment in 2022	Estimated Firm AI Adoption Rate	Estimated Employees Exposed to AI in the Workplace <i>(employment times adoption rate)</i>
Small (4 to 19 employees)	2,232,885	2.6%	58,055
Medium (20 to 99 employees)	3,326,316	6.0%	199,579
Large (100 or more employees)	10,529,495	20.0%	2,105,899

Table 2. Estimates of the number of Canadians working at a firm that has adopted artificial intelligence.

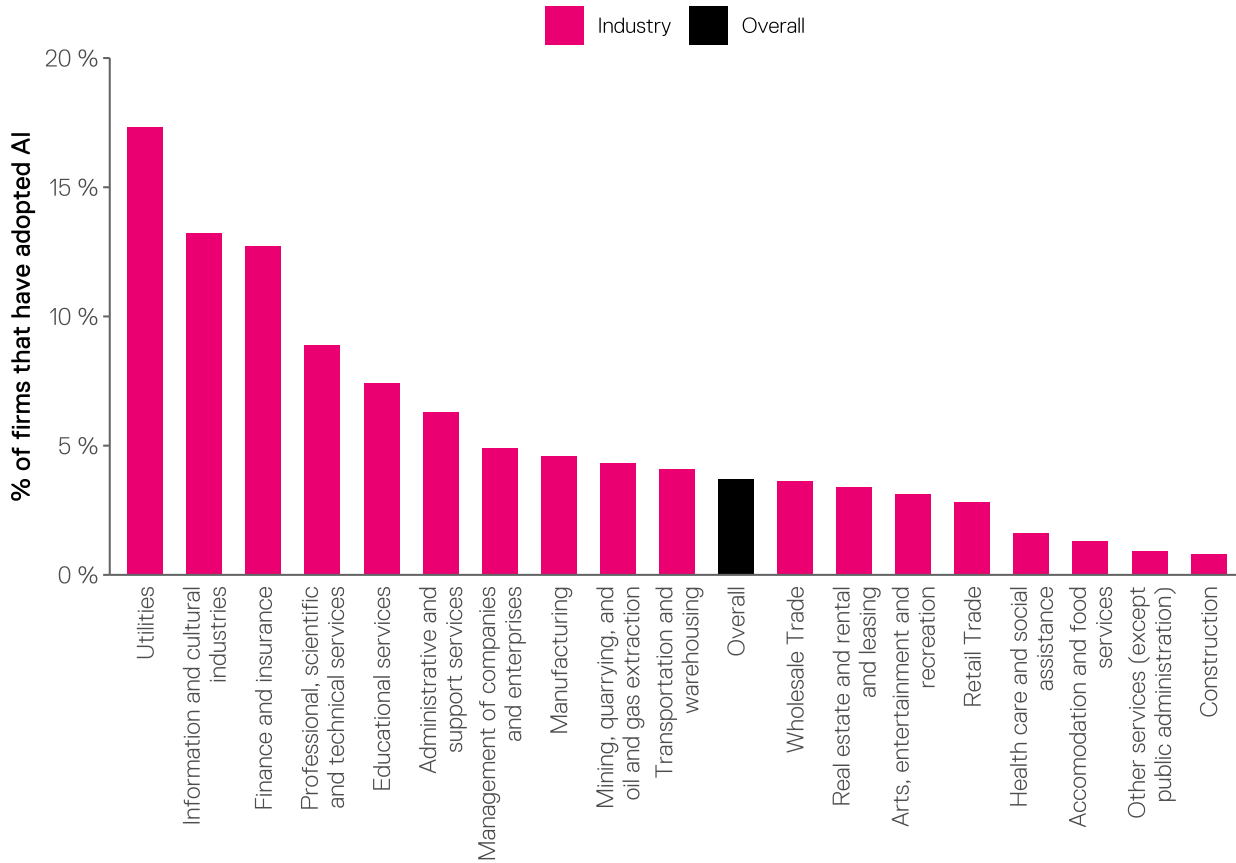
This analysis shows an even larger disparity where workers in Canada are experiencing AI in the workplace. Less than 60,000 workers in small businesses are working with AI, compared to more than two million in large firms exposed to AI at work.

Larger firms have inherent advantages when it comes to AI adoption in the form of access to capital, existing skills, and data infrastructure. These represent important challenges to be addressed before AI is adopted at a firm. Scaling the size of a

firm makes the upfront capital cost of adopting AI easier to bear, increases the likelihood a firm will have dedicated ICT workers with the skills to incorporate AI into practice, and increases the amount of data a firm will have to feed into newly implemented AI algorithms. Additionally, the benefits of AI scale more with firm size—marginal gains on productivity for individual workers are more important in firms with more workers, although many adoption costs will be fixed regardless of firm size.

Industry

Figure 5
AI Adoption by Industry



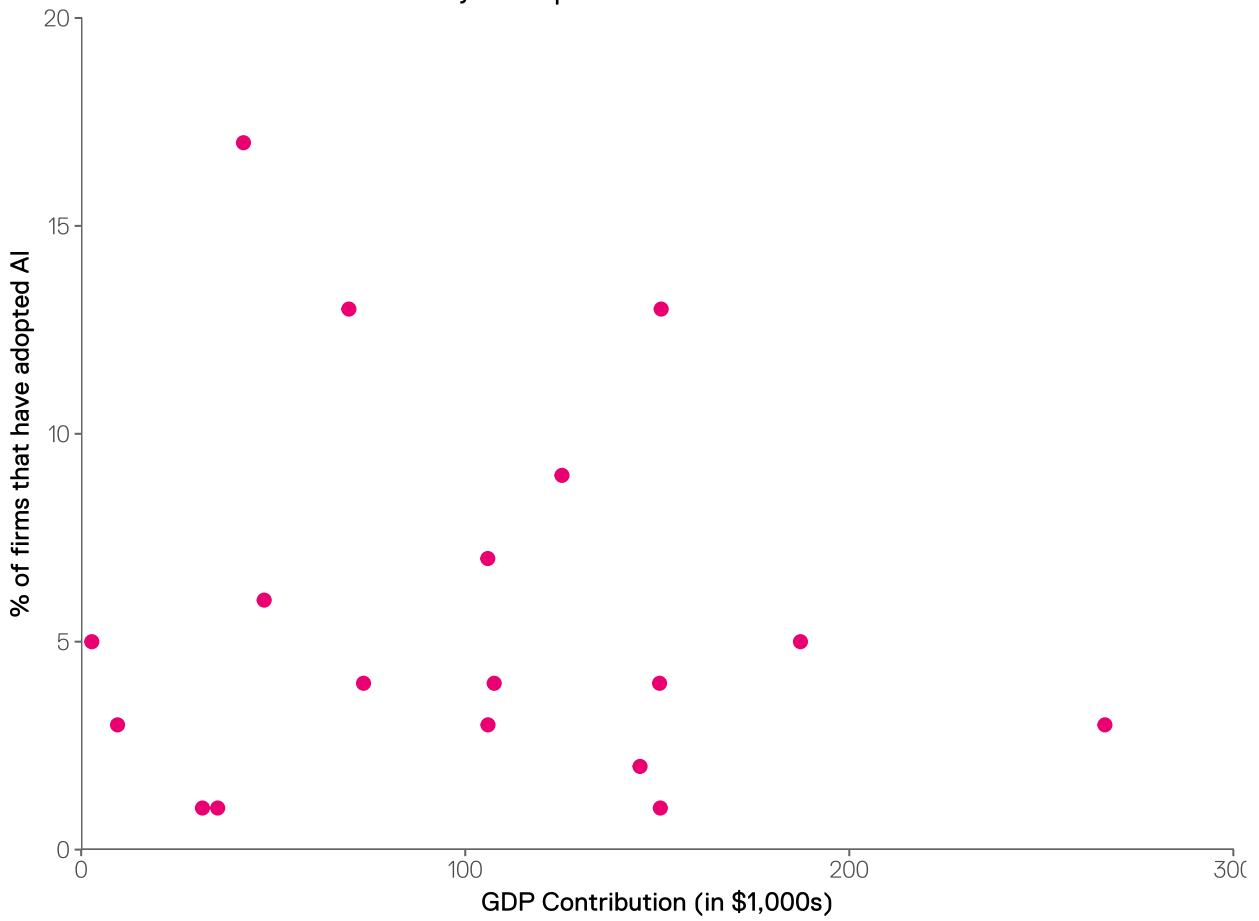
Source: Survey of Digital Technology and Internet Usage

It is clear that companies in some industries have had more success introducing AI into their business practices than companies in other industries. The fastest adopting industries—utilities, information and cultural industries, and finance and insurance—are more than 10 times more likely to have adopted AI than industries that are adopting AI more slowly (such as construction or industries included in other services).

So far, these differences have been the natural fallout of untargeted AI adoption--Canada has yet to adopt any industry-based strategies that would benefit one sector over another. The result of this is that adoption has not been concentrated in areas that have the biggest economic impact. Rather, some of the most important industries in terms of economic contributions or employment have actually been relatively weak in terms of adoption.

Figure 6A

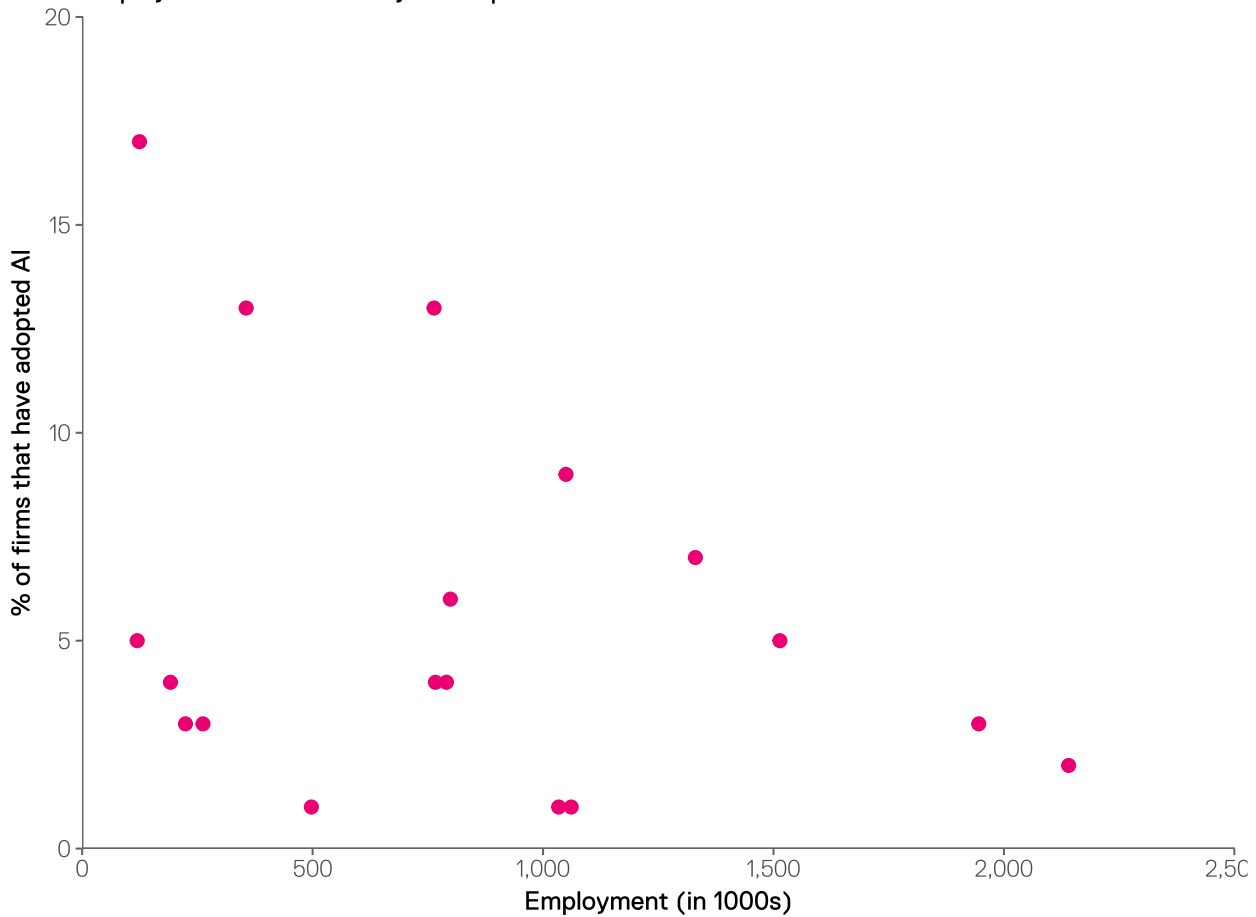
GDP Contribution of Industries by AI Adoption



Source: Survey of Digital Technology and Internet Usage

Figure 6B

Employment in Industries by AI Adoption



Source: Survey of Digital Technology and Internet Usage

The largest contributing industry to Canada’s GDP—real estate—is also one of the weaker industries in terms of AI adoption at only 3.4 percent. Manufacturing, the next largest contributor to GDP is actually above the national average at 4.6 percent adoption, but still far below the leading industries.

Similarly, the largest private-sector employers—health care and social assistance, and retail trade—are also at the lower end of industry adoption at 1.6 percent and 2.8 percent adoption respectively.

Firm Age

The relationship between how long firms have been in business and adoption of AI is less clear. Both models show that firms in the ninety-fifth to ninety-ninth percentile of age for their industry are about four percent less likely than the youngest firms to have adopted AI. However, the oldest firms (in the ninety-ninth and hundredth percentiles) are not significantly less likely to have adopted AI than young firms. Similarly, firms in the ninetieth to ninety-fifth percentiles are also no less likely to have adopted AI. This shows no consistent pattern between the age of a firm and its adoption of AI.

Wages

Both models confirm that there is a significant positive correlation between firms that pay higher wages and likelihood of adopting AI. This is consistent with the needs of a firm to adopt AI. The skills required to implement AI in a firm are in high demand, and so the cost of a worker with those skills will also be high. Model 2 specifically shows that even when the presence of ICT specialists is at the same level, firms that pay higher wages are more likely to have already adopted AI.

R&D Spending

Model 2 also reveals the relationship between R&D spending and AI adoption. Some existing literature uses AI patents and R&D as proxies for AI adoption within a country²³ and this confirms there is a positive relationship at the firm level.

In this case, we find that firms that report any spending on R&D are nearly seven percent more likely to have adopted AI than similar firms with no R&D spending.

ICT Skills

The SDTIU includes a series of questions on the ICT skills of their workforce. This notes the presence of dedicated ICT workers, as well as upskilling for both ICT and non-ICT workers. Results of the regression analysis suggest that there is a significant correlation between all three of these and the pace of AI adoption.

The impact of employing any workers in ICT-specific roles is relatively low. Firms that have ICT workers are 1.8 percent more likely to have already adopted AI. These firms are making significant ongoing investments in their ICT capacity through these workers' salaries. However, among these firms the ones that have continued to actively invest in the skills of their own ICT workers are 16 percent more likely to have adopted AI technology. Firms that actively invest in updating their ICT workers' skills have had more success in adopting AI so far.

Beyond this, there is additionally a positive relationship between investments in the ICT skills of non-ICT workers and adoption of artificial intelligence. Firms that make those investments, regardless of whether or not they have dedicated ICT specialists, are three percent more likely to have adopted artificial intelligence.

Taken together, firms that are actively working to make sure their employees have up-to-date ICT-related skills have been far more successful than their peers at keeping pace with AI adoption.



We find that firms that report any spending on R&D are nearly seven percent more likely to have adopted AI than similar firms with no R&D spending.

Business Ownership

In addition to the differences between firms that adopted artificial intelligence, there are also differences between the characteristics of business owners that adopted AI technology. Specifically, we can look at whether current adoption trends are benefitting or leaving behind businesses that are majority owned by different equity-seeking groups.

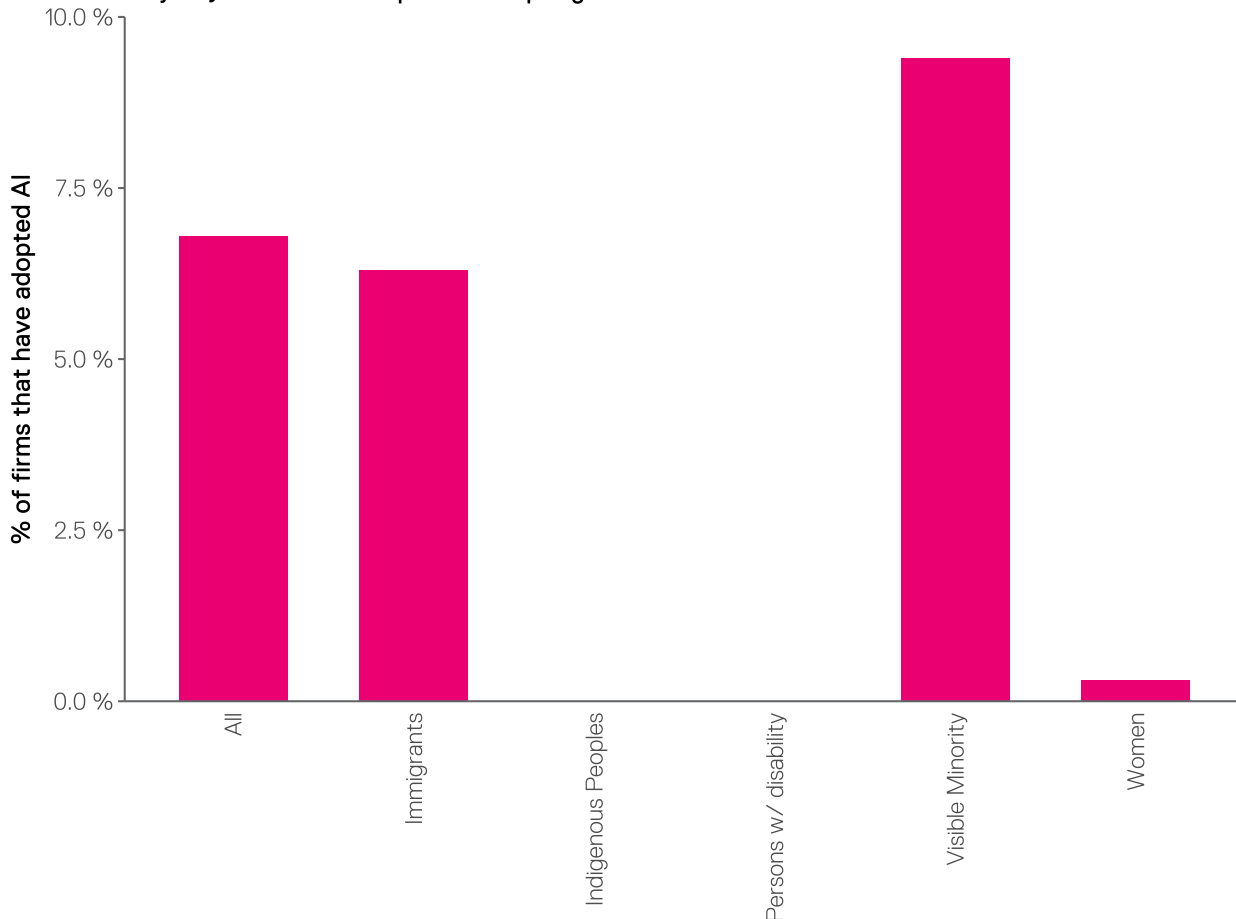
These results are drawn from the Canadian Survey on Business Conditions, a separate survey run by Statistics Canada every quarter. These specific questions on the use of AI were included in the first quarter of 2021.

Figure 7 shows that overall, businesses that are majority-owned by immigrants and those majority-owned by members of visible minorities are at minimum in line with overall AI adoption, with visible minority-owned businesses being more likely than others to have adopted artificial intelligence.

That said, some equity-seeking groups have been left behind to date in AI adoption. Less than one percent of all women-owned businesses have adopted artificial intelligence and among those surveyed, not a single business owned by Indigenous peoples or people living with a disability reported adopting AI technology in any way.

Figure 7

Majority Firm Ownership of AI Adopting Firms



Source: Canadian Survey of Business Conditions



Less than one percent of all women-owned businesses have adopted artificial intelligence and among those surveyed, not a single business owned by Indigenous peoples or people living with a disability reported adopting AI technology in any way.

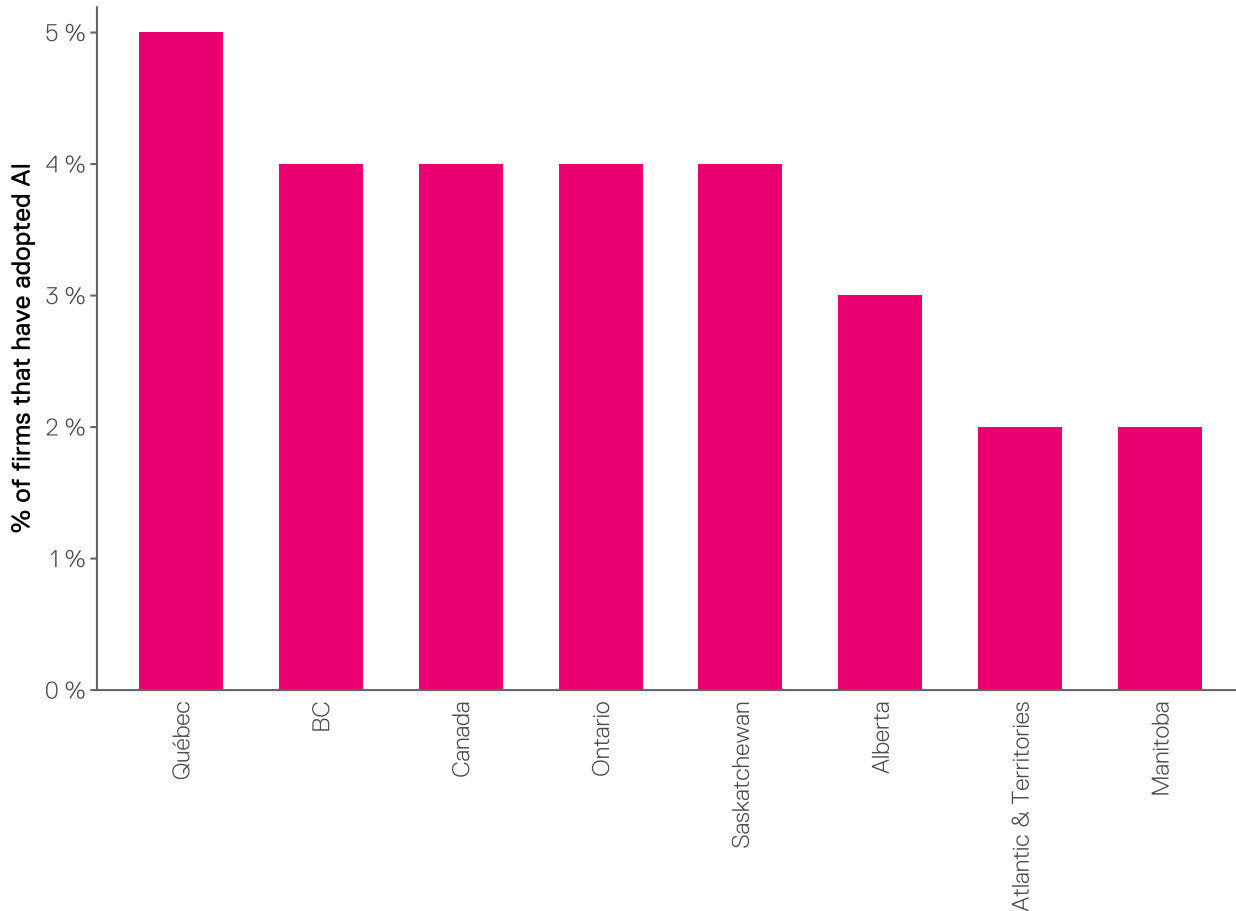
These owner characteristics are correlated to other factors described above. For example, looking only at small and medium enterprises (SMEs), 12.9 percent of all businesses with 5 to 19 employees are owned 100 percent by women while only 5.2 percent of businesses with 100 to 499 employees are owned entirely by women.²⁴ If systemic barriers exist that make it more difficult for SMEs to adopt AI, that will have a disproportionate impact on women-owned businesses.

Similarly, 1.1 percent of those businesses with 5 to 19 employees are majority owned by Indigenous peoples, while only 0.7 percent of businesses with 100 to 499 employees are majority owned by Indigenous peoples. This makes it harder to know if there are distinct barriers these businesses are facing, or if they are part of the broader trend of small firms falling behind. However, regardless of the cause, the end result is that firms owned by equity-seeking groups are not getting the same benefit from artificial intelligence as other firms in Canada.

Regions

Figure 8

AI Adoption by Region



Source: Survey of Digital Technology and Internet Usage

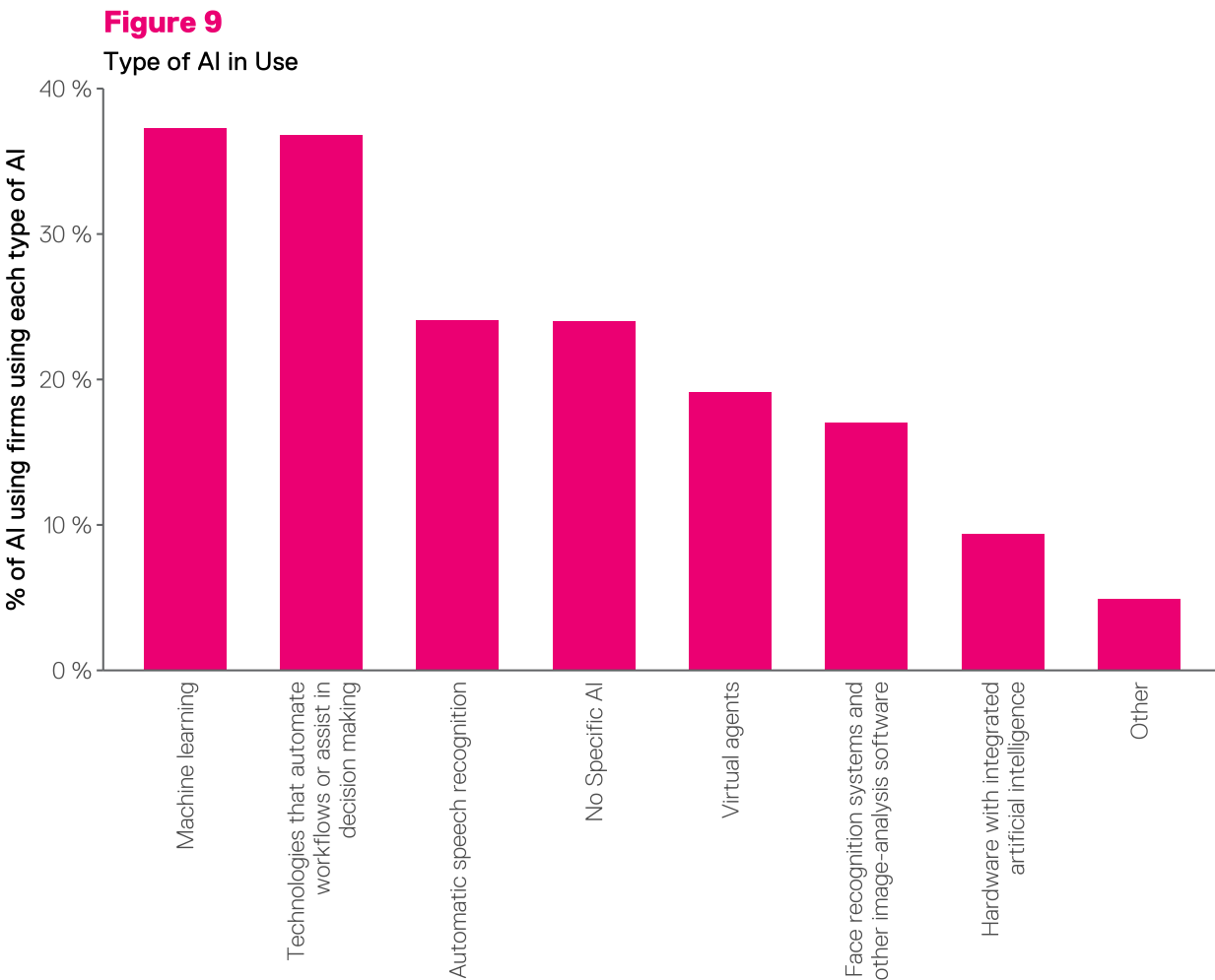
Looking at the differences in AI adoption across Canada, we can see adoption is highest in Québec with five percent of firms reporting adoption of AI, while British Columbia, Ontario, and Saskatchewan all follow at four percent. Alberta is below the national average at only three percent and Manitoba along with Atlantic Canada/the Territories only have two percent of firms adopting AI.

The strength in Québec is likely due to a strong local ecosystem and significant local efforts that have gone into promoting AI adoption through the work of organizations like Mila or Forum IA Québec.

6

How Are Companies Putting AI to Work?

While only a small share of Canadian firms have already adopted AI, those adopters are using a variety of tools for a wide range of tasks.



Source: Survey of Digital Technology and Internet Usage

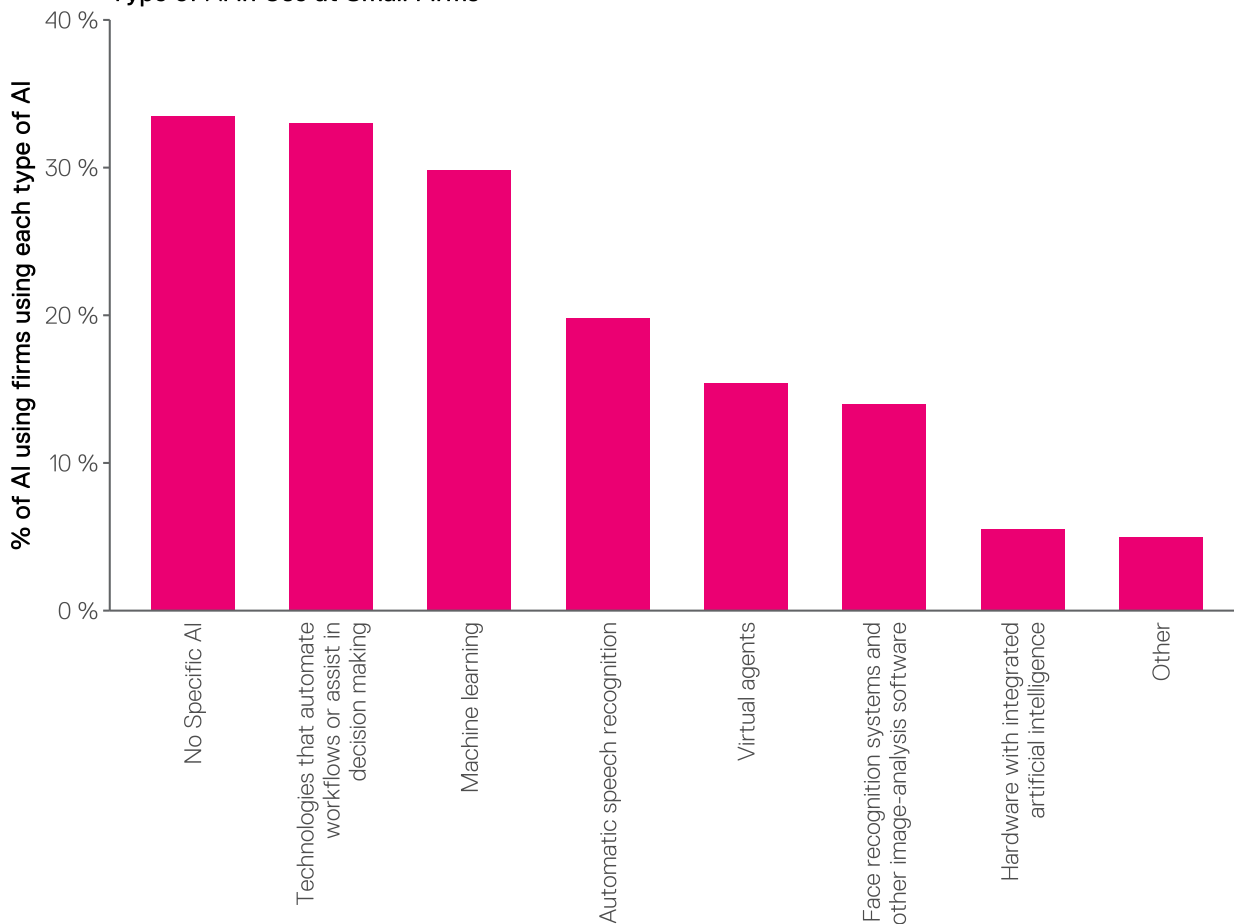
When asked about the AI tools they are using, most firms reported using AI for machine learning and to automate workflows or assist with decision management. Machine learning is a large category of technologies that in some cases is large enough to be considered its own category separate from artificial intelligence.

About a quarter of AI adopters (24 percent) said they don't know what specific technologies they use in their firm. While it's possible that the person answering the survey genuinely was unsure what

tools were in use, it is equally possible that those firms have not actually fully incorporated any specific AI tool into their business and have only just started testing out potential AI tools.

Firms reported AI-integrated hardware (for instance AI integrated into production lines) is the least common applied tool, reflecting the specialty nature of such tools. Many industries in Canada have limited need for specific hardware solutions, particularly service-providing industries.

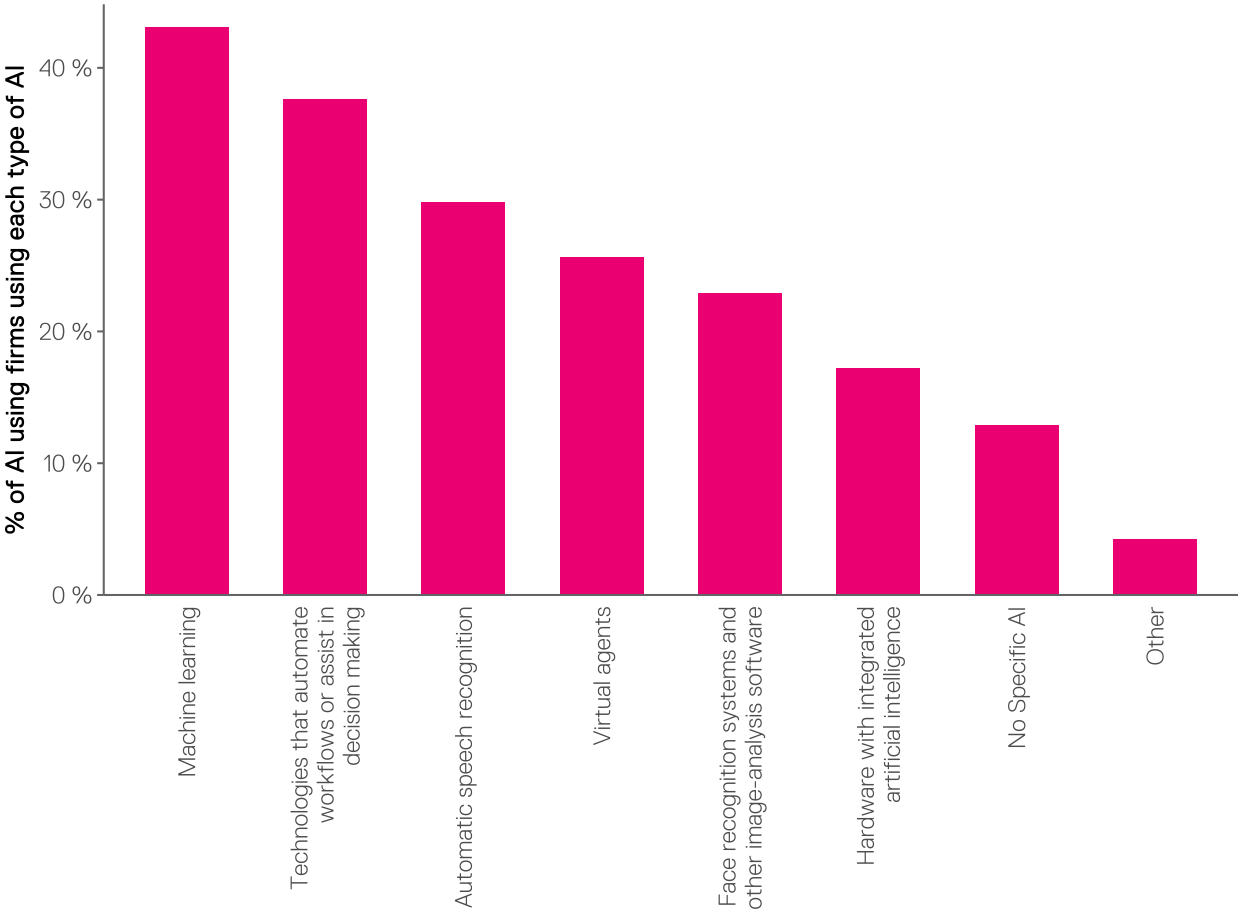
Figure 10
Type of AI in Use at Small Firms



Source: Survey of Digital Technology and Internet Usage

Figure 11

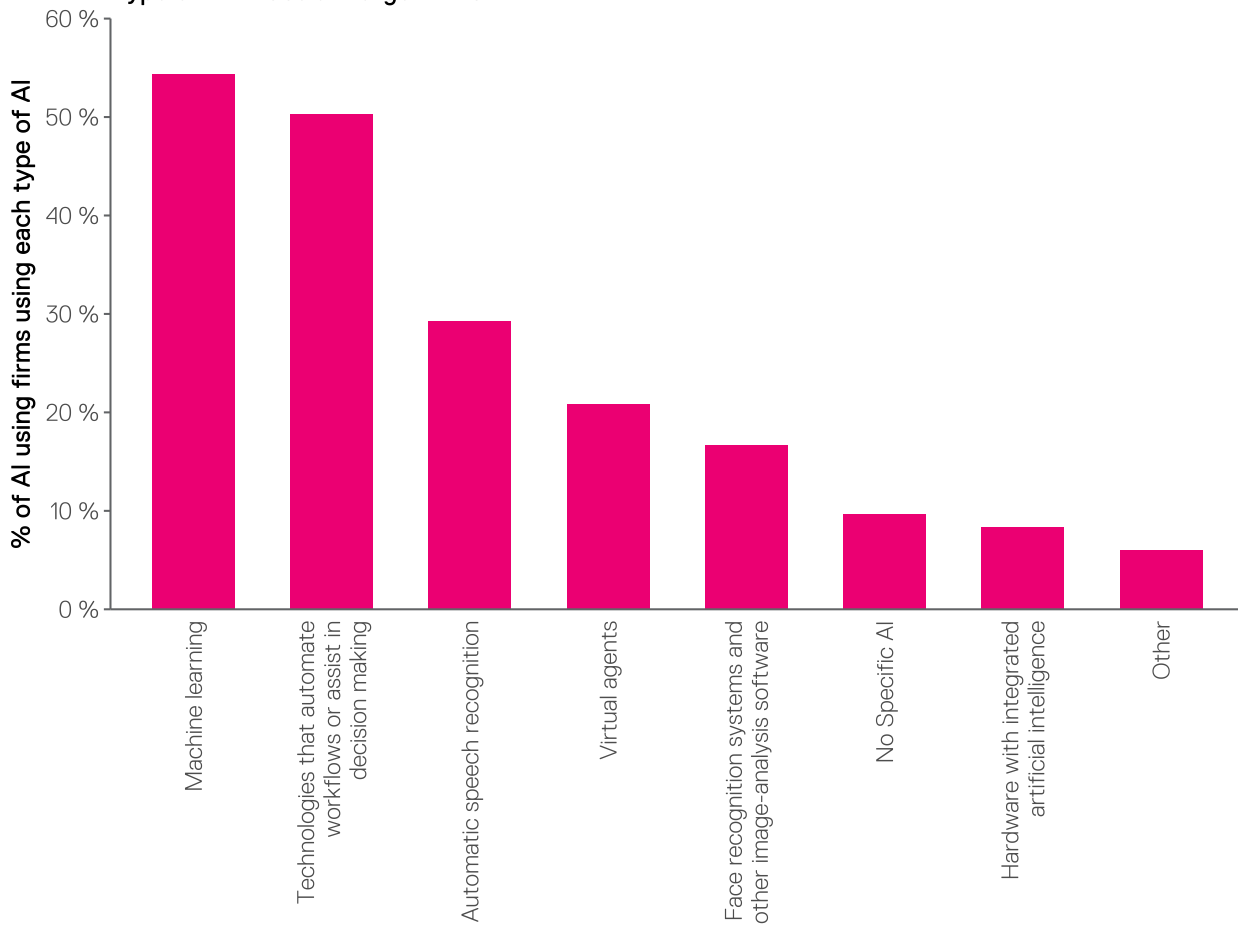
Type of AI in Use at Medium Firms



Source: Survey of Digital Technology and Internet Usage

Figure 12

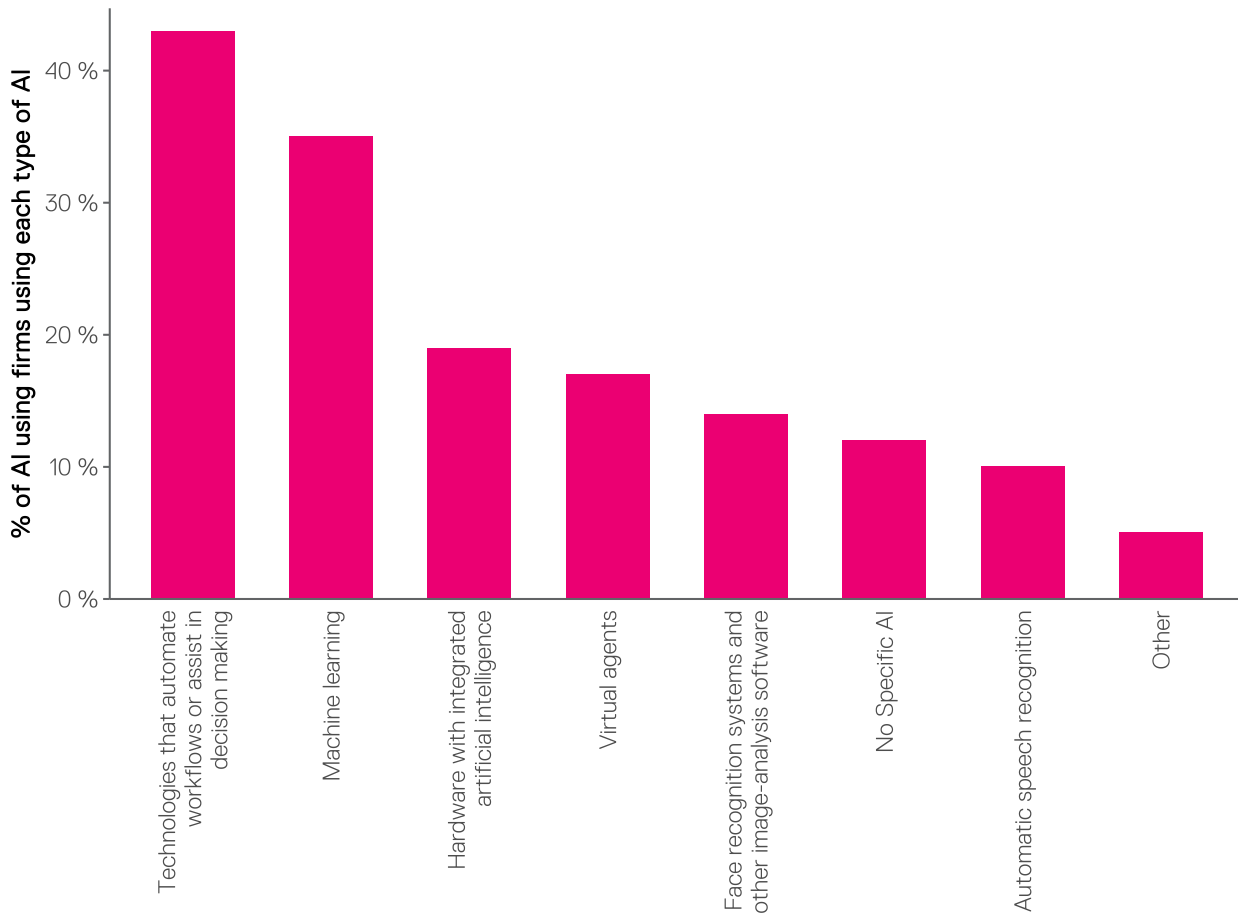
Type of AI in Use at Large Firms



Source: Survey of Digital Technology and Internet Usage

Figure 13

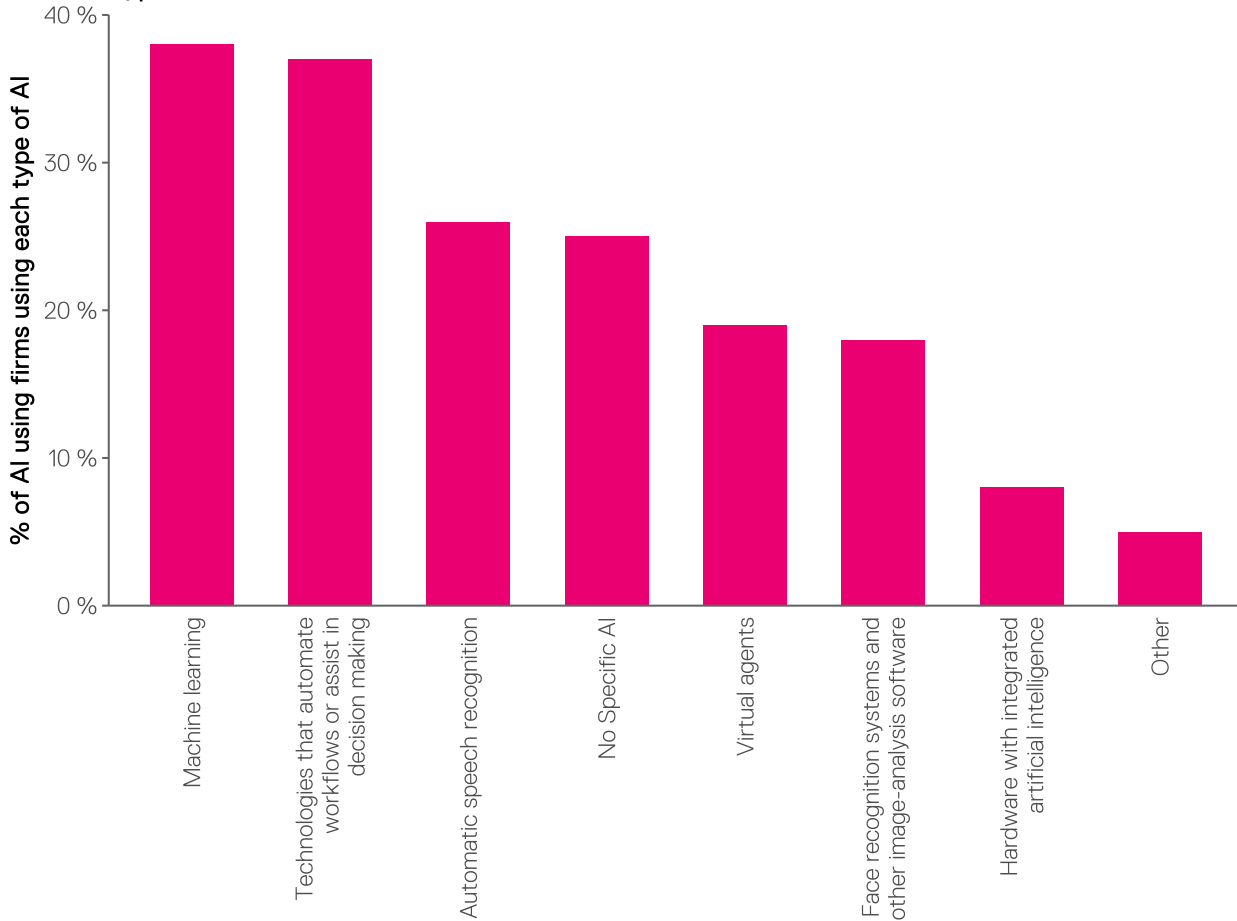
Type of AI in Use in the Goods Sector



Source: Survey of Digital Technology and Internet Usage

Figure 14

Type of AI in Use in the Services Sector



Source: Survey of Digital Technology and Internet Usage

In discussing types of AI being used, there are large differences across industries. While both goods-producing and service-providing industries are relatively likely to be using machine learning, the service industry is far more likely to be using virtual agents and speech recognition systems. Comparatively, the goods industry is more likely to be using decision management systems (although more than a third of firms in the service industry also

use it for the same purpose). These tools are most useful for consumer-facing firms who can use them to augment their call centres and existing customer support systems.

Another way to look at AI adopters is in terms of where they are using artificial intelligence within their businesses.

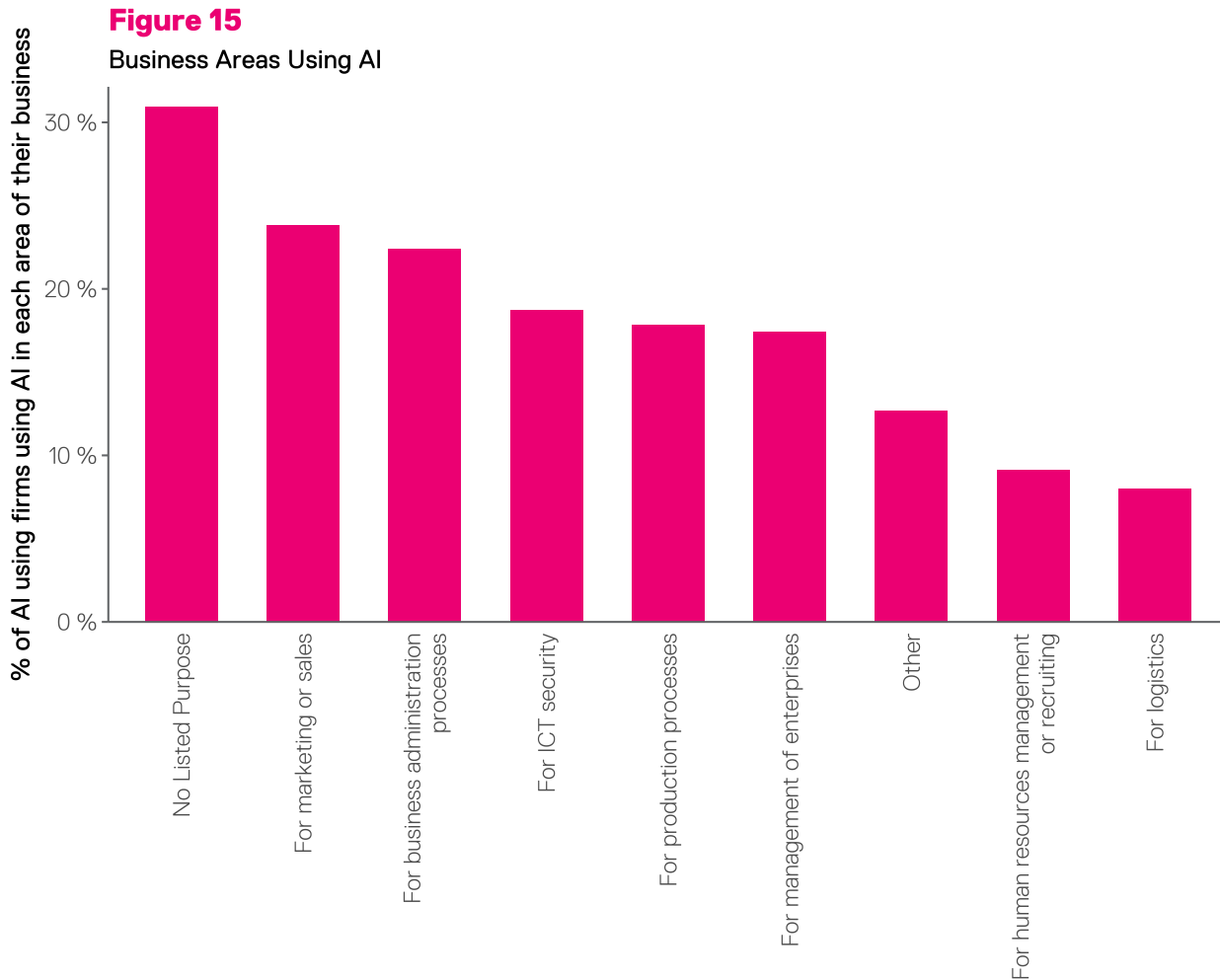
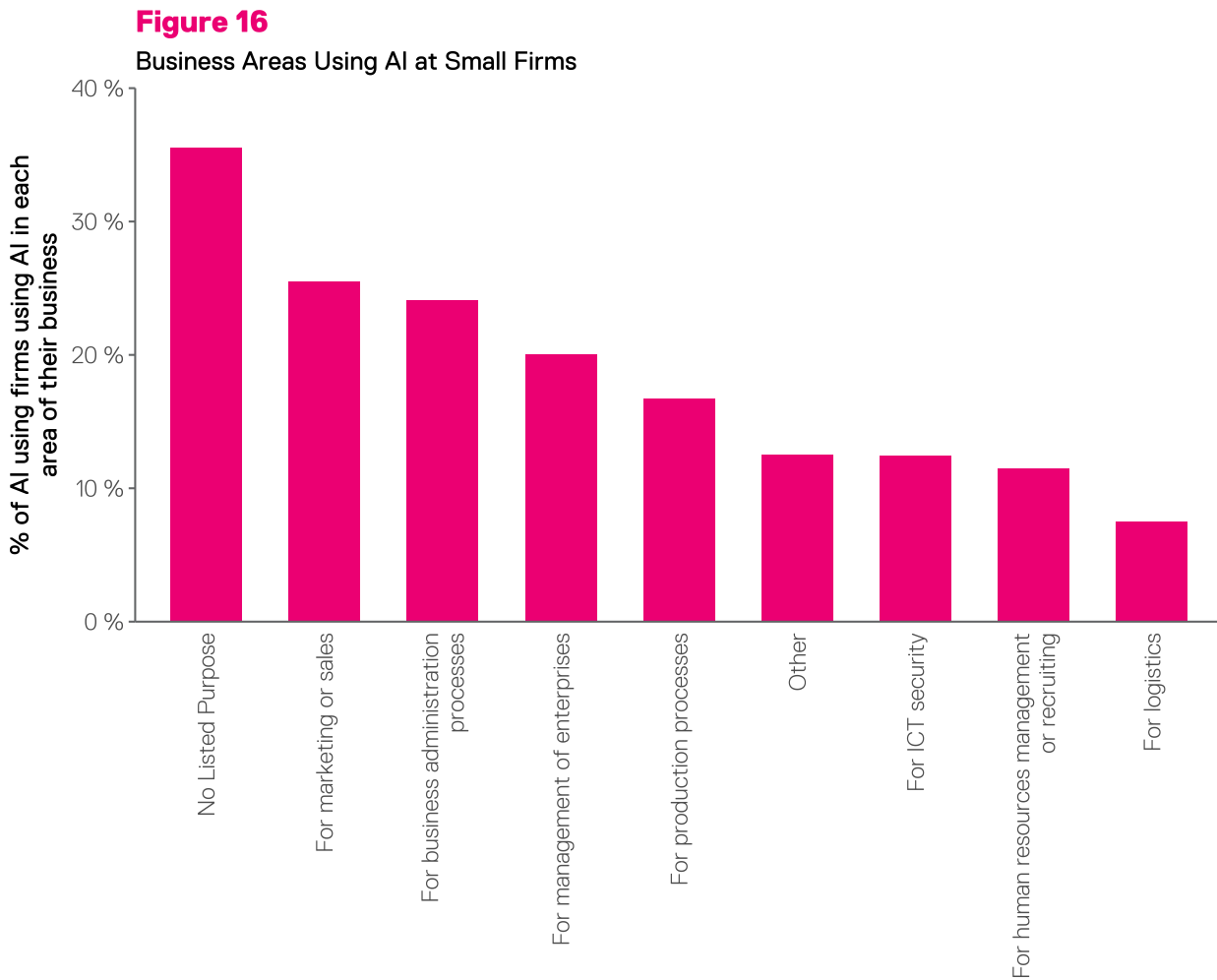


Figure 15 shows that marketing and sales as well as business administration processes are the two most common areas of AI adoption. But again, there are clear differences in where AI is being used depending on the industry adopting it. For firms in goods-producing industries, the technology is being used predominantly for production and ICT security. While service-providing industries are also using AI for ICT security, they are far less likely to be using it in any production capacity and rather use it for sales, business administration, and enterprise solutions.

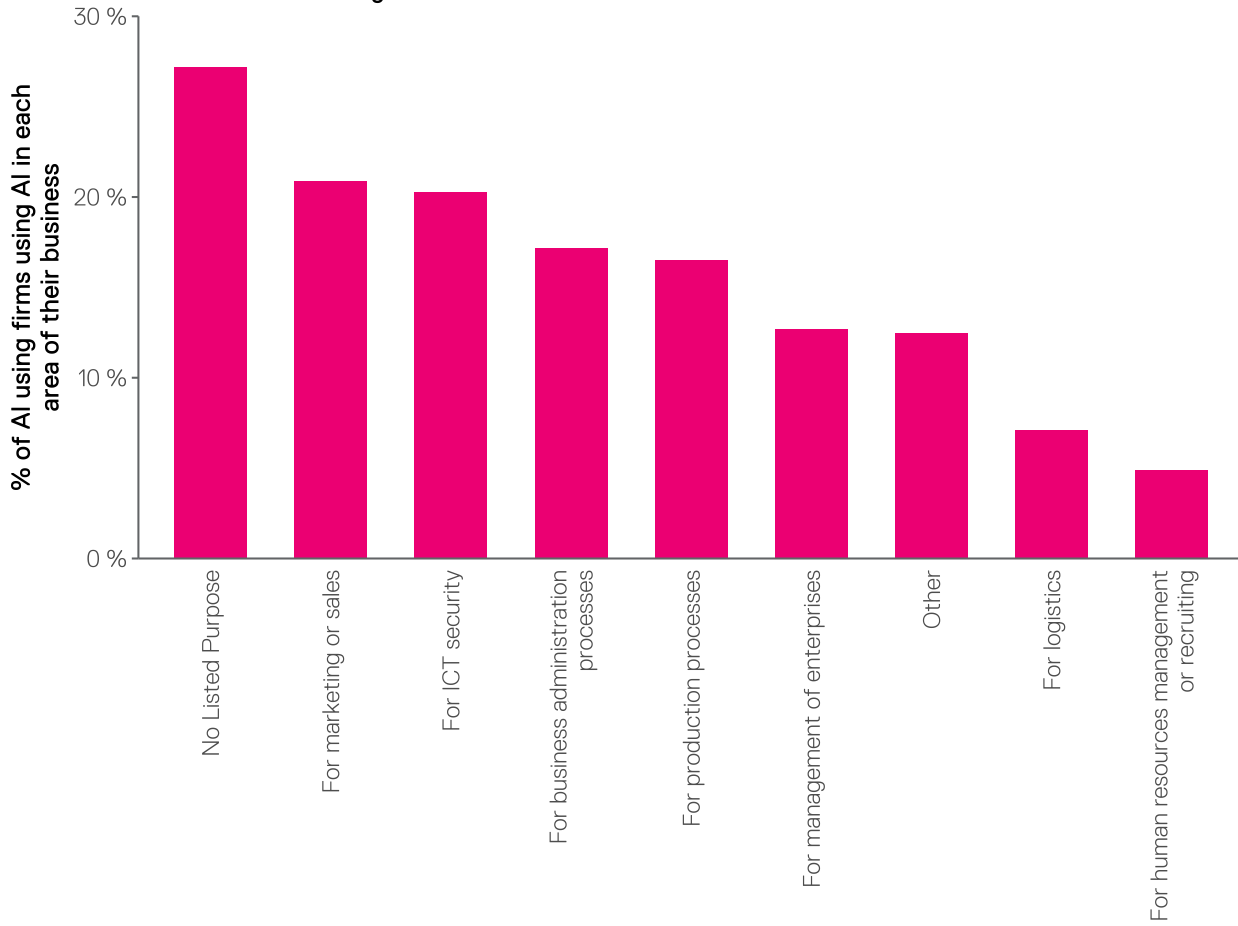
Similar to the previous question, when it comes to the purpose of AI we see an even larger portion of firms indicating they aren't using AI in a specific part of their business (30.9 percent). This further suggests that while 3.7 percent of businesses might have started to use AI in their professional environment, the true share of businesses using AI as part of their real operations is likely lower, potentially as low as three percent.



Source: Survey of Digital Technology and Internet Usage



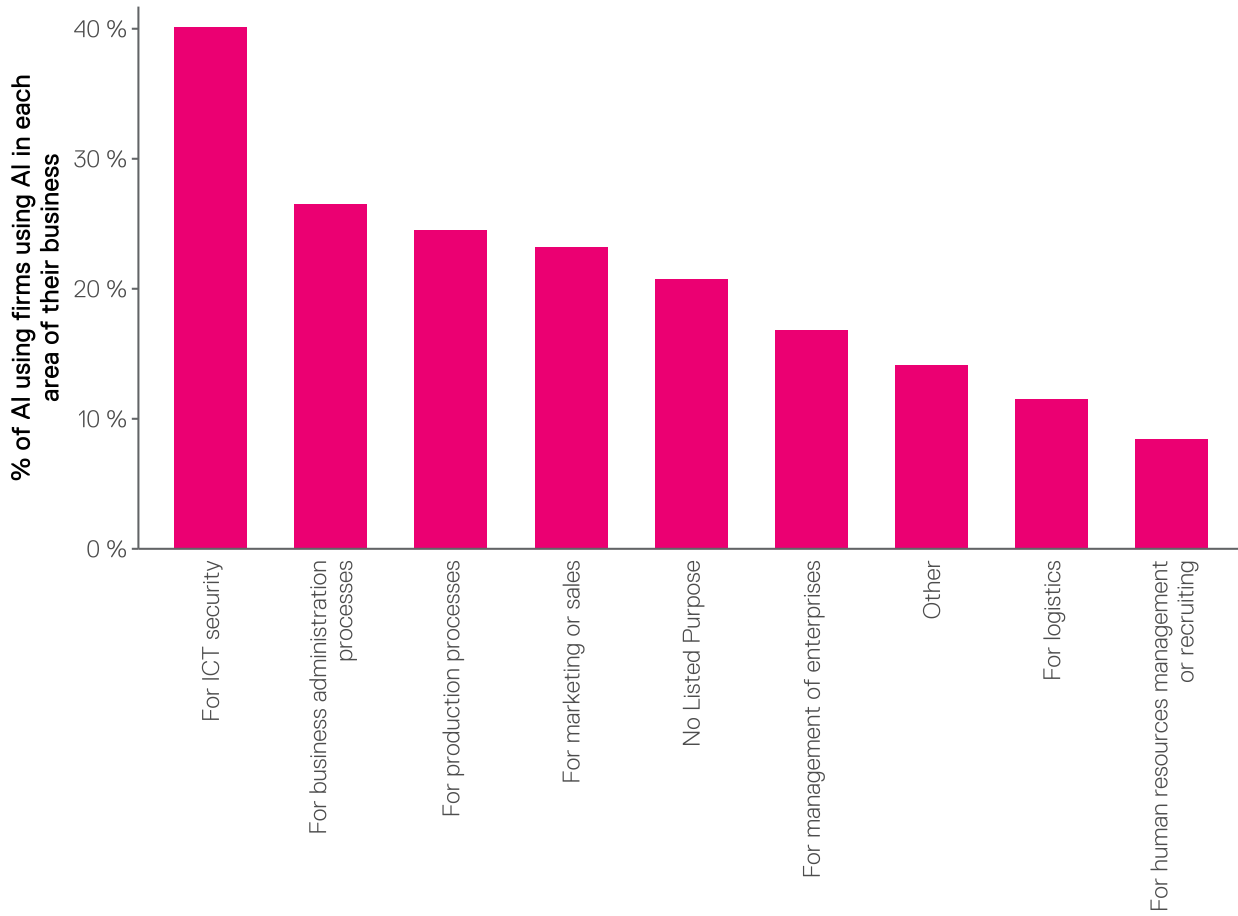
Figure 17
Business Areas Using AI at Medium Firms



Source: Survey of Digital Technology and Internet Usage



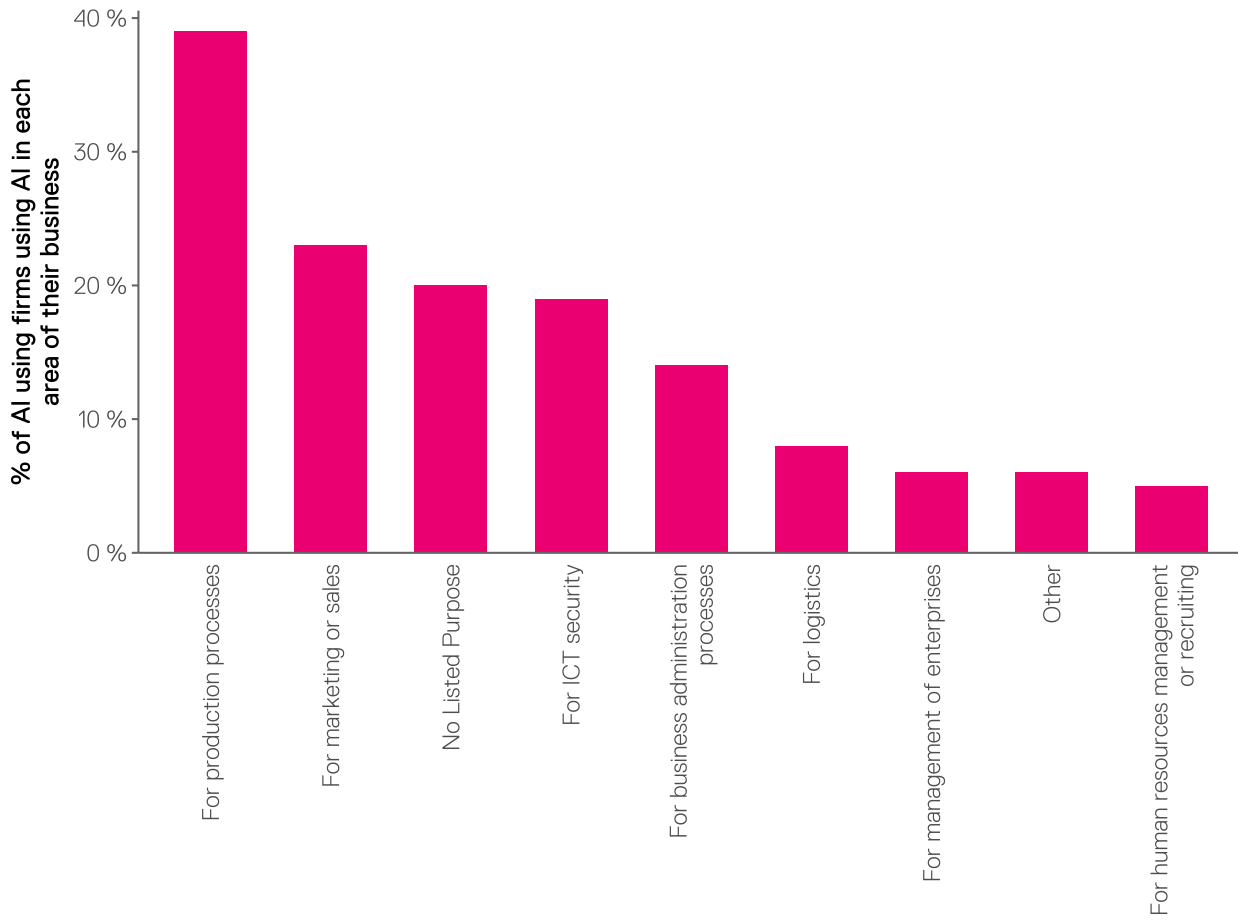
Figure 18
Business Areas Using AI at Large Firms



Source: Survey of Digital Technology and Internet Usage



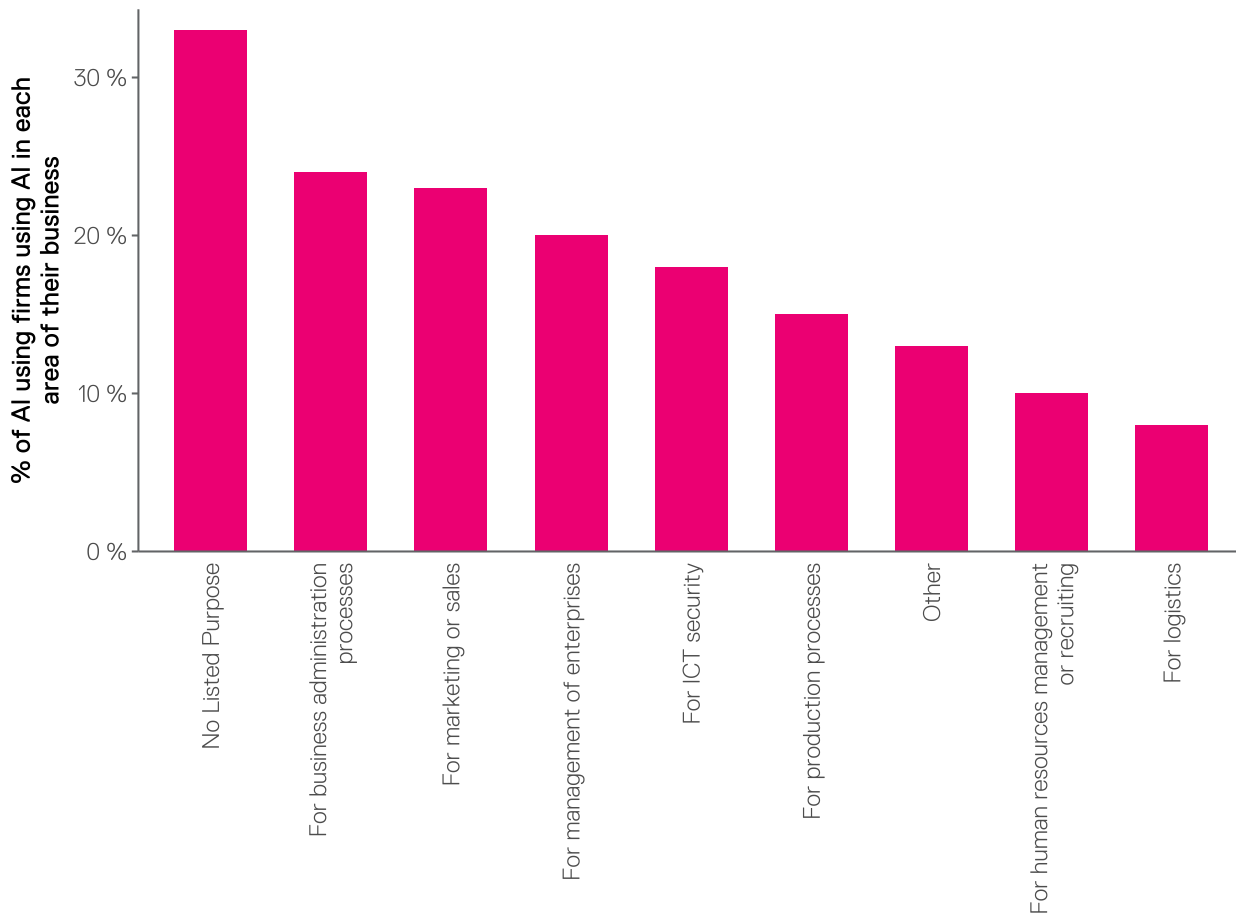
Figure 19
Business Areas Using AI in the Goods Sector



Source: Survey of Digital Technology and Internet Usage

Figure 20

Business Areas Using AI in the Services Sector



Source: Survey of Digital Technology and Internet Usage

We can see this in practice when looking at the differences in the use of these technologies across different industries. As noted above, goods-producing industries are far more likely to be using AI in production relative to service industries.

On the other side, service-providing industries are far more likely to be using AI for sales, business administration processes, and management of enterprises. The difference across these industries

is in line with the business functions that are most important to them. Goods producers are naturally more focused on improving the efficiency of their production processes while service providers naturally focus more on sales.

This highlights the important differences across the AI marketplace. Across industries in Canada, the leading adopters have identified very different use cases for AI from each other.

ICT Security

The only case where there is a significant difference in where AI is being used across businesses of different sizes is ICT security. Among the largest businesses, 40 percent use artificial intelligence in some way to support their operations in this area. Comparatively, only 12 percent of small businesses use the tool to support ICT security efforts. Factoring in the additional difference in overall AI adoption, large firms are close to 20 times more likely to be using AI for security purposes than small businesses.

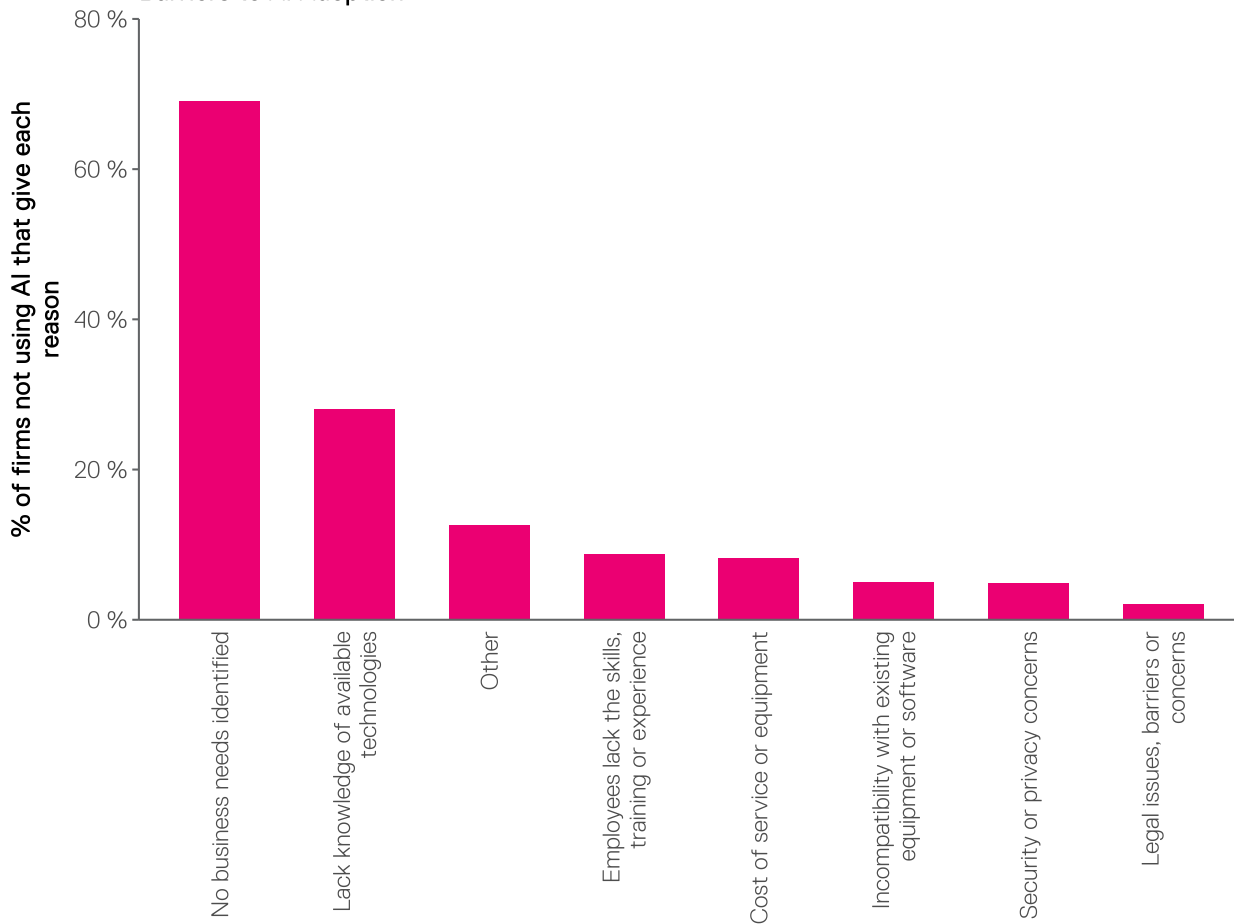
This difference is significant because while small businesses are not keeping pace with technological advancements, bad actors could increasingly exploit this gap, putting smaller firms at risk of increased cyber attacks. While so far cyber attacks have been disproportionately targeted at larger firms, as they become more commonplace it is likely that smaller firms will face growing risk as well.²⁵ It's important for Canada to ensure that we are not leaving our SMEs at a greater risk of attack by ignoring their security needs and leaving them behind on AI adoption.



Barriers to Adoption

While some firms have started to use AI, a large majority of Canadian enterprises have yet to implement the technology.

Figure 21
Barriers to AI Adoption



Source: Survey of Digital Technology and Internet Usage

According to the SDTIU, the largest struggle for firms is being able to identify a business case for any AI technologies. More than two-thirds of businesses that haven't adopted AI yet (69 percent) say that they have not identified a business need for it. This includes a mix of firms that have not yet considered artificial intelligence, and those that have but could not make the business case. The next highest answer is similar—28 percent of non-adopters say that they don't know what AI tools are available. This is in line with findings in a report from Scale AI, which suggested only five percent of executives in Canada believe AI is critically important now and only 27 percent believe it will be critically important to them in the next two years.²⁶

Both of these responses are representative of groups that are not actively in the AI marketplace. They aren't engaged with the options available to them, either from a lack of knowledge or a lack of desire to pick up AI internally. Collectively, businesses agreeing with either of these responses represent the majority of firms in Canada, making this the most important factor behind lack of AI adoption.

However, these are not the only reasons firms provided. Looking at firms that might already be in the AI marketplace, the leading reasons firms say they have yet to adopt AI are the cost of technologies and the skills gaps in their workforces. These are both more commonly discussed as barriers when governments look to promote AI adoption, and are likely the easiest group to convert into adopters.

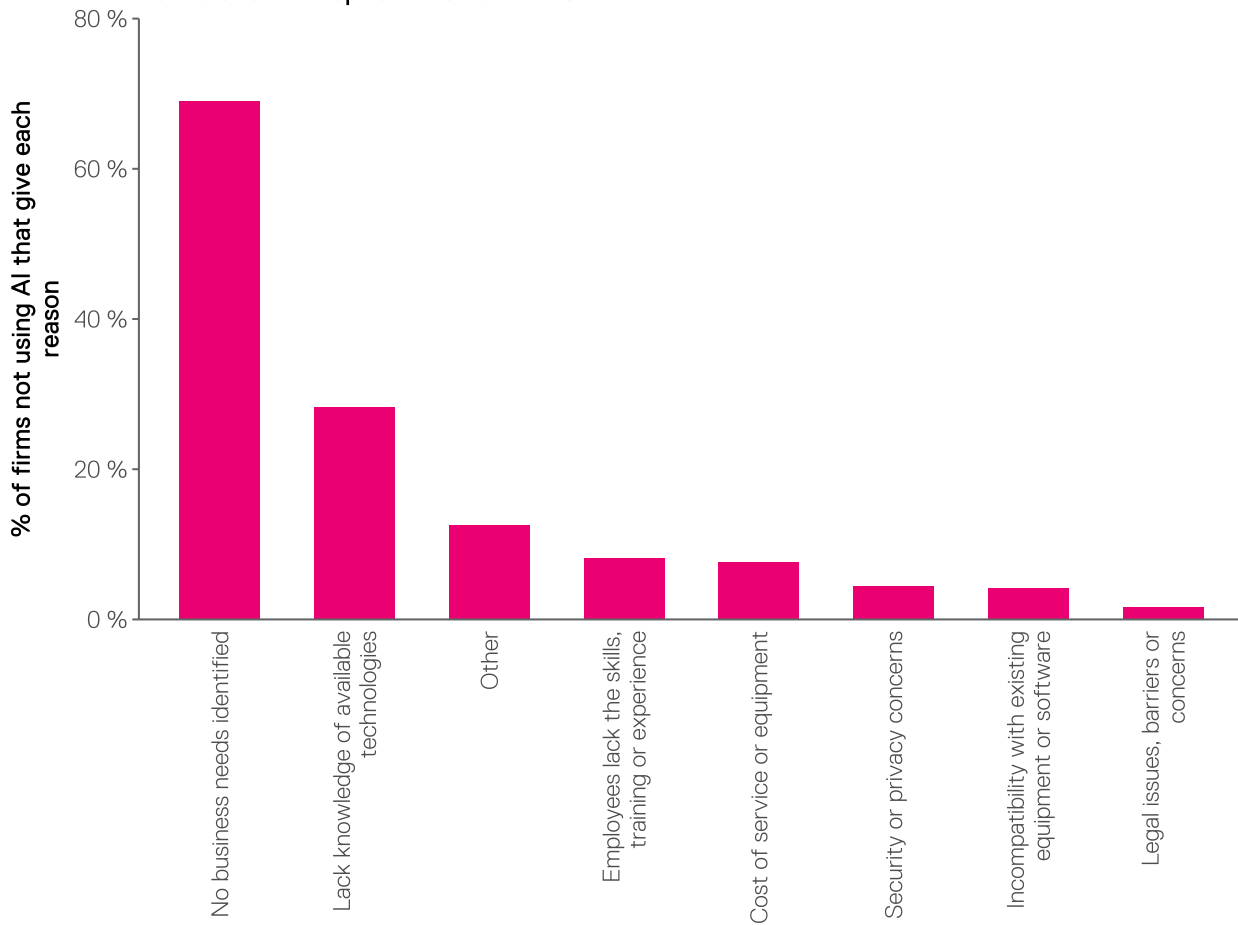
To date, concerns about legal issues and barriers have not been a major factor in slowing the pace of adoption. Only two percent of firms say legal concerns contributed to them having not adopted AI yet. Similarly, privacy and security concerns are also among the smaller barriers to adoption. Only five percent of non-adopting firms say privacy and security concerns are holding them back from deploying AI.



More than two-thirds of businesses that haven't adopted AI yet (69 percent) say that they have not identified a business need for it.

Figure 22

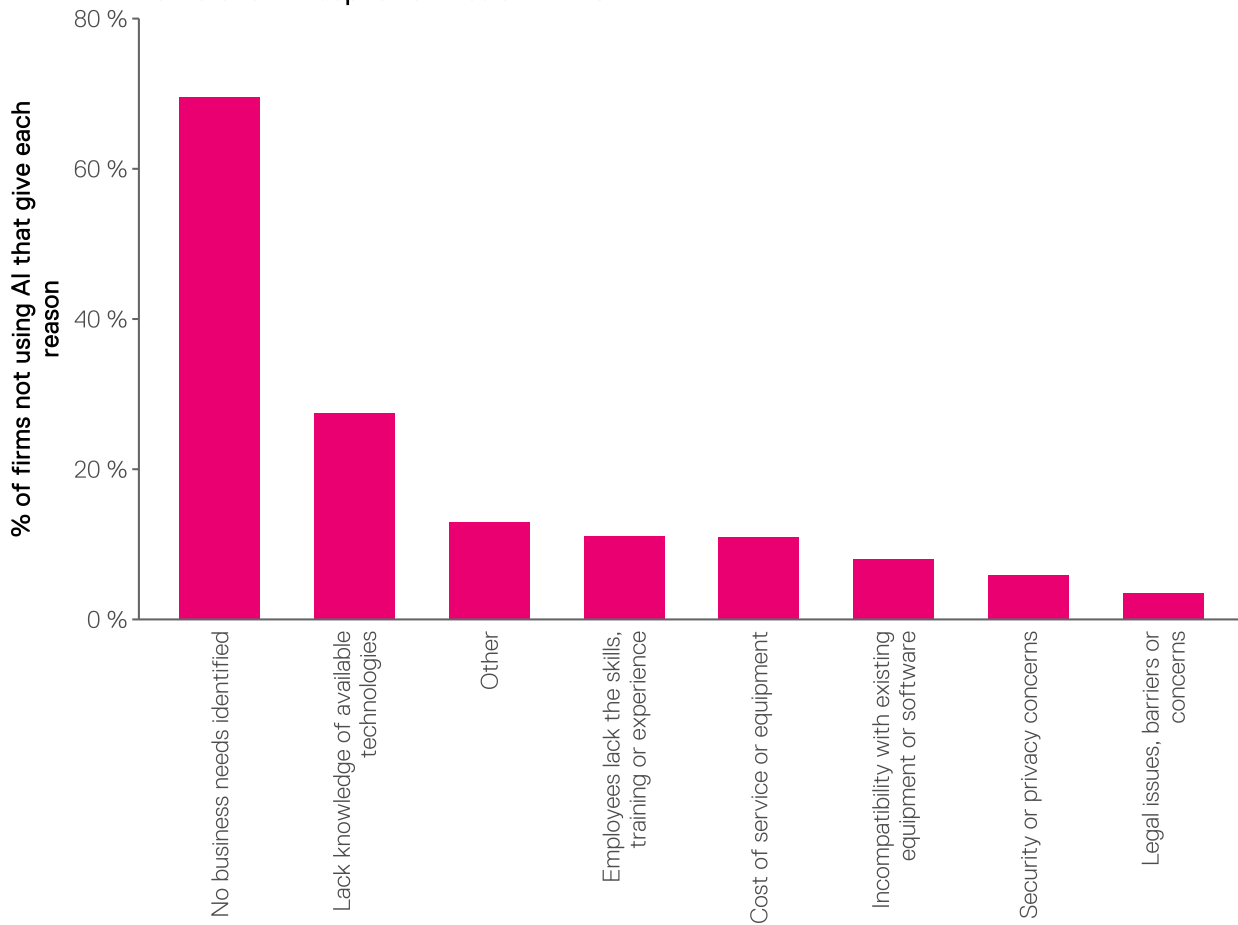
Barriers to AI Adoption at Small Firms



Source: Survey of Digital Technology and Internet Usage

Figure 23

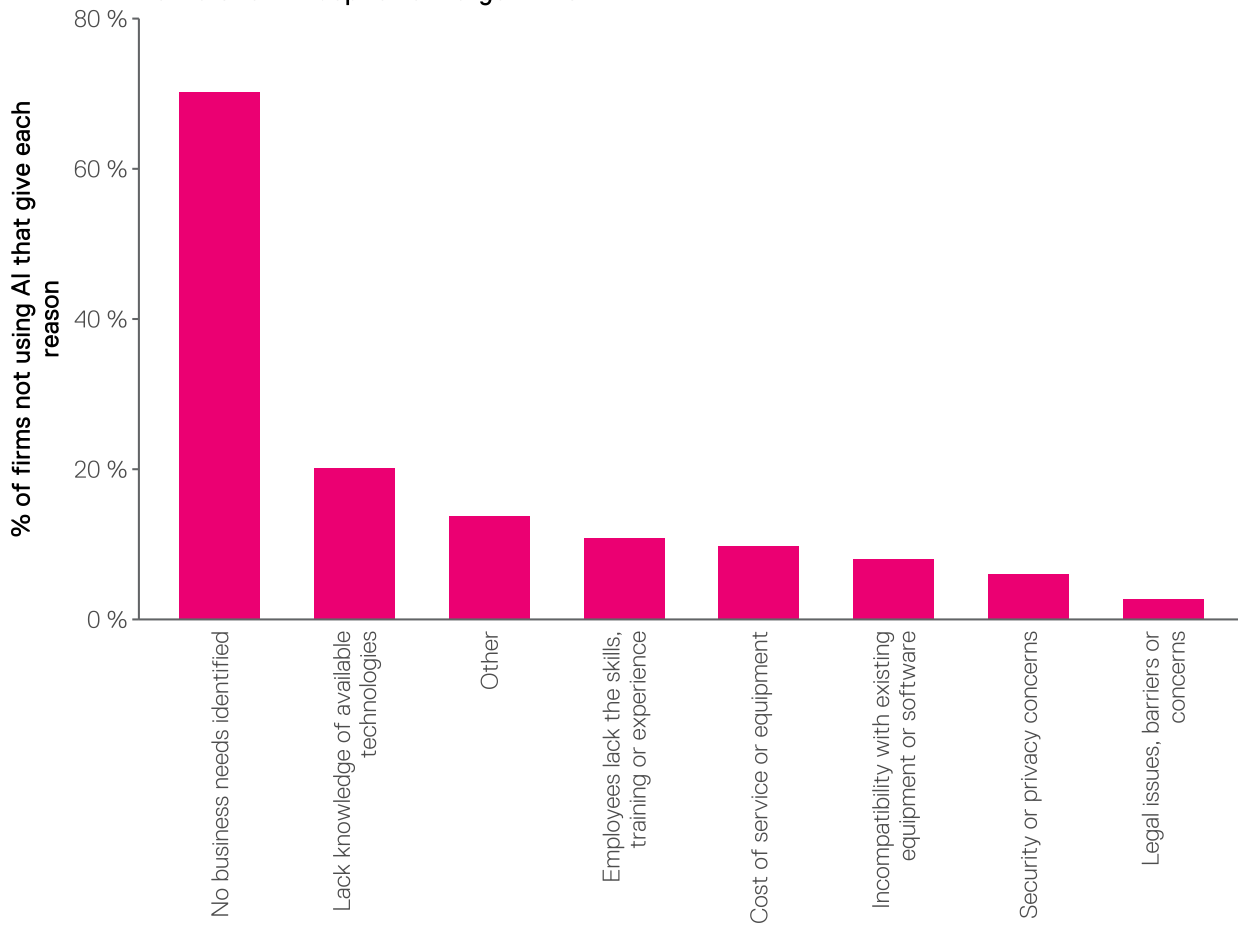
Barriers to AI Adoption at Medium Firms



Source: Survey of Digital Technology and Internet Usage



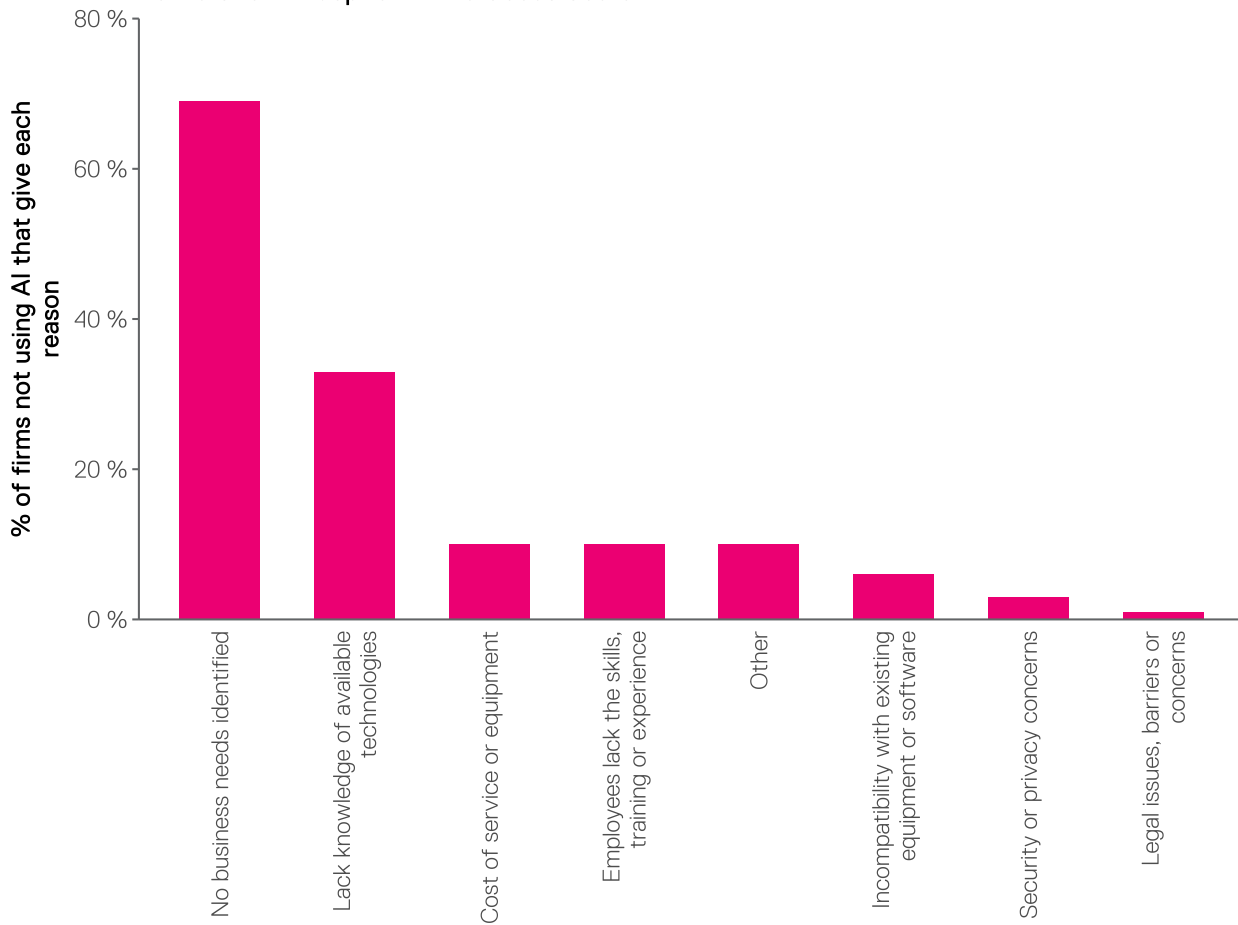
Figure 24
Barriers to AI Adoption at Large Firms



Source: Survey of Digital Technology and Internet Usage

Figure 25

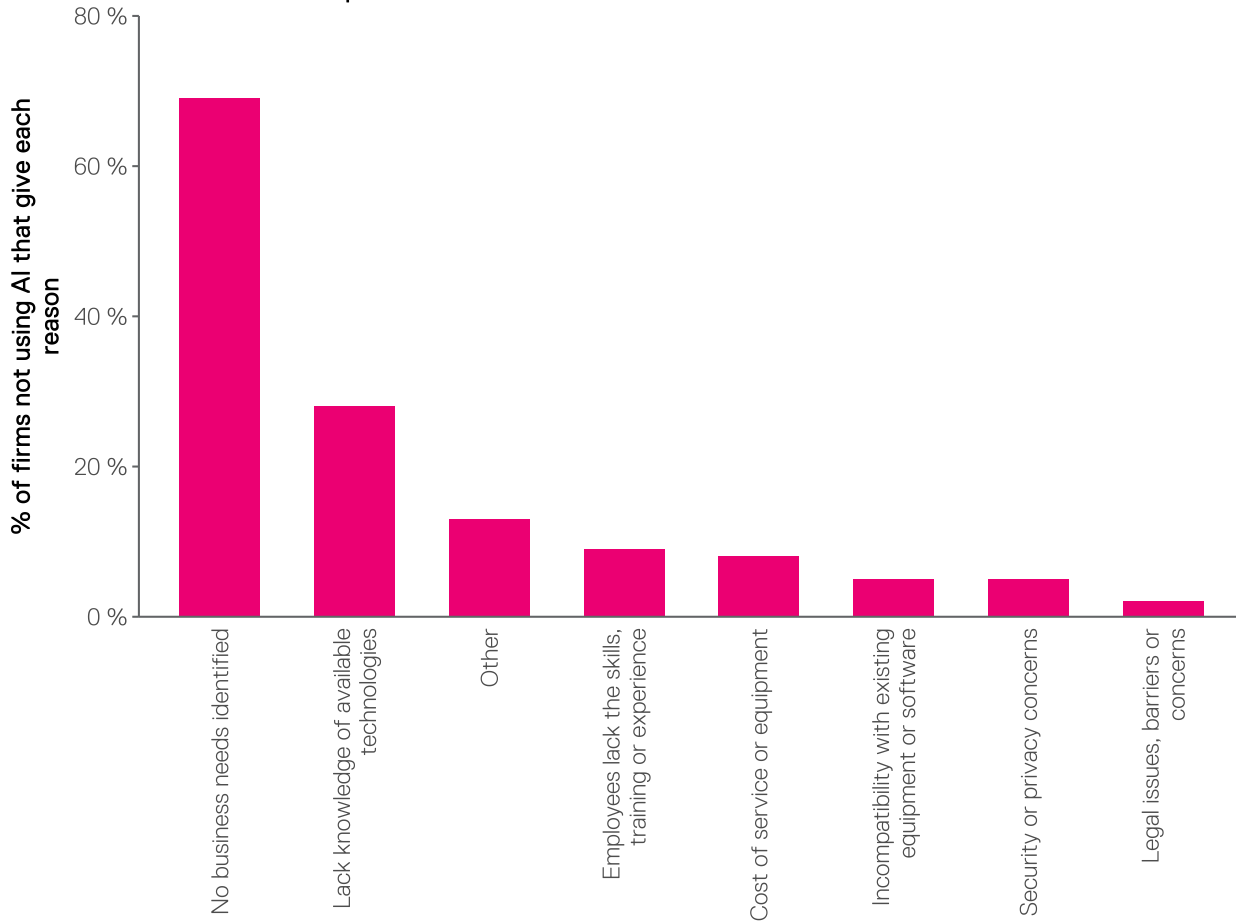
Barriers to AI Adoption in the Goods Sector



Source: Survey of Digital Technology and Internet Usage

Figure 26

Barriers to AI Adoption in the Services Sector



Source: Survey of Digital Technology and Internet Usage

This pattern is consistent both across industries and across firms of different sizes—the majority of firms have yet to enter the AI marketplace, and among those that have entered, the costs and skills gaps are the largest reasons they cite in their hesitation to adopt AI.

This suggests adoption will occur in two phases—first, firms need to see the value of artificial intelligence in their specific field, and second, they need to develop the skills and data infrastructure internally to be able to adopt the tools once they have a business case.

This is consistent with existing literature on technology adoption. Businesses are more likely to adopt new technology if there is already evidence that it is effective in the field, something that has been lacking for artificial intelligence thus far, with existing research on the value of AI remaining unconvincing to decision makers.²⁷

8

Québec in Focus

The Québec Landscape

Since the mid-2010s, both federal and Québec governments have demonstrated a strong commitment to the advancement of artificial intelligence (AI) in Québec. This commitment has translated into substantial investments across research, development, and the adoption of AI solutions. From 2017 to 2021, more than \$800 million in public funding was allocated to foster the growth of Québec's AI ecosystem, stimulating an additional \$1.5 billion in private investments over the same period.

As a result, a robust AI ecosystem has been established. According to Tortoise Media's 2021 regional analysis²⁸, Québec's AI ecosystem ranks seventh among the world's top AI nations, especially excelling in "research, government strategy, and commercial pillars". Presently, Québec hosts a diverse array of more than 550 firms providing AI services and products, as documented by the Vitrine AI Québec directory²⁹.

In 2022, Québec government reaffirmed its commitment towards AI in its new Stratégie québécoise de recherche et d'investissement en innovation (SQRI). In addition to support for AI research and development, AI adoption across Québec's organizations is a key focus of the Strategy. By capitalizing on its existing strength as a leader in

AI research and successfully augmenting its capacity in AI commercialization and adoption, Québec could gain significant productivity growth.

A study conducted by PricewaterhouseCoopers for the Forum IA Québec in 2022³⁰ explored the potential productivity benefits. It concluded that a deliberate shift towards increased AI adoption could potentially drive Québec's GDP to grow by 7% to 14% by 2035, with the creation of an additional 0.8% to 1.8% job opportunities.

In recent years, numerous studies have tried to determine the level of AI adoption in the Canadian economy. The SQRI uses an estimate based on Statistics Canada's Survey of Innovation and Business Strategy³¹, where 6% of businesses reported using AI in 2019. However, subsequent studies aimed at obtaining a more comprehensive understanding into the adoption landscape have revealed that AI adoption might be lagging more than originally anticipated. This discrepancy is shown in the current report, with an estimated adoption rate of only 5% in Québec based on the 2021 Survey of Digital Technology and Internet Use.

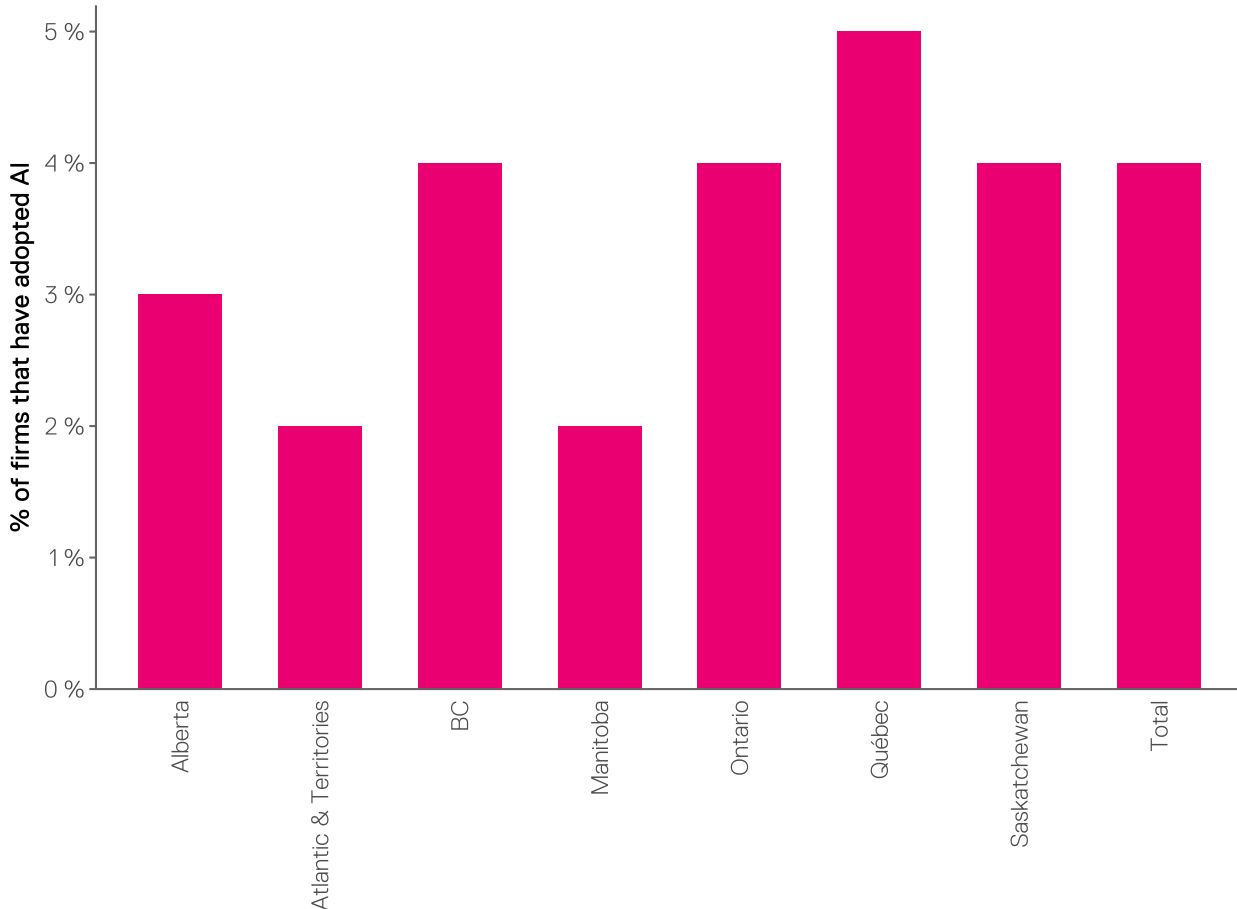
Given the significant benefits linked to increased AI adoption, it is critical to better understand and track the level of AI adoption in order to better inform research, investment as well as industrial policies and decision-making in Québec.

Relative Adoption

While Québec is acknowledged as a leader in the research and development of new AI technologies, its success in the adoption and commercialization of those tools has been more sluggish.

Figure 27

AI Adoption by Region



Source: Survey of Digital Technology and Internet Usage

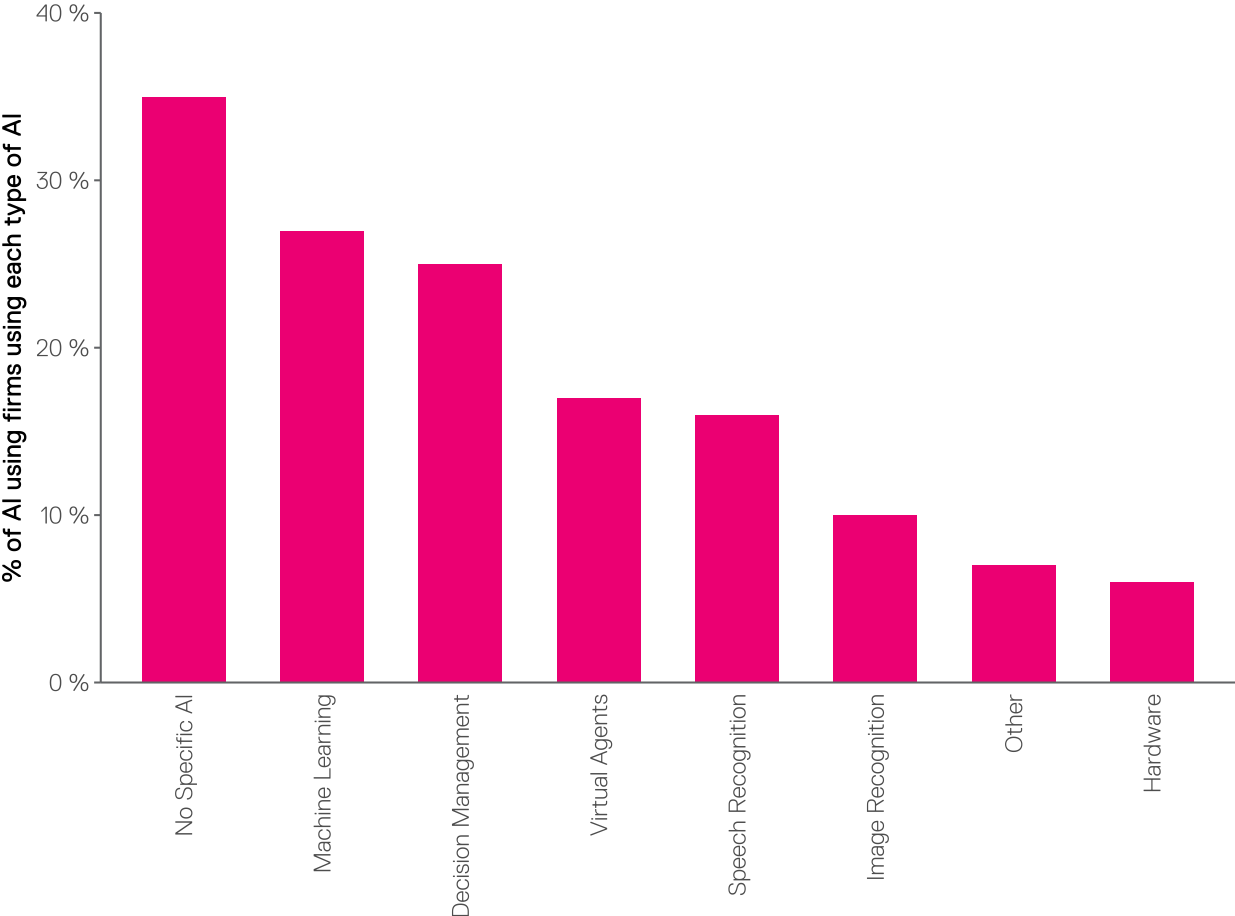
The SDTIU shows that Québec does have the highest rate of AI adoption in Canada, but not by a wide margin and still within the margin of error. This means that just as adoption in Canada has been weak compared to peer countries, adoption in Québec is similarly lagging behind.

Findings from a 2021 study conducted by Leger for The Ministère de l'Économie, de l'Innovation et de l'Énergie and Investissement Québec found that when looking specifically at the manufacturing sector, adoption is higher, with 13 percent of manufacturing firms reporting using AI in some capacity, although only three percent said they used AI a lot.³² Although it is hard to compare across survey instruments, this suggests that the Québec manufacturing sector is ahead of the rest of Canada in adopting AI in their operations.

How Are Québec Companies Putting AI to Work?

As in the rest of Canada, Québec firms have now adopted a wide range of tools to accomplish a suite of tasks.

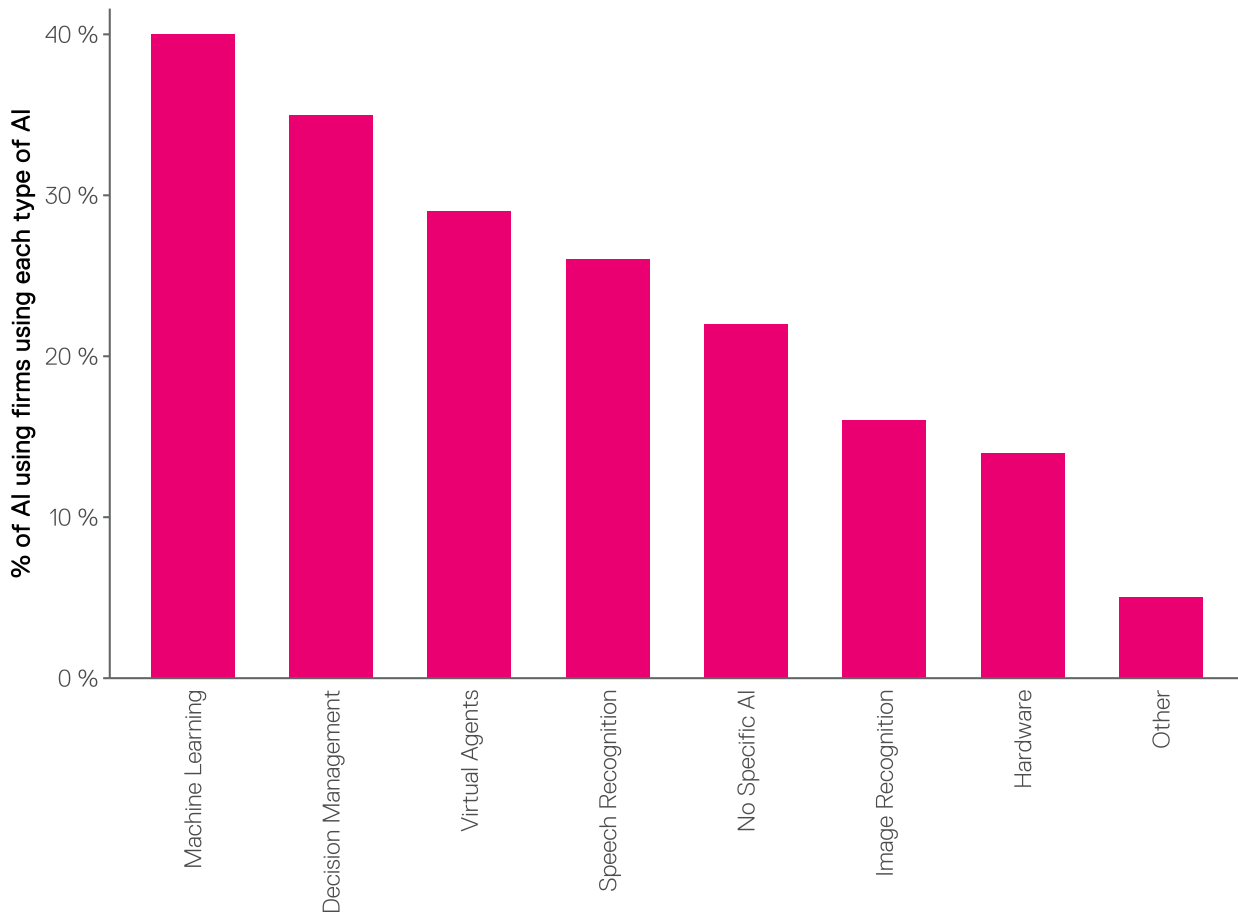
Figure 28
Type of AI in Use in Québec



Source: Survey of Digital Technology and Internet Usage

Figure 29

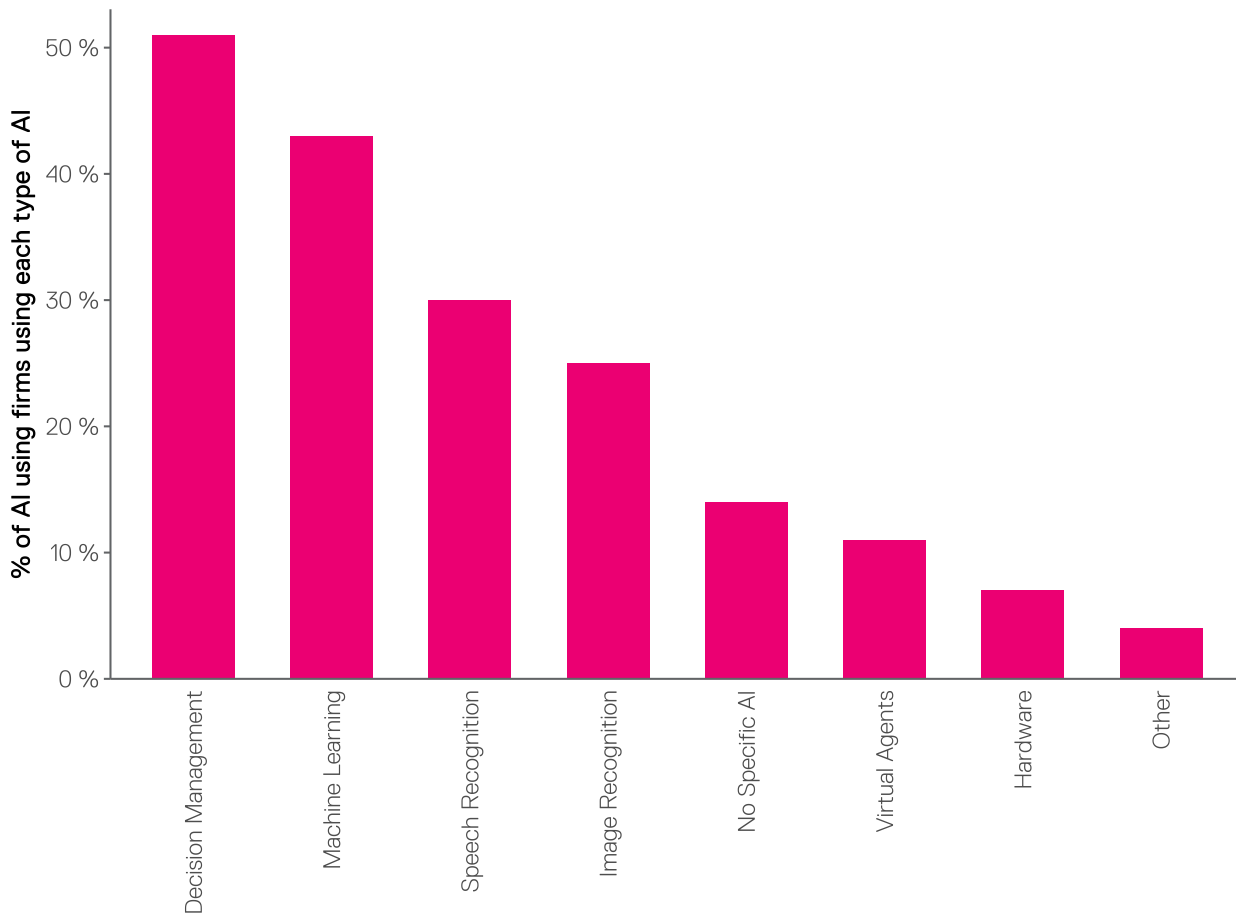
Type of AI in Use in Ontario



Source: Survey of Digital Technology and Internet Usage

Figure 30

Type of AI in Use in the Rest of Canada



Source: Survey of Digital Technology and Internet Usage

Firms in Québec are far more likely than those outside to have reported no specific type of AI in use. More than a third of AI-adopting firms in Québec say they aren't sure what specific type of AI they use. As mentioned in the full report, this group is likely a combination of individuals who are truly not knowledgeable enough about their own firm to specify the type of AI in use, as well as some who are at a firm that has not actually fully adopted AI yet. It is likely that some of these firms are still in the early stages of exploring the potential uses of AI without adopting any specific tools.

Among those that specified using a specific AI tool, machine learning was the most common, but it was followed closely by decision management tools. In Québec, 27 percent of firms using AI said they

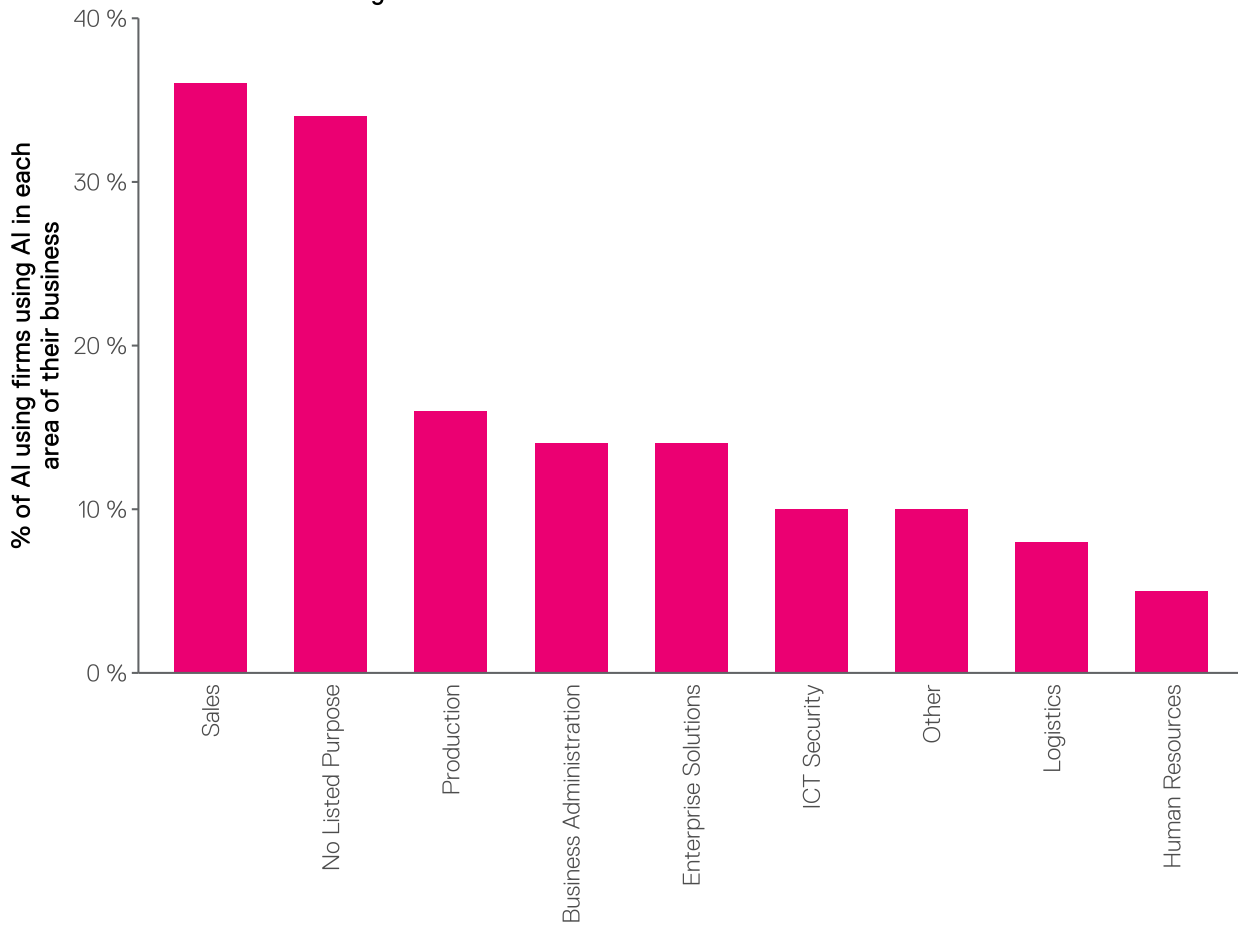
were using machine learning and 25 percent said they were using decision management software. In both cases this is lower than Ontario or the rest of Canada, where more than four in ten AI using firms have deployed machine learning and more than three in ten have deployed decision management systems.

While hardware is consistently the least-used technology across Canada, image recognition tools are particularly uncommon in Québec. Only 10 percent of AI-adopting firms in Québec report using it, compared to 16 percent in Ontario and 25 percent of AI-using firms in the rest of Canada.

We can again also look at what part of businesses have taken up artificial intelligence.

Figure 31

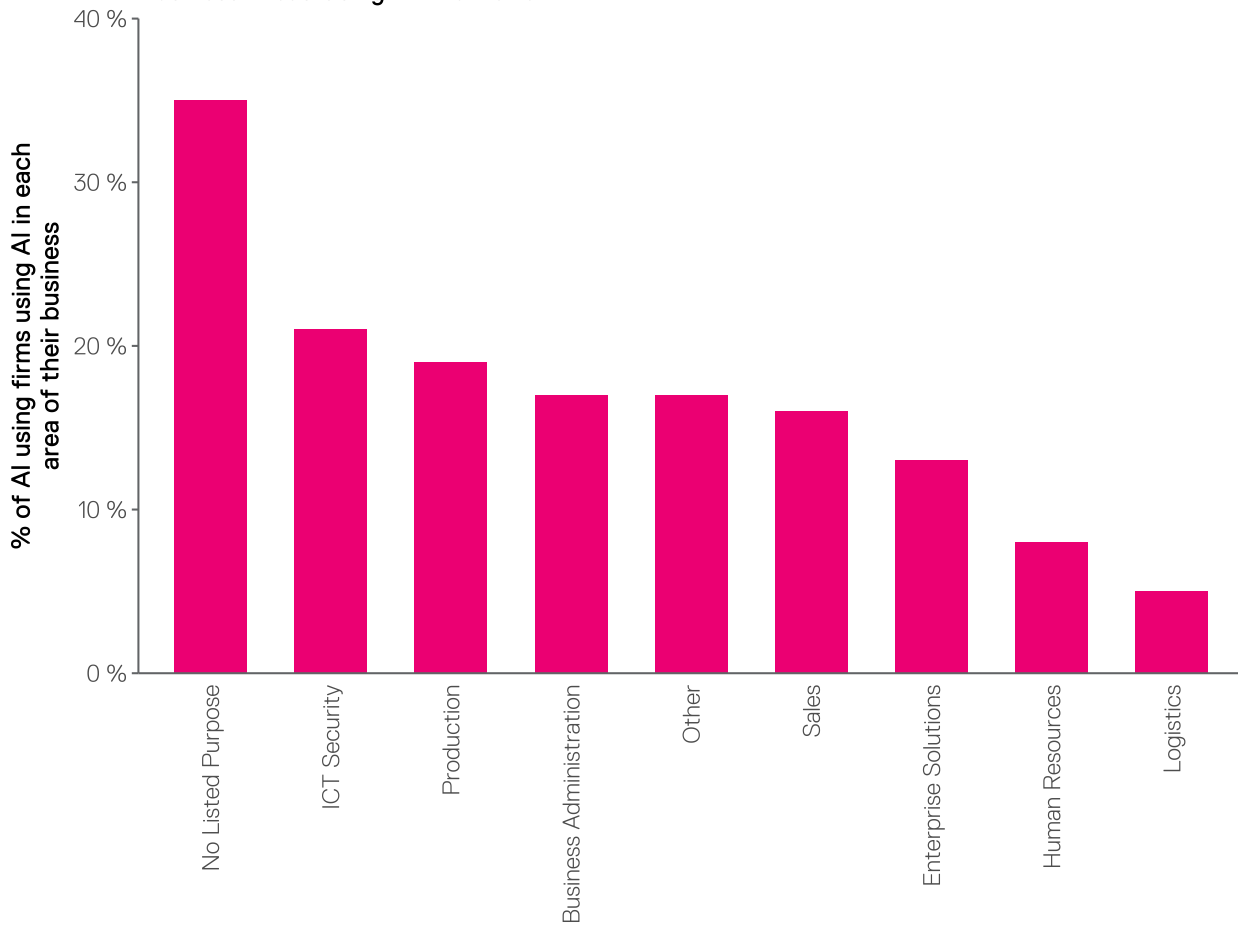
Business Areas Using AI in Québec



Source: Survey of Digital Technology and Internet Usage

Figure 32

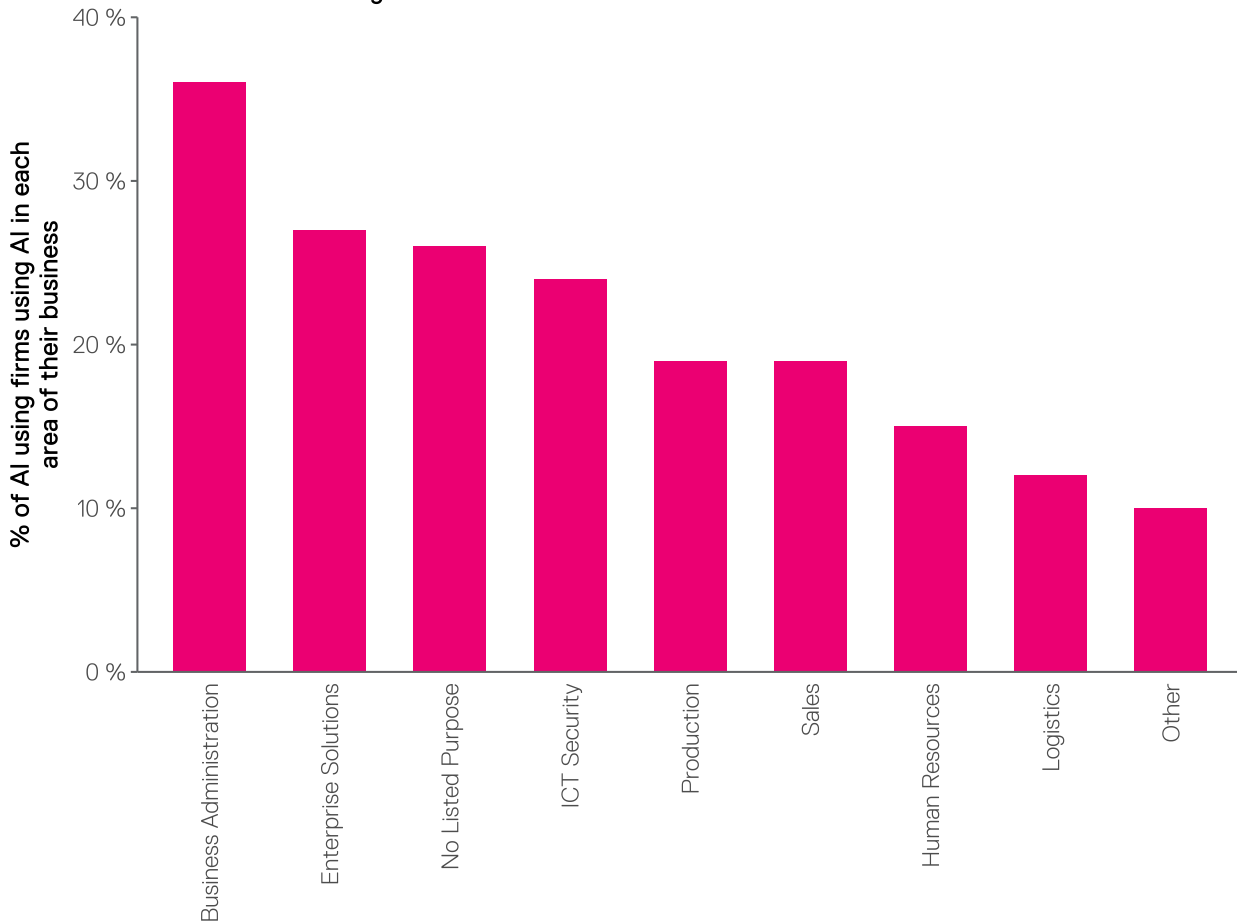
Business Areas Using AI in Ontario



Source: Survey of Digital Technology and Internet Usage

Figure 33

Business Areas Using AI in the Rest of Canada



Source: Survey of Digital Technology and Internet Usage

Québec is an outlier compared to the rest of Canada in the areas where AI is in use. More than a third of firms are using AI for sales in Québec (36 percent), compared with only 16 percent of Ontario firms and 19 percent of firms in the rest of Canada. This makes sales the main use of AI in Québec, while elsewhere it is more evenly split.

Only 14 percent of firms in Québec are using AI for the administration of their business—while this is similar to Ontario (17 percent), it's far lower than the share of firms in the rest of Canada. In Québec, more firms are using AI in their production lines than in administration, and the same number are using it as part of their enterprise systems.

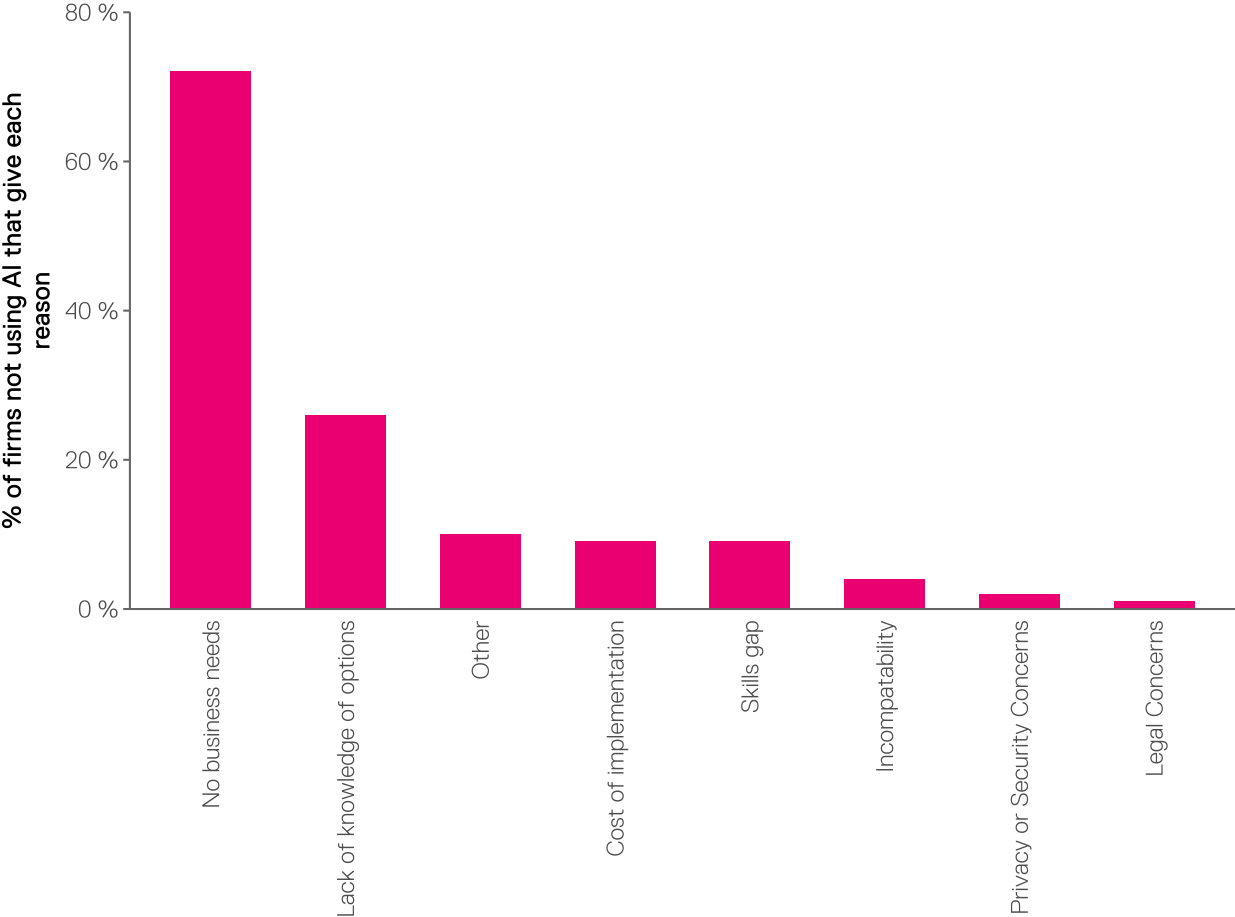
Québec firms are also less likely to be using AI for ICT security. While across Canada 19 percent of businesses say they use AI for their security, that number is only 10 percent in Québec.

Looking at these two elements together, there are clear differences between how AI is being used in Québec firms and in the rest of the country.

Barriers to Adoption in Québec

While the market for AI looks different in Québec from the rest of Canada, non-adopting firms continue to cite the same reasons.

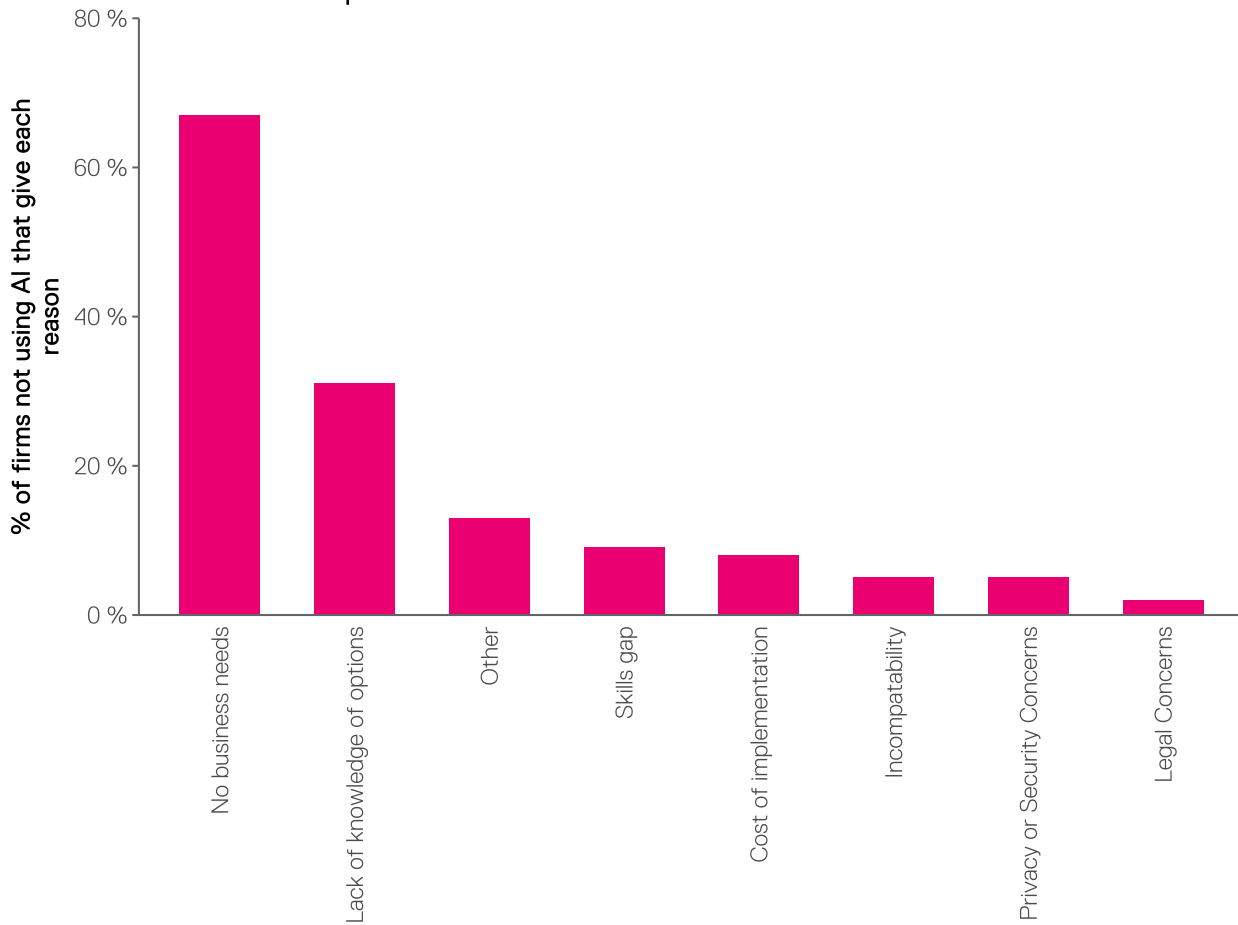
Figure 34
Barriers to AI Adoption in Québec



Source: Survey of Digital Technology and Internet Usage

Figure 35

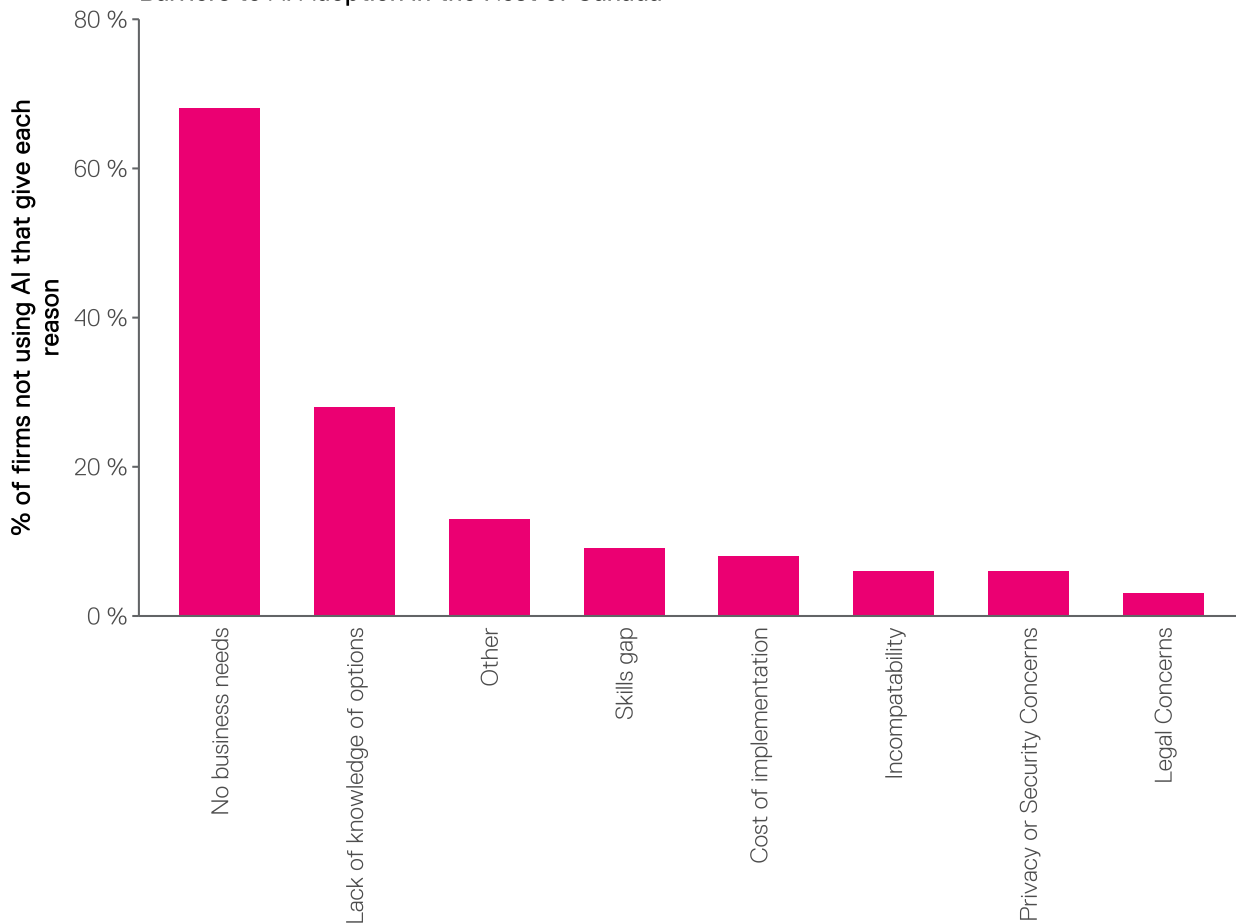
Barriers to AI Adoption in Ontario



Source: Survey of Digital Technology and Internet Usage

Figure 36

Barriers to AI Adoption in the Rest of Canada



Source: Survey of Digital Technology and Internet Usage

As in the rest of Canada, the first and current largest barrier to adopting AI in Québec is making a business case. Most firms in Québec say they have no business need for AI. As with the rest of Canada, the next largest reason is that firms do not understand what AI options are available.

These two reasons reflect a large body of firms in Québec that have not yet entered the market for AI—they need to be sold on the value of existing technologies before they will be ready to adopt them.

However, some firms in Québec cite other reasons for not adopting AI. Cost and skill represent the most common barriers. These are still significant and important barriers to help firms overcome once

they have entered the AI marketplace. The least common concerns in the rest of Canada are even less common in Québec. Only two percent of firms cite security or privacy concerns, and even fewer cite legal barriers. Similarly, very few firms in Québec have yet to adopt AI because it is incompatible with their existing systems.

This ultimately leaves Québec in a similar position to the rest of Canada. While more firms in Québec have already deployed AI, the majority have not been able to make a business case for AI. Helping Québec businesses—and particularly small businesses—make the case for AI will be critical to moving forward adoption in Québec and realizing the potential productivity and employment gains from that shift.

9

Implications for Industry Policymakers

Room for Growth

The most important takeaway from studying business adoption of AI is that there is significant room for growth in responsible AI use in Canada. Putting aside the question of how Canada should deal with new, controversial AI technologies like generative AI, there is still significant room for growth in our use of more traditional tools that frontier firms have been using in Canada for several years, such as tools that support decision-making or the automation of routine tasks.

Even modest improvements in the rate of adoption of these technologies could move Canada from a global laggard to a frontrunner in AI adoption, with large potential benefits for productivity and our economy. While Canada should not sacrifice the quality of our research environment to get there, an increased focus on commercialization can spur Canadian businesses to the forefront of global adoption.

Broaden Policy Tools

While Canada was an early leader in producing a national strategy on AI, the Pan-Canadian AI Strategy has had a limited scope, historically more focused on development of new technology than adoption of existing tools.

Using the policy classification system devised by the OECD’s AI Policy Observatory, we can compare the policy instruments that are part of Canada’s AI strategy to the instruments used in other countries’ strategies.

Policy Instrument	Number of non-Canadian countries using that instrument	Canada
Strategies, agendas, and plans	53	In use
Science and technology regulation	42	In use
Formal consultation of stakeholders or experts	36	In use
Policy intelligence (e.g., evaluations, benchmarking, and forecasts)	35	In use
Creation or reform of governance structure or public body	32	In use
Project grants for public research	21	In use
Grants for business R&D and innovation	20	Not in use
Networking and collaborative platforms	20	In use
Public awareness campaigns and other outreach activities	17	Not in use
Regulatory oversight and ethical advice bodies	15	In use
Dedicated support to research infrastructures	12	Not in use
Fellowships, postgraduate loans, and scholarships	11	In use
Information services and access to datasets	11	Not in use
Institutional funding for public research	10	In use

Table 3. Policy instruments used by other countries in their AI strategies according to the OECD AI Policy Observatory, and whether or not Canada currently uses them. Showing only instruments used by 10 or more countries.

Canada’s strategy does employ most of the common policy instruments; however, many of these are focused on research such as grants for public research, institutional research funding, and Centre of Excellence grants. There are tools that Canada has yet to include in the AI strategy, including public awareness campaigns and outreach programs.

Tools like public awareness campaigns are promising instruments to help promote mass adoption among businesses that are not in the AI marketplace yet, and these were early parts of AI strategies for countries that have been global leaders on AI adoption such as India who have included similar tools in their AI strategy from the beginning.³³

Focus on SMEs

While Canada has been relatively effective at getting large firms on board with AI technologies, small firms have been left behind. As new proposals are developed to improve the pace of adoption, special focus should be placed on supporting small and medium enterprises in implementing AI.

The majority of firms in Canada fall into these categories, and they have been significantly slower than large firms to adopt AI. Failure to act on this goal risks making SMEs less competitive relative to both their international peers and to larger firms in Canada. Given the natural benefits large firms have at adopting AI, active efforts are needed to help smaller firms keep pace.

However, it is also important to note that not all small firms will want or need to adopt AI. Not all small firms will be looking to grow or increase productivity—in some cases stability will be more desirable. In those cases, even with government support some firms will decide against AI adoption. This will likely mean that the rate of adoption will always be higher for larger firms than small firms.

Build Demand

An important part of helping firms adopt AI is to actively work to build demand for it. While it might have seemed that demand would be induced naturally by the economic benefits of AI, the informational barriers about what technology exists appear to be limiting the demand for commercial AI.

Canada has made some progress so far to help promote this. A few efforts have been made to date to help executives at SMEs build business cases for AI. Recently, the Computer Research Institute of Montreal (CRIM) launched training programs in partnership with the University of Sherbrooke to teach business leaders to write business plans for AI use at their firm. Similarly, the Smith School of Business at Queen's University offers a Master of Management in Artificial Intelligence degree that includes programming designed to help make business cases for AI in the workplace.

Such efforts should also pay attention to the characteristics of the firms and that they are serving. By targeting executives, outreach programs have the potential to close the gap on who is benefitting from AI adoption in Canada. If particular focus is given to businesses majority owned by women and Indigenous peoples, Canada can help overcome the inequality that has come to exist in AI adoption.

Pick Verticals

The Canadian AI approach could also stand to be more strategic. To date, the Canadian AI strategy has not put significant effort into promoting adoption within specific industries. The end result of this has been that the industries best suited for adoption have been most successful, but some industries most important to Canada's economy have not necessarily been as successful in adoption.

While Canada has been hesitant so far to target specific industries with its support, this research suggests that focused efforts would be more effective. The largest barriers to adoption are related to finding the right tools to meet particular business challenges. The trouble is that in different industries, different tools are more relevant to their challenges. That means the information challenges differ across industries and so solving these challenges will need to be done on an industry-by-industry basis.

This strategy is currently being used in the United Kingdom, where the National AI Strategy is targeting specific high-potential sectors where AI adoption needs to grow. In Canada, our relative weakness of AI adoption in most sectors means there is clear room to focus our efforts in the sectors with the highest potential for adoption.

Focusing efforts on specific industries will mean creating messaging and information that is targeted to the specific tools, making it easier for decision-makers to understand the value AI represents for their firm.

Promote Upskilling

Once firms make the decision to adopt AI and start looking for tools that can solve their challenges, they still need to develop the in-house capabilities to use those tools. As we have seen, there is a strong relationship between firms that are actively investing in the skills of their existing workers and the adoption of an emerging technology like artificial intelligence.

This should be focused on upskilling both types of workers within a firm. Existing ICT workers are best suited to support the implementation of AI systems within their firm--they have knowledge about the data infrastructure and business processes already in place. Providing the support for them to develop the skills necessary is essential to helping businesses set up new AI tools.

Beyond this, upskilling non-ICT workers is also important to the successful implementation of AI tools. It's not enough to develop the tools intuitively, they need to be actively used within the business for them to be effective. Programs need to be in place to help non-ICT workers understand the AI tools that exist, make internal business cases for the implementation of AI, and understand the nature of the tools they are already using.

Data from the OECD shows that this has already been effective elsewhere.³⁴ Since releasing its initial strategy on AI in 2018, India has had a focus on upskilling its workforce and the end result has been significant improvement in AI talent concentration.

Monitoring Adoption

We have shown that the Survey of Digital Technology and Internet Usage (SDTIU) is an invaluable tool for effectively monitoring the state of adoption in Canada — it provides a quality of data that cannot be replicated by private firms trying to conduct research in this area. It is therefore essential that Statistics Canada ensure that Canadians have access to timely, relevant, and detailed information from the survey itself.

It is critical that the findings of surveys get into the hands of researchers quickly so that they remain relevant and accurate. If information is delayed too much in this fast-moving area, we risk making decisions on the basis of facts that are no longer true.

The survey also needs to keep pace with advancements to remain relevant. With the relentless pace of new AI technologies released to the public, the nature of adoption changes quickly. New tools like ChatGPT have changed the skills necessary to start implementing AI in the workplace and so marks a significant shift in the barriers to one form of adoption, but at the same time does nothing to change the barriers to adopting other tools like computer vision and decision management tools. Ensuring the SDTIU and similar Statistics Canada surveys accurately capture the full picture of adoption as its nature changes is essential.

It is also important that the findings of the survey provide a sufficient level of detail to make accurate policy assessments. There are important differences between firms that adopt only off-the-shelf AI solutions and those that build in-house capacity for AI. Structuring the data collection to get at important distinctions in adoption will make the final data more valuable for decision makers.

Responsible Adoption

As firms move to adopt AI, they will need to contend with an increasingly complex regulatory environment designed to mitigate potential risks. Internally, firms should be embracing the ethos of responsible AI use in internal policies and practices, and potentially through adoption of emerging industry or global standards. Innovation Minister François-Philippe Champagne has called for firms to adopt a “voluntary code” as a stopgap measure.³⁵

These internal voluntary codes are only a temporary measure as Canada builds out its regulatory framework for AI. Firms will need to be prepared for increased policy and regulatory requirements, notably through Bill C-27, which modernizes privacy and data protection legislation and introduces the *Artificial Intelligence and Data Act* (AIDA). The proposed AIDA provides that AI systems deemed “high impact” must identify, assess, and mitigate risks of: physical, psychological or economic harm, and biased output on grounds prohibited in the *Canadian Human Rights Act*.

While very few firms to date say they have delayed AI adoption because of legal concerns, a more complex regulatory environment will become an increasingly important area for firms to address. For policymakers, moving quickly to put appropriate and predictable guardrails on high-risk AI systems will also ensure that Canadian businesses can confidently invest in and maximize their benefits while minimizing the risks of AI adoption.



Conclusion

With a more accurate picture of AI adoption in Canada than was previously available, we can now see that Canada is indeed lagging behind. Despite a strong history in the development of new AI technologies, Canada has yet to develop the same strength in commercialization. As the rest of the world ramps up these efforts, Canada cannot afford to fall behind and miss out on the potential productivity benefits of artificial intelligence.

While this report focused on the firm perspective, there are other factors that warrant additional future research. From the level of private investment Canada is attracting to AI startups, to the computational power available to firms looking to adopt the technology, and beyond at the level of trust Canadians have in AI being used more widely, there are many contributing factors to adoption that all need to be understood and monitored.



Appendix A - Detailed Regression Results

We present the results of the two regression models below. The first model is as follows:

$$A_f = \beta_1 S_f + \beta_2 G_f + \beta_3 W_f + \beta_4 I_f + \varepsilon_f$$

More formally, we model adoption (A) as a function of the number of employees in a firm relative to their industry (S), the length of time the business has been operating (G), the average wages at the firm (W), and the North American Industry Classification System (NAICS) industry of the firm (I). We model industries at their most aggregated level, differentiating between the service- and goods-producing industries. The count of employees in a firm and the length of time the business has been operating are modeled as percentiles relative to their industry.

The second model expands this as follows:

$$A_f = \beta_1 S_f + \beta_2 G_f + \beta_3 W_f + \beta_4 I_f + \beta_5 T_f + \beta_6 U_f + \beta_7 O_f + \beta_8 R_f + \varepsilon_f$$

This now includes some additional, less stable features of Canadian firms. We now include a dummy variable for the presence of IT workers in a firm (T), a dummy variable for firms providing ICT upskilling to their IT workers (U), a dummy variable for firms providing ICT upskilling for non-IT workers (O), and a dummy variable for firms reporting spending on R&D (R).

	Model 1 Dependent variable: % AI Adoption	Model 2 Dependent variable: % AI Adoption
Goods Industry	-0.019*** (0.005)	-0.016*** (0.005)
Age (10th to 50th percentile)	-0.0005 (0.007)	-0.001 (0.007)
Age (50th to 75th percentile)	-0.007 (0.008)	-0.007 (0.007)
Age (75th to 90th percentile)	-0.022*** (0.008)	-0.017** (0.008)
Age (90th to 95th percentile)	0.003 (0.011)	0.008 (0.011)
Age (95th to 99th percentile)	-0.038*** (0.014)	-0.044*** (0.014)
Age (99th percentile and above)	-0.038 (0.035)	-0.030 (0.034)
Employee Count (50th to 75th percentile)	0.040*** (0.005)	0.025*** (0.005)

	Model 1 Dependent variable: % AI Adoption	Model 2 Dependent variable: % AI Adoption
Employee Count (75th to 90th percentile)	0.085*** (0.011)	0.042*** (0.011)
Employee Count (90th to 95th percentile)	0.154*** (0.026)	0.092*** (0.026)
Employee Count (95th to 99th percentile)	0.244*** (0.031)	0.164*** (0.031)
Employee Count (99th percentile and above)	0.286*** (0.062)	0.218*** (0.060)
Mean Wage (Logged)	0.025*** (0.002)	0.012*** (0.003)
ICT Workers		0.018** (0.008)
Upskilling for ICT Workers		0.160*** (0.012)
Upskilling for non-ICT Workers		0.031*** (0.007)
R&D Spending		0.068*** (0.011)
Constant	-0.213*** (0.026)	-0.096*** (0.026)
Observations	10,355	10,355
R2	0.030	0.075
Adjusted R2	0.029	0.074
Residual Std. Error	1.036 (df = 10340)	1.012 (df = 10335)
F Statistic	24.475*** (df = 15; 10340)	49.505*** (df = 20; 10335)

Note: *p<0.1; **p<0.05; ***p<0.01

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