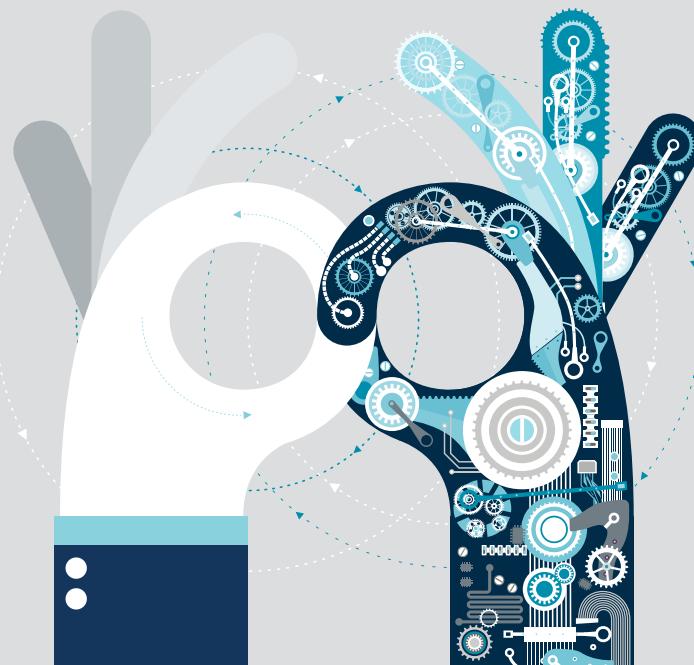


DATA INSIGHTS

Automation Across the Nation:

Understanding the potential impacts
of technological trends across Canada



brookfield
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for innovation + entrepreneurship

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INTRODUCTION

The advent and rapid adoption of new technologies, such as machine learning and advanced robotics, have resurfaced concerns over technology eliminating jobs. Many now worry that more jobs are at risk than ever before.¹ However, this debate all too often ignores the complexity of technology's relationship to labour. Technological advancements throughout Canada's history have helped to drive innovation and raise productivity, improve wealth and increase consumption, and give rise to entirely new industries and economic opportunities.^{2 3 4} As a result, in the long run, technology has often helped to produce more jobs than it destroyed.⁵

Whether or not this trend continues, technology will continue to change the kinds of jobs available and the skills they require. This can take a toll on workers filling roles that can largely be substituted by technology.^{5 6} Canada has already witnessed drastic shifts in the composition of its labour market, partially driven by technological change. In the 1980s and 1990s, advances in information communications technology (ICT) reduced the need for many routine tasks across the economy, such as the calculations performed by many bookkeepers. At the same time, these technologies helped improve the productivity of jobs demanding creativity, complex-problem solving and interpersonal interaction, such as those filled by lawyers, managers and scientists. These changes contributed to larger employment shares for both high and low-skilled workers in Canada, at the expense of the middle-skilled.⁷

The regional implications of these changes can be striking. Take for example the impact of industrial robotics on employment in highly concentrated manufacturing towns and cities. In Canada, it took 20 jobs to generate \$1 million in manufacturing output in 1980. By 2013, this number had been cut in half.⁸

A recent study from the United States (US) demonstrates that between 1990 and 2007, the introduction of one robot per 1,000 workers reduced employment by nearly six individuals, resulting in upwards of 670,000 jobs lost.⁹ While these technologies have been fundamental in improving the productivity of manufacturing across the industrial world, the brunt of this change has been felt by workers in routine jobs in the manufacturing sector.

Modern breakthroughs, such as natural language processing and autonomous vehicle technology, mean that machines are now performing a whole new set of tasks, potentially more efficiently and effectively than humans. Current predictions suggest that these technologies are likely to disproportionately affect lower paying, lower skilled jobs.¹⁰

The impact of technological trends will not be consistent across the country. To help identify which cities and towns in Canada are most susceptible to modern advances in technology, the Brookfield Institute for Innovation and Entrepreneurship (BII+E) translated findings from a recent McKinsey Global Institute report to the Canadian context—mapping automation impact data against Canadian cities and towns, and examining trends to extract relevant insights. The goal of this data insights report is to begin to map the uneven distribution of risks and benefits associated with automation, and to uncover some of the regional tensions that exist between innovation driven growth and inclusive growth in Canada. While the data highlights that certain cities and towns in Canada are more susceptible to automation than others, it also suggests that, as a result of the increasing capacity of technology and fairly similar regional economies, technology has the potential to automate a large number of work activities across the country.

D A T A

MCKINSEY DATA

McKinsey's recent report, *A Future That Works: Automation, Employment and Productivity*, identified the proportion of work with the potential to be automated using current technology. McKinsey examined labour force data across 54 countries covering 78 percent of the global labour market.¹¹

McKinsey's report departed from earlier studies by examining the potential for automation of specific work activities, rather than entire occupations. Within each occupation, an individual performs a variety of tasks, some of which are susceptible to automation, some of which are not. As a result, an examination of automation risk at the occupational level can overstate potential impacts.¹²

To assess the technical potential for automation, McKinsey disaggregated occupations into 18 capabilities, which were categorized into five groups: sensory perception, cognitive capabilities, natural language processing, social and emotional capabilities, and physical capabilities. The level of performance required to successfully carry out each work activity in each occupation (i.e. the median human level, or top 25th percentile) was then estimated and compared to the performance of existing technologies. This enabled analysis of the potential for automation across more than 2,000 work activities for more than 800 US occupations. McKinsey then applied this framework across the global economy.¹³

McKinsey estimated that 50 percent of work activities around the globe can be automated by adapting existing technology, representing \$14.6 trillion (USD) in wages. However, less than five percent of occupations can be fully automated.¹⁴

Routine work activities were found to be most at risk, including predictable physical work, prevalent in manufacturing and retail trades, as well as work involving processing and collecting data,

found across the spectrum of skills and wages.¹⁵ In contrast, activities such as managing others and applying expertise remain relatively resistant to automation.¹⁶

However, McKinsey also recognized that just because work can technically be automated, it does not necessarily mean that it will be. McKinsey identified five sets of factors that will impact the adoption of technology: technical feasibility; cost of developing and deploying solutions; labour market dynamics such as the supply, demand and cost of human labour; economic benefits such as productivity gains, quality and profit; as well as regulatory and social acceptance.¹⁷

STATISTICS CANADA DATA

To apply McKinsey findings to Canadian labour force data, we used Statistics Canada's National Household Survey (NHS), 2011. The NHS provides the latest data currently available on employment figures at the necessary geographic level. It was a voluntary survey for which approximately 4.5 million households received a questionnaire and includes social, economic and geographic information.

The NHS provides data for all of Canada's Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs). These include one or more adjacent municipalities, with a population centre. A CMA must have a total population of at least 100,000 with a minimum of 50,000 living in the core. A CA must have a core population of at least 10,000. While large parts of Canada's geography are not captured by CMAs and CAs, the vast majority of Canada's population is. In 2011, workers in Canada's CMAs and CAs constituted roughly 83 percent of the country's total labour force. However, due to low population density, data for Canada's North is particularly limited.

The NHS has a number of limitations. First and foremost, the data is six years old and therefore does not reflect recent shifts in Canada's labour market. Second, the survey was not mandatory and therefore departed from the methodologies of

previous censuses. As a result, the non-response rate was significantly higher. At the national level, the Global Non-Response Rate (GNR) was 26.1 percent, compared to the 6.5 percent in the 2006 long form census. Non-response rates can be much higher for smaller geographic regions. There are also non-response biases present in the survey, as certain groups such as low-income individuals are less likely to respond to the survey.¹⁸

As a result, these findings are designed to help to set the context and begin to identify areas that are most and least likely to be impacted by automation. To mitigate data limitations and provide a more up-to-date labour market picture, BII+E plans to update this analysis with 2016 Census data upon its public release.

METHODOLOGY

For each country studied, McKinsey identified the proportion of work activities in each industry with the potential to be automated. To conduct our analysis, we applied these figures to the number of individuals employed in each industry in every Canadian CMA and CA. This enabled us to identify the proportion of work activities with the potential to be automated across all Canadian CMAs and CAs.

We compared these proportions against the national average to create a location quotient. A location quotient greater than one signals that the region's concentration of work activities with the potential to be automated is greater than the national average. In contrast, a location quotient less than one signals that the region's concentration of work activities with the potential to be automated is less than the national average.

However, there are limitations with this approach. In particular, using McKinsey's industry data at a subnational level assumes that the occupational composition of each industry, in each CMA or CA, reflects the national average, which may not always be true. For example, in certain regions such as Kitchener-Waterloo, Ont., there is a thriving advanced manufacturing industry. Compared to other regions with a significant

manufacturing presence, this region may require a higher proportion of highly skilled workers, which could make it less susceptible to automation. The data used for this report will not reflect these differences.

We also investigated the industrial diversity of CMAs and CAs using a "diversity index". This index enabled us to rank a CMA or CA as either diverse, if the distribution of employment in 2011 across all two-digit industry codes is similar to Canada as a whole, or less diverse, if the distribution of employment is more concentrated.¹⁹ The diversity index is calculated as follows:

$$Diversity_j = \sum_i^I \frac{\left(\left(\frac{emp_{ij}}{emp_j} - \frac{emp_i^{Canada}}{emp^{Canada}} \right)^2 \right)^{\frac{1}{2}}}{\frac{emp_i^{Canada}}{emp^{Canada}}}$$

In this formula, $Diversity_j$ is the index unique to a CMA or CA, comparable to all other CMAs and CAs across Canada. The CMA or CA is denoted by j , and industry by i . A higher value in the index indicates that employment in the particular CMA or CA is less diverse compared to Canada as a whole.

INSIGHTS

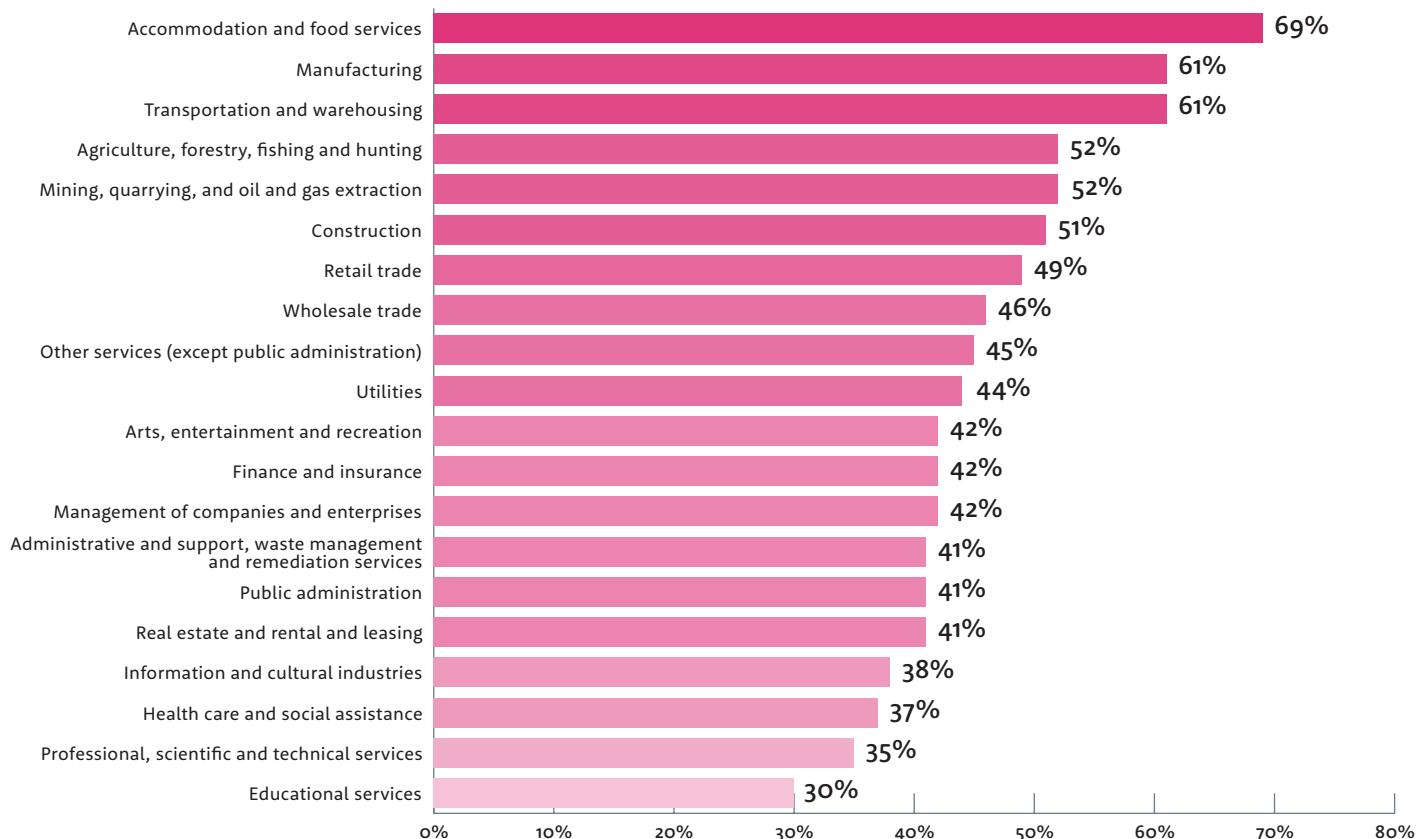
POTENTIAL FOR AUTOMATION ACROSS CANADIAN INDUSTRIES

The potential for automation varies greatly between industries in Canada—ranging from 30 percent of work activities in educational services to 69 percent in accommodation and food services. Overall, 46 percent of work activities in Canada have the potential to be automated, across all industries; this is equivalent to 7.7 million jobs.ⁱ

i. The equivalent number of jobs with the potential to be automated is calculated by multiplying the number of employees in an industry by the proportion of work activities in that industry with the potential for automation. This figure does not indicate that this number of jobs have the potential to be automated, since the proportion of work activities in each industry is spread across many occupations. Instead, it is designed to give an indication of the potential extent of automation impacts in each sector.

Figure 1:

Percent of Work Activities with the Potential for Automation, by Industry



Source: McKinsey Global Institute (2017), BII+E analysis

The industries with the highest proportion of work activities that are technically automatable (top quartile) were classified as highly susceptible to automation. These industries are: accommodation and food services; transportation and warehousing; manufacturing; mining, quarrying, and oil and gas extraction; and agriculture, forestry, fishing and hunting. Across Canada, the proportion of work activities in these industries with the potential to be automated is equivalent to 2.5 million jobs.²⁰

The industries least susceptible to automation (bottom quartile) are: educational services; professional, scientific and technical services; health care and social assistance; and information and cultural industries. Collectively, more Canadians are employed in these industries, accounting for 28 percent of Canada's total employment, compared to the industries most susceptible to automation, accounting for 24

percent of total employment. However, automation can still impact the equivalent of over 1.6 million jobs in these relatively insulated industries.²¹

INDUSTRY DIVERSITY

In addition to examining which industries are more susceptible to automation, we are also interested in how other factors—such as industrial diversity—could exacerbate or inhibit any negative implications of automation on the labour force.

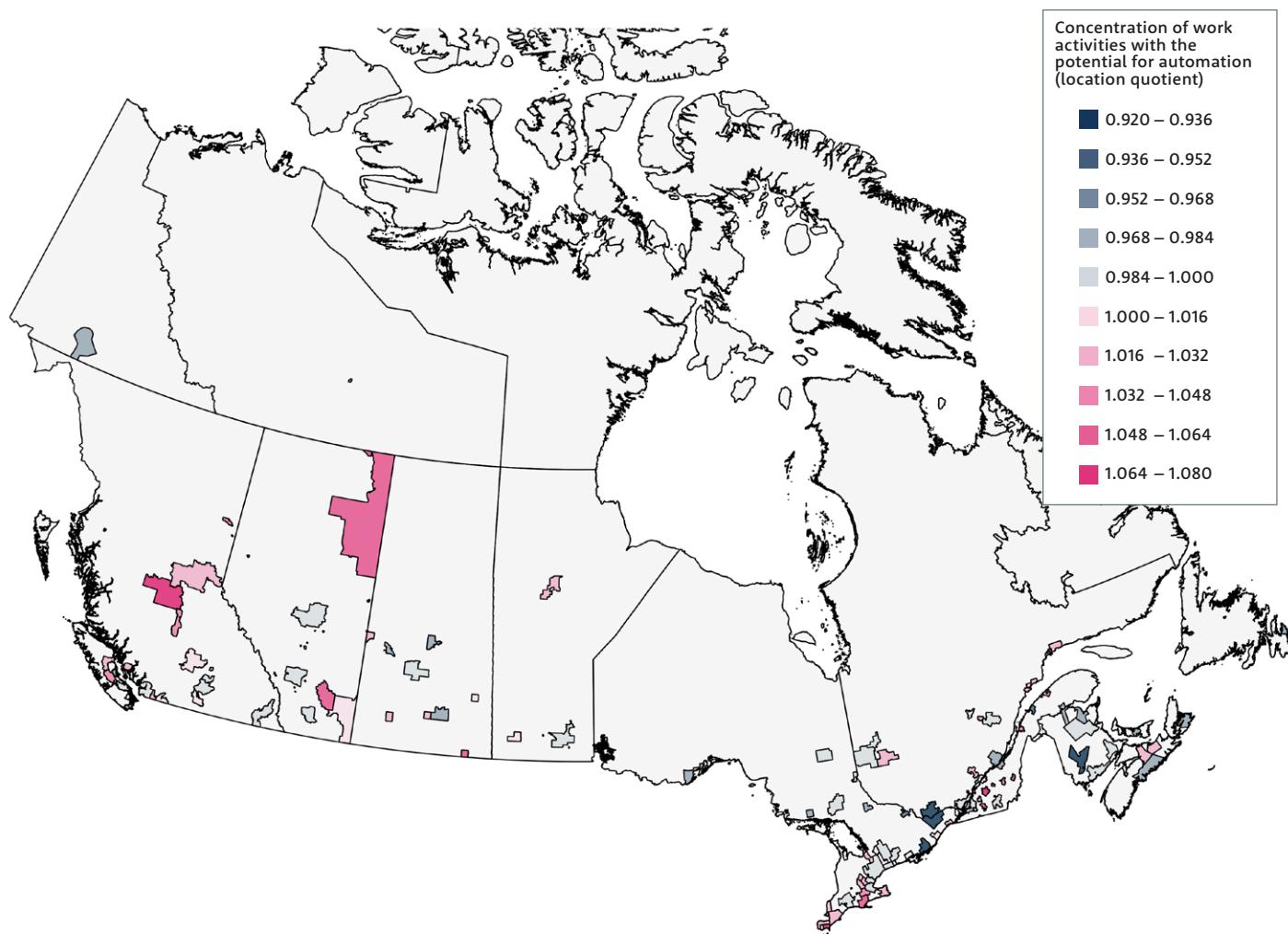
It is likely that smaller cities and towns, heavily reliant on one industry or employer, will experience automation differently from either larger or more diversified economies, regardless of the proportion of work activities with the potential to be automated. These areas may have a lesser ability to reabsorb displaced labour. Their local economies

are also more exposed to automation risk, as a decision to adopt technology on the part of one large employer, or several employers in a dominant industry, would have a much larger impact than it would in a city or town with greater industry diversity.²²

The CMAs and CAs ranking highest in the diversity index are largely found in the Prairie Provinces, specializing in oil and gas extraction. They include: Wood Buffalo, Alta., with a diversity index of 26.6, Estevan, Sask., with a diversity index of 26.5, and Cold Lake, Alta., with a diversity index of 22.9. The average diversity index score across all Canadian CMAs and CAs is 8.6.

CANADIAN CMAS AND CAS WITH THE HIGHEST AND LOWEST POTENTIAL FOR AUTOMATION

Figure 2:
Susceptibility of Canada's CMAs and CAs to Automation, 2011

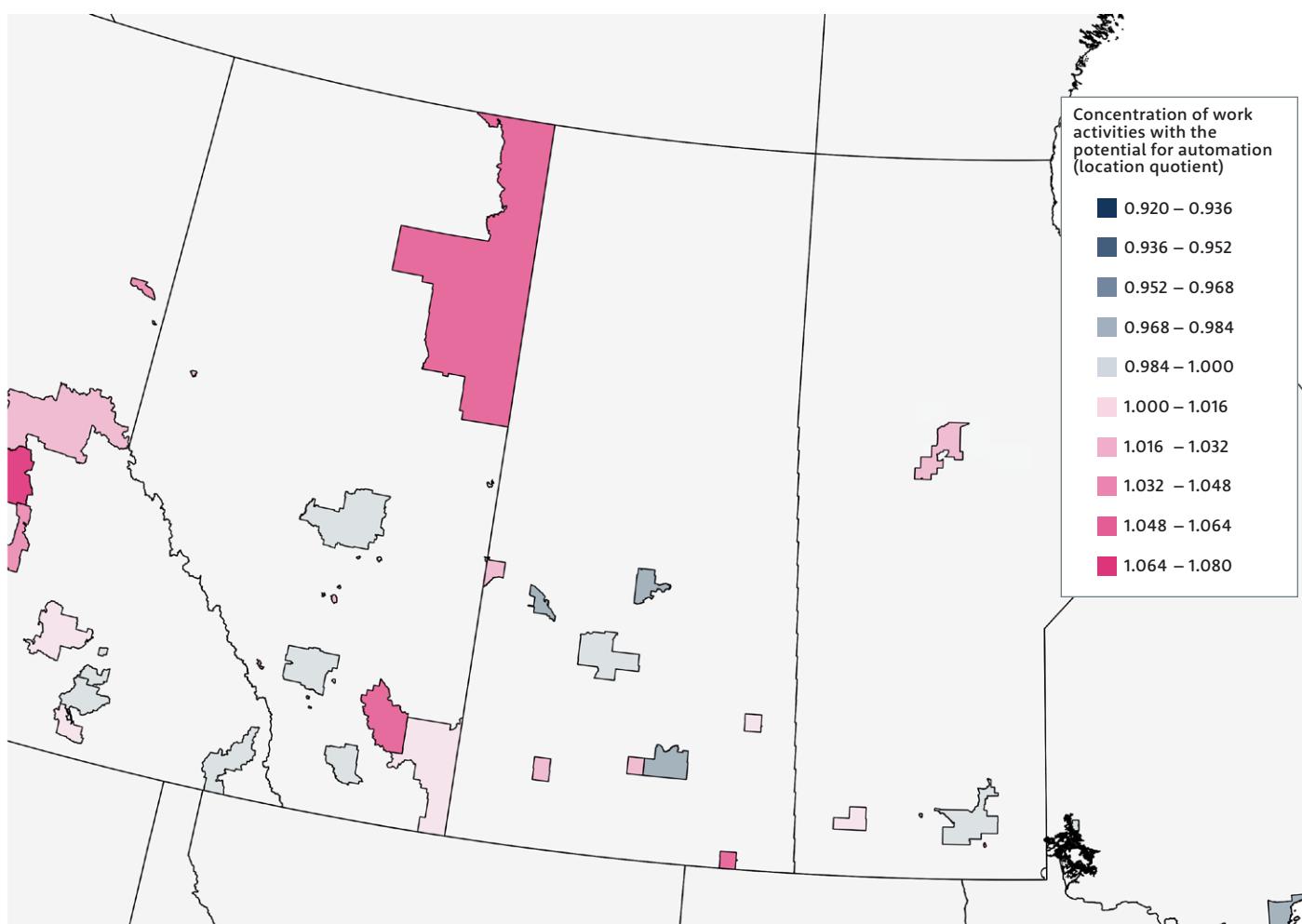


Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average. For an interactive version of this map, please visit brookfieldinstitute.ca.

Figure 2 helps to visualize the uneven distribution of risks associated with automation across Canada based on the concentration of work activities that could be automated. A number of smaller towns and cities specializing in manufacturing, mining, quarrying, or oil and gas extraction appear most at risk. These towns are found primarily in Alberta and Saskatchewan, as well as southern Ontario and Quebec.

Figure 3:

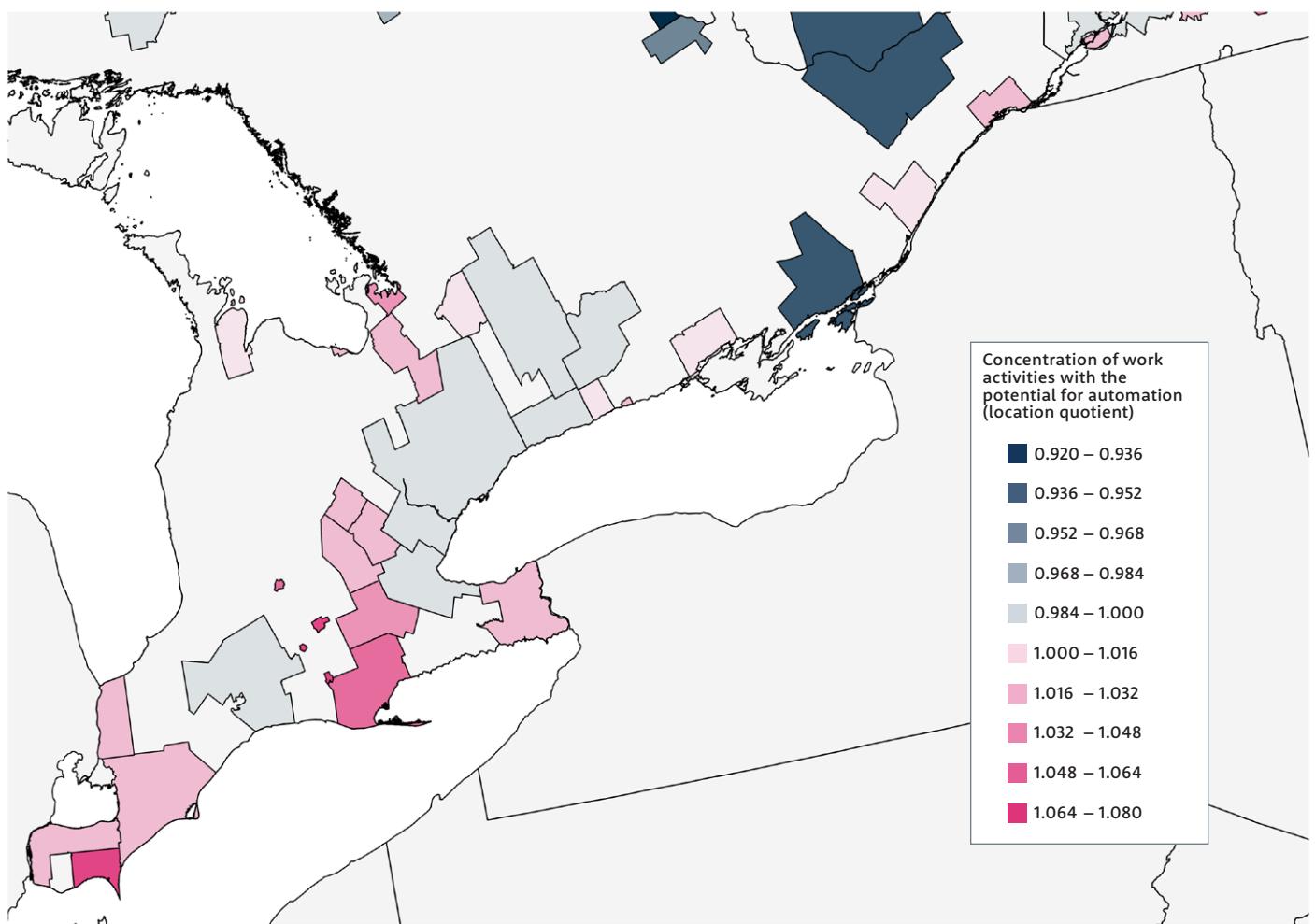
Susceptibility of Prairie Province CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

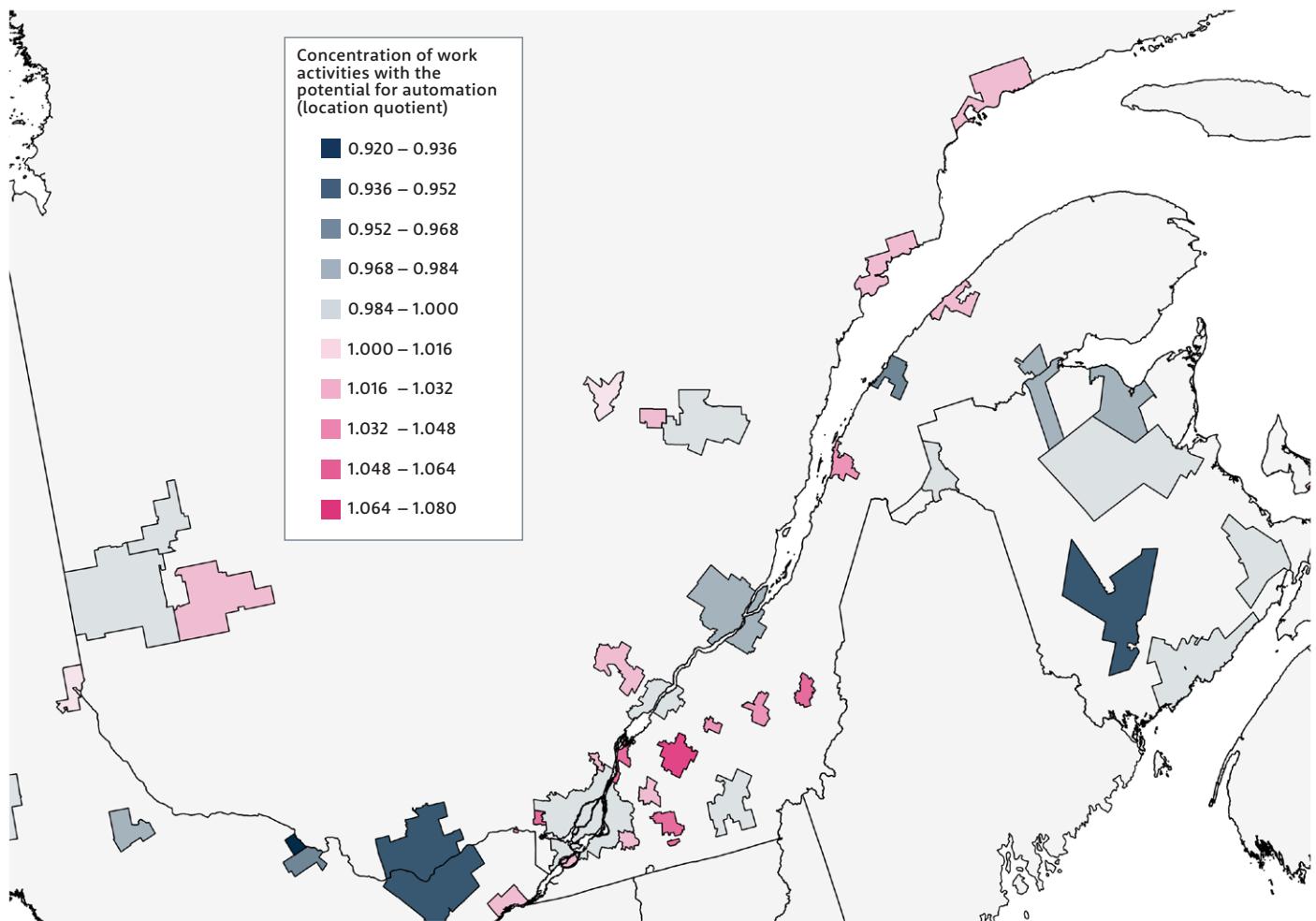
Figure 4:

Susceptibility of Southern Ontario CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

Figure 5:
Susceptibility of Quebec's CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

Manufacturing employment has already felt the impacts of industrial robotics around the world. However, automation is projected to continue to impact the sector.²³ A recent study showed that Canada ranks relatively low when it comes to the density of robots (robots per 10,000 workers) in the manufacturing sector, compared to international peers such as South Korea, Germany or Sweden.²⁴ This may indicate that Canada's manufacturing industry has room to expand when it comes to adopting this productivity enhancing technology. For many of Canada's small and medium-sized manufacturing firms, the decline in the price of industrial robotics, which from 1990-2005 fell by approximately one half across six major developed

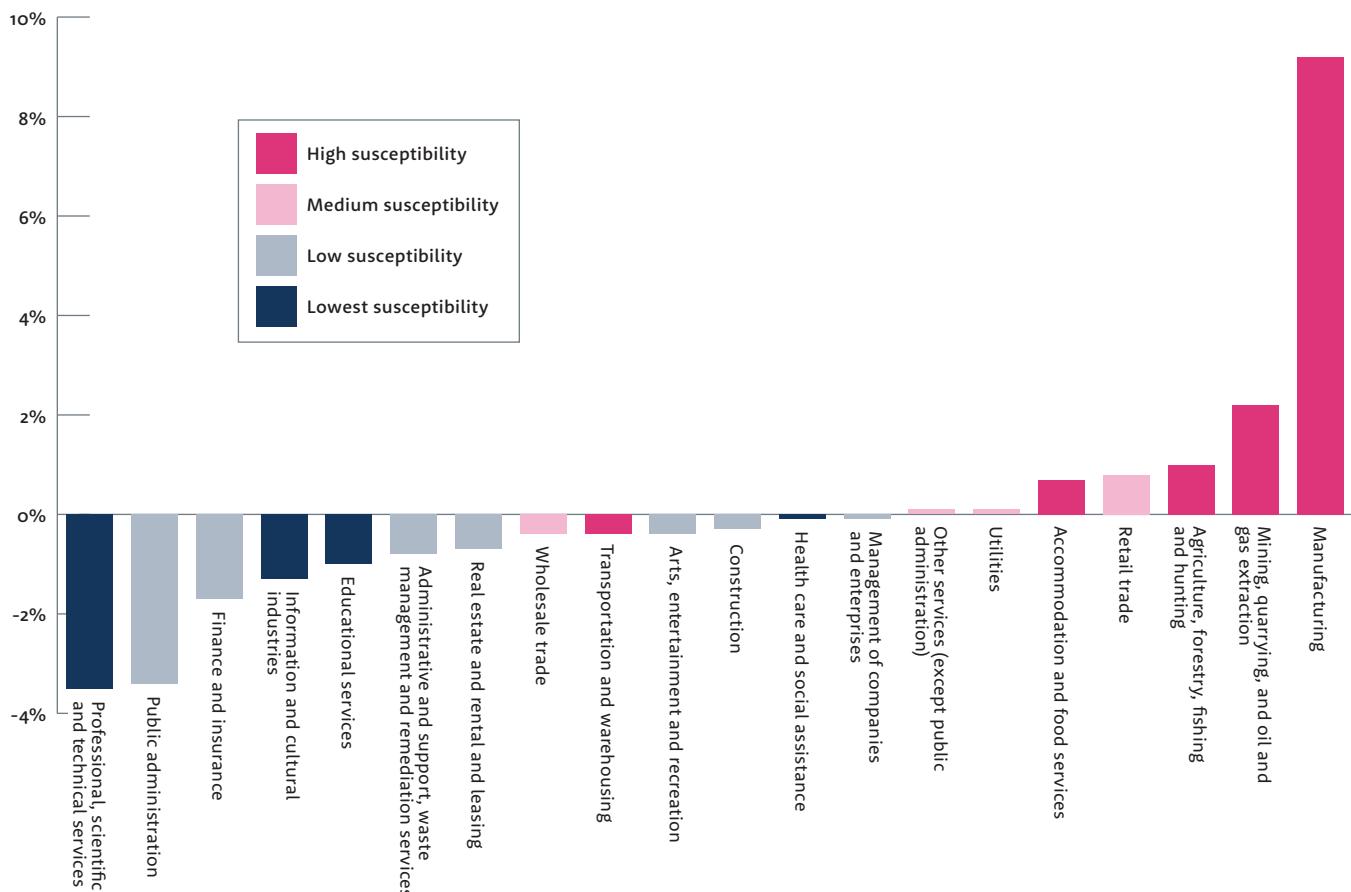
economies, could enable increased robot adoption.²⁵

Even though manufacturing has traditionally been the focus of the automation discourse, cities and towns specializing in oil, gas and other extractive industries may also be highly susceptible to these trends. Recent employment declines in these industries, particularly in Alberta, have largely been the result of exogenous shocks to oil prices, not automation.²⁶ However, advances in labour saving technologies, such as autonomous vehicles, are predicted to inhibit a return to pre-shock employment levels in Alberta's oil industry, even as it recovers from the downturn.²⁷

INDUSTRIAL DRIVERS OF THE MOST SUSCEPTIBLE CMAS AND CAs

Figure 6:

Difference in Industry Proportions, CMAs and CAs Most Susceptible to Automation (Top 20) Compared to National Average, 2011



Note: Industries were separated into quartiles based on the proportion of work that can be automated. High susceptibility is the top quartile, whereas low susceptibility is the bottom quartile.

The most susceptible CMAs and CAs in Canada are primarily small in population size. The average population of the 20 most susceptible CMAs and CAs is about 29,000. While these towns are geographically diverse, a disproportionate number are found in southwestern Ontario and southern Quebec.

Amongst the 20 most susceptible CMAs and CAs, manufacturing employment, which has a high potential for automation, captures on average 18 percent of the total labour force, compared to nine

Source: McKinsey Global Institute (2017), BII+E analysis

See Appendix A for all CMAs and CAs.

percent across Canada. Mining, quarrying, and oil and gas extraction, also with a high potential for automation, represents on average four percent of the total labour force, compared to one percent across Canada.

These highly susceptible CMAs and CAs also have a lower proportion of relatively insulated industries, such as professional, scientific and technical services, public administration, as well as finance and insurance, compared to the Canadian average.



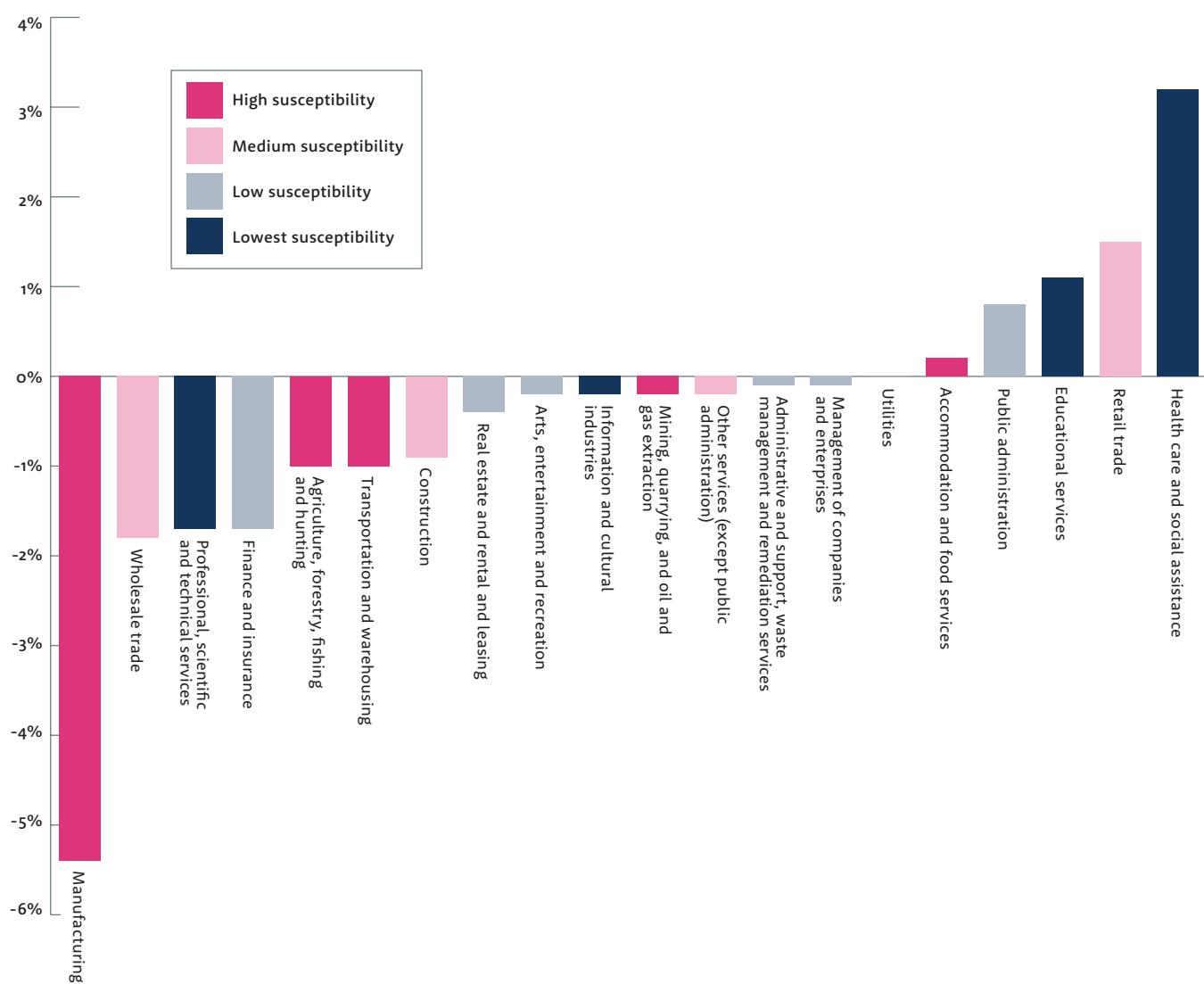
However, these highly susceptible CMAs and CAs vary greatly in terms of industrial diversity. CMAs and CAs such as Leamington, Ont., Brooks and Wood Buffalo, Alta., and Estevan, Sask., rank relatively high on the diversity index, meaning they are highly specialized. This lack of industrial diversity could inhibit their resilience to potential shocks as a result of automation. On

the other hand, CMAs and CAs such as Granby or Victoriaville, Que., have relatively diverse industrial mixes and may be better positioned to weather the negative labour market implications posed by automation.

INDUSTRIAL DRIVERS OF THE LEAST SUSCEPTIBLE CMAS AND CAs

Figure 7:

Difference in Industry Proportions, CMAs and CAs Least Susceptible to Automation (Bottom 20) Compared to National Average, 2011



Note: industries were separated into quartiles based on the proportion of work that can be automated. High susceptibility is the top quartile, whereas low susceptibility is the bottom quartile.

Source: McKinsey Global Institute (2017), BII+E analysis

See Appendix A for all CMAs and CAs.

Canada is also home to a large number of cities and towns that are relatively resistant to the effects of automation. The CMAs and CAs least susceptible to automation include many smaller cities and towns with a large healthcare presence, such as Corner Brook, Nfld., or Campbellton, N.B., where more than 20 percent of the total labour force is employed in healthcare and social assistance.

They also include cities and towns with a large post-secondary presence, such as Kingston, Ont., where 15 percent of total employment is in educational services, as well as those with a high proportion of employment in public administration, such as Ottawa-Gatineau, Ont., where about one quarter of the labour force is employed in this sector.

Canada's largest cities, Toronto, Montreal, and Vancouver, were not amongst the 20 CMAs and CAs with the lowest susceptibility to automation. Each of these cities has above average employment in highly specialized industries, with a low potential for automation, such as professional, scientific and technical services. However, they also have diverse economies with a large proportion of employment in industries that are more susceptible to automation, such as manufacturing.

While different towns and cities will likely feel the impacts of automation differently, even in the least susceptible towns and cities there is a sizable proportion of the labour force with the potential for automation. Across all CMAs and CAs, the proportion of work activities with the potential to be automated ranges from 43 percent in Petawawa, Ont., to over 50 percent in Ingersoll, Ont.

The relatively limited variation in potential automation impacts across Canada's CMAs and CAs is the result of two factors. First, as technology becomes increasingly capable of performing complex tasks, it has the potential to impact workers across industries.²⁸ CMAs and CAs may therefore feel the effects of these trends regardless of their industrial composition. For example, even a town with a significant number of employees in health care, which is relatively resistant to the impacts of automation, is not immune. 37

percent of work activities in this industry still have the potential to be automated. This town may also have a large proportion of employment in industries more susceptible to automation, such as accommodation and food services. Second, the proportion of employment across industries in Canada's cities and towns is fairly consistent, with some exceptions.

However, the potential for automation will not always be realized, as other factors (described in the section on data sources) will influence employer decisions. In addition, a city's or town's resilience to the effects of these trends may be enhanced by a more diverse industry mix.

CONCLUSION

Throughout history, technology has been a major driving force behind significant changes in our society —everything from how long we live, to what people do for work. The most recent wave of technological advancements, dubbed by the World Economic Forum as the Fourth Industrial Revolution, will continue to produce much more sophisticated technology at a much quicker pace. As a result, technology is projected to have wide-ranging impacts on the Canadian labour force.

However, these impacts are likely to be felt differently across the country. By mapping McKinsey automation data against labour force data for Canada's CMAs and CAs, this report suggests that, in the coming years, smaller cities and towns specializing in either manufacturing or resource extraction, particularly in the Canadian Prairies, southern Ontario and Quebec, will face the highest potential for job disruption as a result of automation.

In contrast, the areas least susceptible to automation in Canada range from smaller towns and cities with a large hospital, government or post-secondary presence, to some larger cities with diversified economies and a highly skilled labour force.

Overall, automation holds huge promise, as well significant risks for individual Canadians and communities. While the rate and extent of adoption of different technologies across industries is unknown, the benefits as well as the job displacement risks resulting from automation are likely to be more concentrated in certain industries, and in certain cities and towns. This suggests a need to more deeply understand the areas and people that are most at risk and to design policy and program responses—including in the areas of training, upskilling, education, and social safety nets—that take this uneven distribution of risk into account.

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In the coming months, BII+E will continue to examine the differentiated impacts of automation on disparate regions and individuals across the country. Our goal is to interrogate and analyze the industrial, socioeconomic, and demographic characteristics associated with a higher susceptibility to automation. We aim to create a profile of the regions and people that are most likely to be impacted by automation, recognizing the complex array of factors that will influence the future of work.

We will build on this initial data insights report to inform the Canadian discourse on what technology and innovation mean for inclusive economic growth in Canada. By mapping these trends and relationships at a more micro level, we will help to build a robust evidence base to inform the design of policies related to skills training, employment and social safety nets.

A P P E N D I X A :

M O S T A N D L E A S T S U S C E P T I B L E C M A S

A C R O S S C A N A D A

Figure 8:

Top 20 CMAs and CAs with the Highest Susceptibility to Automation, 2011

CMA or CA	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index
Ingersoll, Ont.	1.082	50%	9,700	8.253
Tillsonburg, Ont.	1.076	50%	12,770	8.054
Quesnel, B.C.	1.073	50%	18,160	9.715
Leamington, Ont.	1.072	50%	37,540	11.008
Woodstock, Ont.	1.070	50%	30,470	7.536
Drummondville, Que.	1.065	49%	71,195	7.820
Granby, Que.	1.064	49%	62,650	6.996
Brooks, Alta.	1.063	49%	17,530	18.919
Lachute, Que.	1.059	49%	10,435	8.247
Cowansville, Que.	1.058	49%	10,070	8.112
Norfolk County, Ont.	1.054	49%	51,705	8.920
Saint-Georges, Que.	1.051	49%	28,130	9.922
Wood Buffalo, Alta.	1.051	49%	54,230	26.579
Stratford, Ont.	1.046	48%	25,175	8.720
Steinbach, Man.	1.046	48%	10,320	8.377
Sorel-Tracy, Que.	1.046	48%	40,685	7.593
Estevan, Sask.	1.045	48%	10,135	26.496
Victoriaville, Que.	1.044	48%	37,255	7.081
Hawkesbury, Ont.	1.043	48%	10,010	8.822
Thetford Mines, Que.	1.043	48%	23,265	8.929



Figure 9:

Top 20 Canadian CMAs and CAs with the Lowest Susceptibility to Automation, 2011

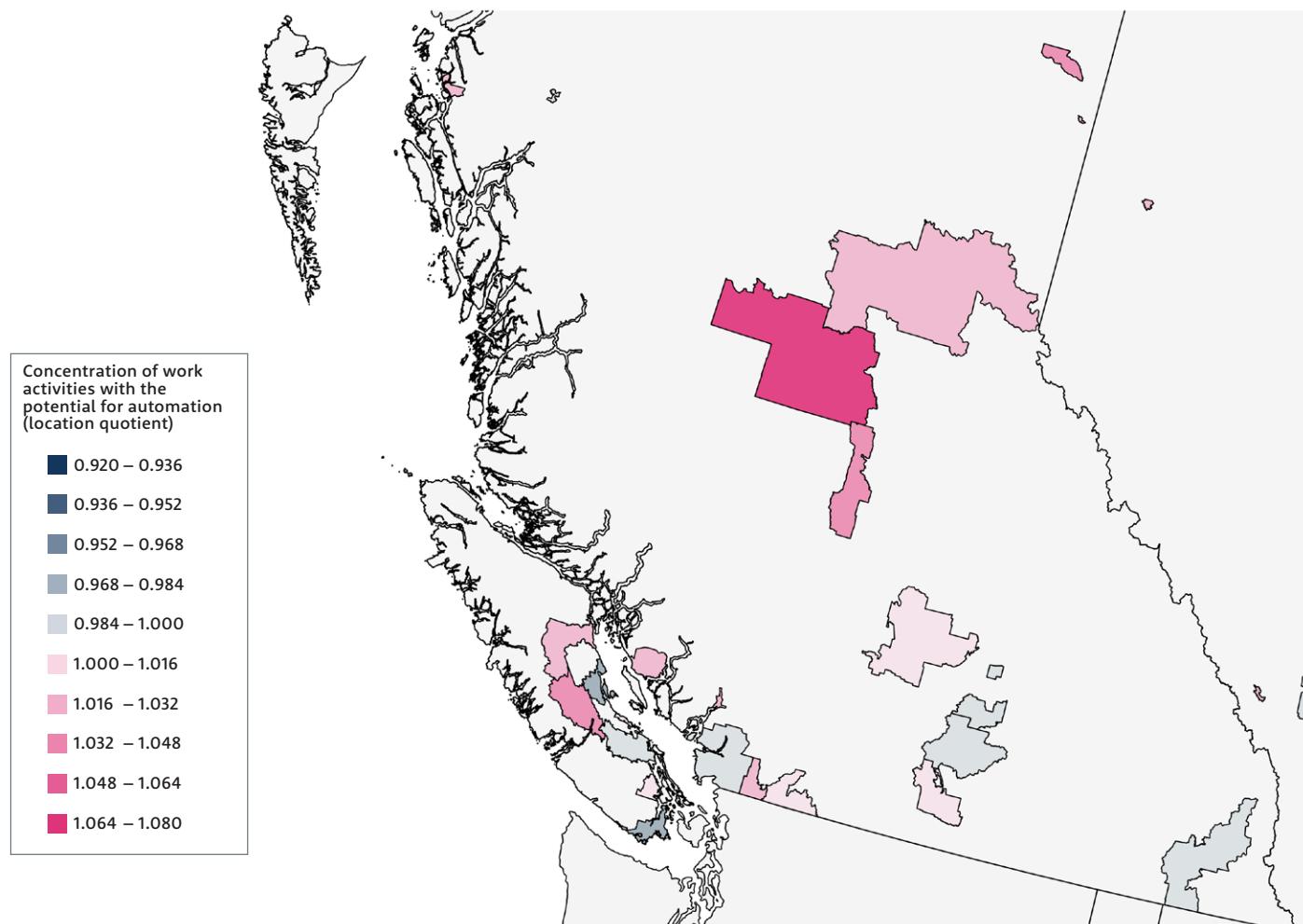
CMA or CA	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index
North Battleford, Sask.	0.979	45%	14,770	9.053
Quebec City, Que.	0.978	45%	634,200	5.461
Campbellton, N.B.	0.977	45%	14,770	7.844
Grand Falls-Windsor, Nfld.	0.977	45%	11,360	10.486
North Bay, Ont.	0.976	45%	53,210	6.840
Whitehorse, Yukon	0.976	45%	20,915	10.286
Prince Albert, Sask.	0.975	45%	31,925	7.698
Yellowknife, NWT	0.974	45%	15,030	10.173
Cape Breton Island, N.S.	0.972	45%	84,950	7.320
Charlottetown, PEI	0.970	45%	52,505	6.769
Corner Brook, Nfld.	0.970	45%	22,715	7.746
St. John's , Nfld.	0.969	45%	162,995	5.117
Halifax, N.S.	0.968	45%	325,050	4.792
Victoria, B.C.	0.966	45%	290,655	6.550
Pembroke, Ont.	0.961	44%	19,570	8.224
Rimouski, Que.	0.957	44%	41,945	8.397
Kingston, Ont.	0.954	44%	129,865	7.196
Fredericton, N.B.	0.952	44%	77,585	7.579
Ottawa - Gatineau, Ont.	0.947	44%	1,005,005	7.903
Petawawa, Ont.	0.919	43%	12,180	16.953

APPENDIX B:

A CLOSER LOOK AT AUTOMATION IN DIFFERENT REGIONS IN CANADA

BRITISH COLUMBIA (BC)

Figure 10:
Susceptibility of BC CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to Canadian average.

The five CMAs and CAs in B.C. most susceptible to automation have particularly high employment in two highly susceptible industries: agriculture, forestry, fishing and hunting, which represents on average 6 percent of total employment,ⁱⁱ as well as manufacturing, which represents on average 11 percent of total employment.ⁱⁱⁱ

Take for example Quesnel, a small city in the heart of the province. This city is amongst the most susceptible CMAs and CAs in B.C., largely driven by its predominant forestry^{iv} and wood product manufacturing^v industries.

The CMAs and CAs most susceptible to automation in B.C. also have a larger proportion of total

employment in mining, quarrying, and oil and gas extraction, at five percent of total employment on average, compared to the national average of two percent. This includes Fort St. John, a city in northeastern B.C., which is the home of the provincial Oil and Gas Commission and where 14 percent of total employment is in the oil and gas industry.

Compared to the least susceptible CMAs and CAs in the province, these cities and towns are also more concentrated in terms of industry mix, most notably Williams Lake, B.C. This could limit their resilience to any potential labour market dislocations associated with automation.

Figure 11:
British Columbia CMAs and CAs with the Highest Susceptibility to Automation, 2011^{vi}

British Columbia CMAs and CAs	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in:			
					Agriculture, forestry, fishing and hunting	Mining, quarrying, and oil and gas extraction	Manufacturing	Construction
Quesnel	1.073	50%	18,160	9.715	8%	1%	21%	6%
Williams Lake	1.042	48%	15,040	11.010	6%	7%	11%	5%
Port Alberni	1.037	48%	21,145	8.556	8%	1%	9%	8%
Fort St. John	1.036	48%	20,645	15.243	3%	14%	4%	11%
Abbotsford-Mission	1.030	48%	134,385	6.312	6%	0%	9%	10%

The CMAs and CAs in B.C. with the lowest susceptibility to automation appear to specialize in healthcare, social assistance and public administration, as is the case in Victoria and

Courtenay, in professional, scientific and technical services, as is the case in Vancouver, or in educational services, as is the case in Terrace.

ii. compared to the national average of two percent

iii. compared to the national average of nine percent

iv. roughly eight percent of total employment

v. roughly 21 percent of total employment

vi. The industries displayed were selected because: a) they are at high or medium-risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

Figure 12:

BC CMAs and CAs with the Lowest Susceptibility to Automation, 2011^{vii}

British Columbia CMAs and CAs	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity Index	Proportion of employment in:			
					Healthcare and social assistance	Admin. and support, waste mgmt. and remediation services	Public administration	Educational services
Terrace	0.998	46%	12,325	6.263	13%	3%	9%	10%
Kelowna	0.996	46%	150,320	5.140	13%	5%	5%	6%
Vancouver	0.991	46%	1,926,225	5.262	10%	4%	5%	8%
Courtenay	0.979	45%	46,330	7.281	14%	5%	11%	8%
Victoria	0.966	45%	290,655	6.550	14%	4%	15%	8%

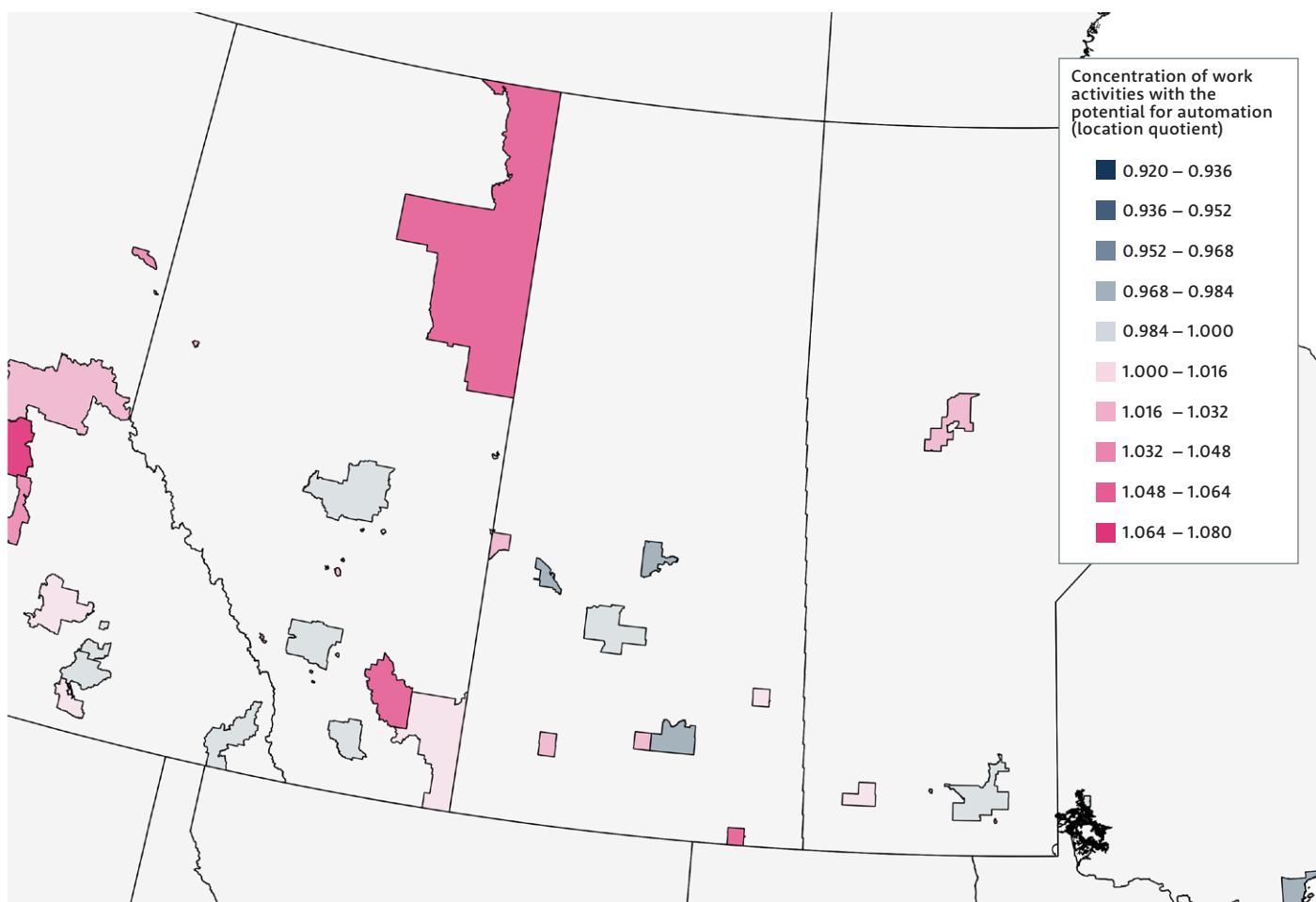


vii. Ibid.

PRAIRIE PROVINCES

Figure 13:

Susceptibility of Prairie Province CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

In the Canadian Prairies, the CMAs and CAs most susceptible to automation have workforces heavily concentrated in resource extraction. On average, amongst the most susceptible cities and towns, the proportion of total employment in mining, quarrying, and oil and gas extraction exceeds the Canadian average by 16 percentage points. For example, the Regional Municipality of Wood Buffalo, Alta., which is home to Fort McMurray and the Athabasca Oil Sands, has 30 percent of total employment in mining, quarrying, and oil and gas extraction, compared to one percent of total employment across Canada.

Brooks, a city in southeast Alberta, has the highest concentration of high susceptibility industries in

the Canadian Prairies. This is driven primarily by the high proportion of employment in energy (oil and gas) and manufacturing (metals). The Prairie Provinces are also home to other highly susceptible industries, including agriculture, forestry, fishing and hunting, construction and utilities.

Compared to other regions, the CMAs and CAs most susceptible to automation in the Canadian Prairies rank the highest on the diversity index—indicating highly specialized local economies. This suggests that these cities and towns may be more vulnerable than the rest of the country to the potential negative impacts of automation.

Figure 14:

Prairie Province CMAs and CAs with the Highest Susceptibility to Automation, 2011^{viii}

	Concen-tration of work with the potential to be automat-ed (location quotient)	Proportion of work with the potential to be au-tomated	Popula-tion	Diversity index	Proportion of employment in:				
					Mining, quarrying, and oil and gas extraction	Con-struction	Utilities	Other services	Agriculture, forestry, fishing and hunting
Brooks, Alta.	1.063	49%	17,530	18.919	15%	6%	2%	5%	8%
Wood Buffalo, Alta.	1.051	49%	54,230	26.579	30%	11%	1%	4%	0%
Steinbach, Man.	1.046	48%	10,320	8.377	0%	9%	1%	6%	4%
Estevan, Sask.	1.045	48%	10,135	26.496	21%	8%	6%	6%	2%
Lloydminster, Alta.	1.030	48%	23,450	17.143	17%	9%	1%	6%	2%

The cities and towns least susceptible to automation in the Canadian Prairies have on average much higher proportions of employment in public administration—13 percent of the local labour force compared to the seven percent national average—as well as health care and social assistance and educational services.

For example, the city of Cold Lake, Alta., has close ties to the Canadian Forces Base (CFB) Cold Lake. As a result, 27 percent of total employment is in public administration, compared to the national average of seven percent. Another example is North Battleford, Sask. This small city falls within

the province's Prairie North Health Region and is home to two large hospitals, believed to be the region's largest employers. As a result, 20 percent of total employment in North Battleford is in the healthcare industry, compared to the national average of 11 percent.

However, many of these CMAs and CAs, such as Cold Lake, Alta., are still home to large extractive industries at 17 percent of the total labour force, which have a higher potential to be impacted by automation.

viii. The industries displayed were selected because: a) they are at high or medium-risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

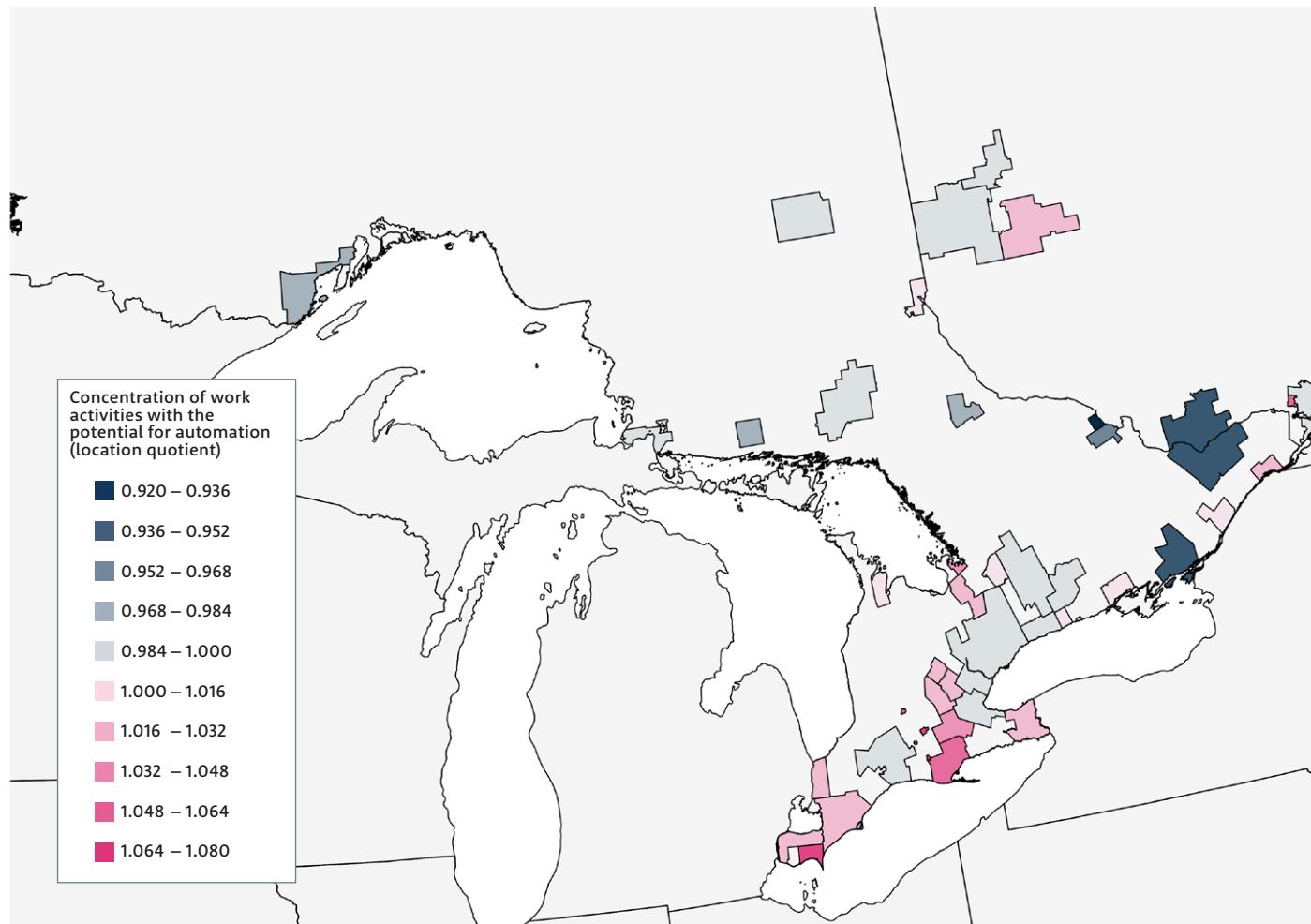
Figure 15:
Prairie Province CMAs and CAs with the Lowest Susceptibility to Automation, 2011^{ix}

	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in:			
					Public administration	Healthcare and social assistance	Educational services	Arts entertainment and recreation
Cold Lake, AB	0.988	46%	10,625	22.913	27%	6%	8%	1%
Regina, SK	0.982	45%	170,070	4.969	11%	12%	5%	2%
Lacombe, AB	0.982	45%	9,055	8.995	7%	11%	8%	1%
North Battleford, SK	0.979	45%	14,770	9.053	5%	20%	5%	0%
Prince Albert, SK	0.975	45%	31,925	7.698	15%	15%	7%	1%

ix. The industries displayed were selected because: a) they are at relatively low risk of being affected by automation, and b) the proportions of employment in these industries for the CMAs and CAs listed have the largest positive deviations from the national average.

ONTARIO

Figure 16:
Susceptibility of Ontario CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

The CMAs and CAs in Ontario most susceptible to automation are primarily small manufacturing cities and towns in the southwest—a region once considered Canada’s industrial heartland. However, due to a number of factors including the rising dollar, manufacturing employment in this region has already experienced significant decline over the past decade or so.²⁹ Employment may continue to decline in the area if existing manufacturers continue to invest in labour saving technologies to improve productivity and maintain cost competitiveness.

Among the most susceptible CMAs and CAs, manufacturing employment represents 21 percent of the total labour force on average, compared to the national average of nine percent. This includes Ingersoll, Woodstock and Tillsonburg, Ont., whose proportion of total employment in manufacturing exceeds 20 percent.

The most susceptible cities and towns also have higher proportions of employment in agriculture, forestry, fishing and hunting,^x accommodation and food services,^{xi} and transportation and warehousing.^{xii}

When considering overall industrial diversity, on average these highly susceptible CMAs and CAs in

Ontario do not differ drastically from the national average. The major exception is Leamington, Ont., whose diversity index score of 11.0 indicates a notably greater industry uniformity compared to the national average. This could indicate that Leamington, Ont., may be less resilient to the potential impacts of automation compared to the other highly susceptible CMAs and CAs in Ontario.

Figure 18:

Ontario CMAs and CAs with the Highest Susceptibility to Automation, 2011^{xiii}

	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in:			
					Manufacturing	Agriculture, forestry, fishing and hunting	Accommodation and food services	Transportation and warehousing
Ingersoll, Ont.	1.082	50%	9,700	8.253	24%	2%	9%	6%
Tillsonburg, Ont.	1.076	50%	12,770	8.054	23%	2%	8%	4%
Leamington, Ont.	1.072	50%	37,540	11.008	18%	12%	6%	6%
Woodstock, Ont.	1.070	50%	30,470	7.536	25%	1%	7%	5%
Norfolk, Ont.	1.054	49%	51,705	8.920	17%	9%	6%	4%

The cities least susceptible to automation in Ontario include Ottawa-Gatineau, Ont., home of Canada's federal public service, where about one-quarter of total employment is in public administration. It also includes smaller cities with a high proportion of employment in health care and educational services such as Kingston, Ont., home of Queen's University and a number of large hospitals.

Toronto, the country's largest city, ranks 9th lowest in Canada when it comes to the concentration

of work with the potential to be automated. As a large, economically diverse city, Toronto has a significant proportion of employment in industries with both a low and high susceptibility to automation. For example, professional, scientific and technical services make up 10 percent of Toronto's total employment, compared to the national average of seven percent. However, Toronto is also home to many highly susceptible industries such as manufacturing, which makes up 10 percent of the city's total employment.

x. Five percent of total employment on average

xi. Seven percent of total employment on average

xii. Five percent of total employment on average

xiii. The industries displayed were selected because: a) they are at high or medium-risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.



While on average, the least susceptible CMAs and CAs in Ontario have relatively diverse economies, there are some exceptions, namely Petawawa,

Ont., where most workers are employed as either civilians or military personnel at CFB Petawawa.

Figure 19:

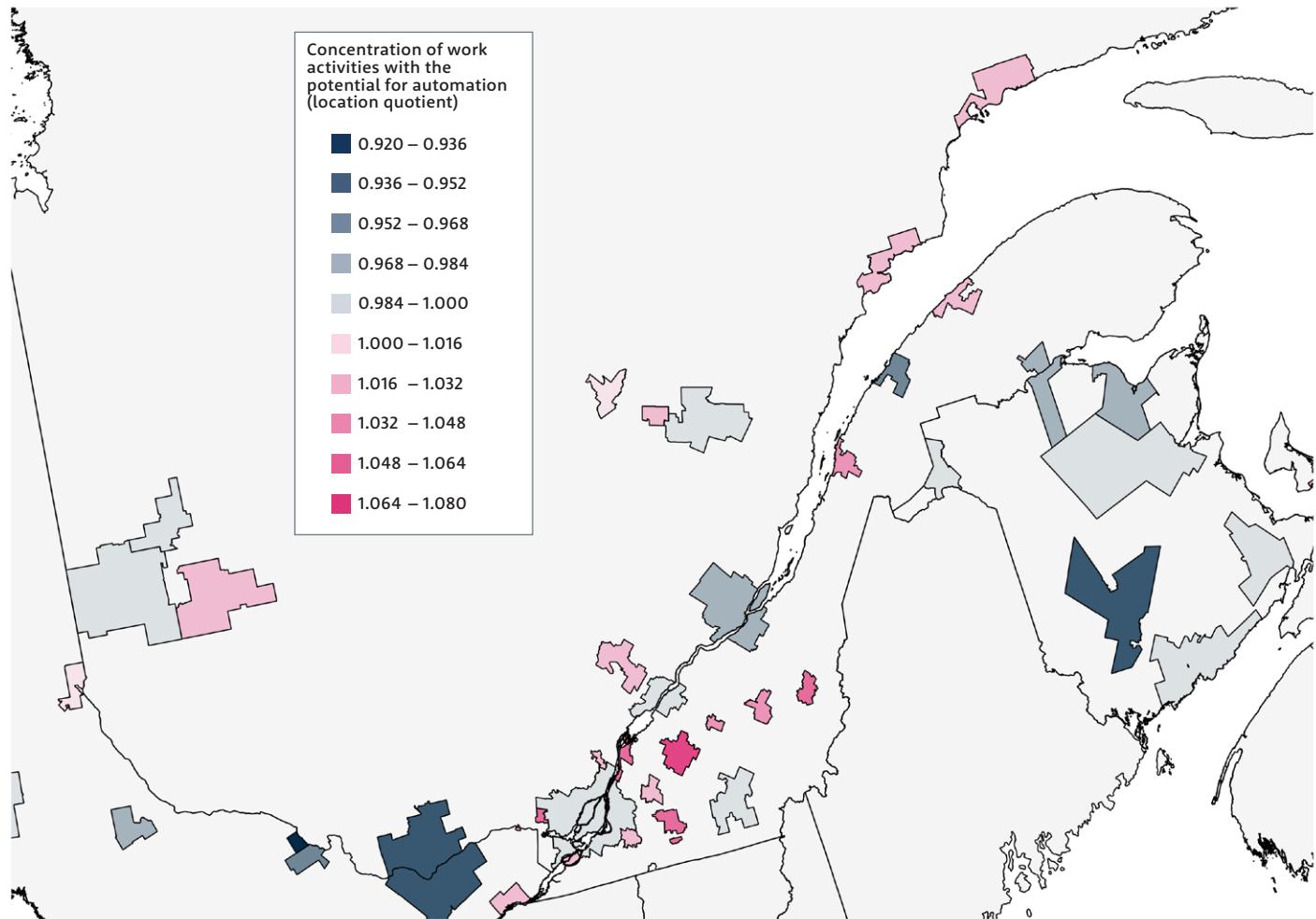
Ontario CMAs and CAs with the Lowest Susceptibility to Automation, 2011^{xiv}

	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in			
					Public administration	Health care and social assistance	Professional, scientific and technical services	Educational services
North Bay, Ont.	0.976	45%	53,210	6.8	10%	14%	5%	15%
Pembroke, Ont.	0.961	44%	19,570	8.2	13%	20%	2%	10%
Kingston, Ont.	0.954	44%	129,865	7.2	13%	16%	8%	8%
Ottawa-Gatineau, Ont.	0.947	44%	1,005,005	7.9	25%	17%	5%	10%
Petawawa, Ont.	0.919	43%	12,180	17.0	54%	16%	5%	9%

xiv. The industries displayed were selected because: a) they are at relatively low risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

QUEBEC

Figure 20:
Susceptibility of Quebec CMAs and CAs to Automation, 2011



Note: A location quotient above one indicates a higher concentration of work activities with the potential to be automated, compared to the Canadian average.

Similar to Ontario, small manufacturing towns and cities in southern Quebec have the highest potential for automation. Amongst the most susceptible CMAs and CAs, the proportion of total employment in manufacturing averaged 22 percent.

These CMAs and CAs also have above average employment, as a proportion of total, in retail trade, accommodation and food services, as well as agriculture, forestry, fishing and hunting. For

example, employment in the town of Cowansville, Que., is particularly concentrated in manufacturing and retail trade.

However, these CMAs and CAs also have relatively diverse industry mixes. This could help insulate their economies from some of the negative repercussions associated with automation.

Figure 21:

Quebec CMAs and CAs with the Highest Susceptibility to Automation, 2011^{xv}

	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in:			
					Manufacturing	Retail trade	Accommodation and food services	Agriculture, forestry, fishing and hunting
Drummondville, Que.	1.065	49%	71,195	7.820	22%	13%	7%	4%
Granby, Que.	1.064	49%	62,650	6.996	24%	12%	6%	3%
Lachute, Que.	1.059	49%	10,435	8.247	19%	13%	7%	2%
Cowansville, Que.	1.058	49%	10,070	8.112	19%	17%	8%	3%
Saint-Georges, Que.	1.051	49%	28,130	9.9922	23%	14%	6%	2%

The CMAs and CAs with the least potential for automation in Quebec range from cities with diversified economies and a highly skilled labour force, such as Montreal, where 9 percent of total employment is in professional, scientific and technical services, to Quebec City, the provincial capital, where nearly 14 percent of total employment is in public administration in 2011.

They also include smaller towns and cities such as Rimouski, which is home to the Université du Québec à Rimouski and the Conservatory of

Music. As a result, this city has a high proportion of total employment in educational services as well as information and cultural industries, which are some of the least susceptible industries to automation.

These relatively insulated CMAs and CAs in Quebec also have comparatively diverse economies, in particular the larger metropolitan areas of Montréal and Québec.

xv. The industries displayed were selected because: a) they are at high or medium-risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

Figure 22:

Quebec CMAs and CAs with the Lowest Susceptibility to Automation, 2011^{xvi}

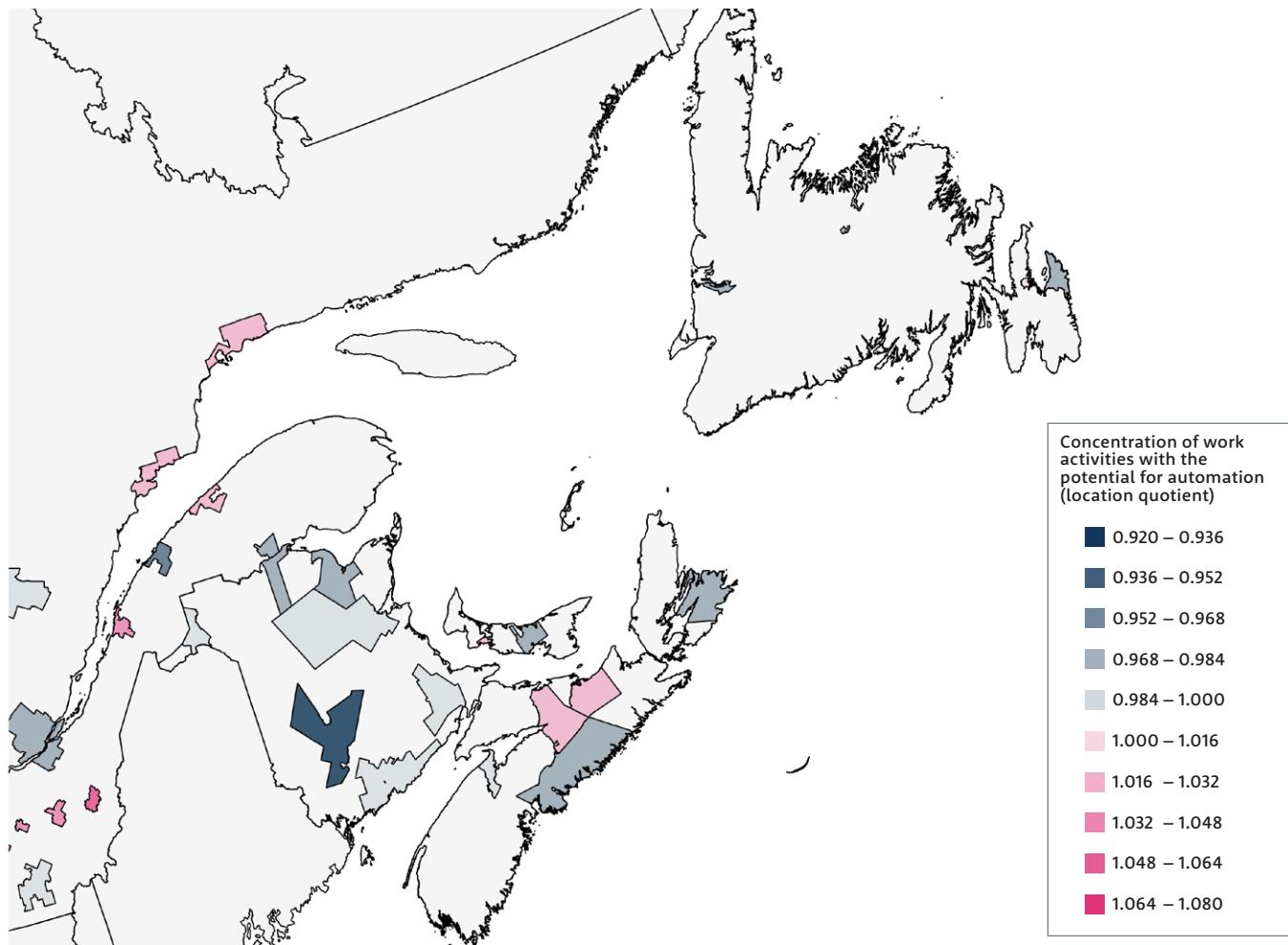
	Concentration of work with the potential to be automated (location quotient)	Proportion of work with the potential to be automated	Population	Diversity index	Proportion of employment in:			
					Health care and social assistance	Educational services	Public administration	Informational and cultural industries
Sherbrooke, Que.	0.992	46%	165,090	6.060	16%	11%	5%	1%
Montréal, Que.	0.991	46%	3,120,060	4.078	12%	8%	5%	4%
Amos, Que.	0.991	46%	13,710	10.426	20%	8%	8%	1%
Québec, Que.	0.978	45%	634,200	5.461	13%	7%	14%	2%
Rimouski, Que.	0.957	44%	41,945	8.397	15%	10%	9%	6%

xvi. The industries displayed were selected because: a) they are at relatively low risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

MARITIMES

Figure 23:

Susceptibility of Maritime Province CMAs and CAs to Automation, 2011



Note: A location quotient above 1 indicates a higher concentration of work activities with the potential to be automated versus the Canadian average.

The CMAs and CAs most susceptible to automation in the Maritimes have, on average, much higher employment in retail trade, as well as manufacturing; agriculture, forestry, fishing and hunting; and accommodation and food services.

However, unlike in other parts of Canada, the most susceptible Maritime cities and towns have fairly diverse economies and are home to large industries relatively insulated from automation. On average, 14 percent of total employment in these CMAs and CAs is in health care and social assistance, compared to 11 percent across Canada,

and nine percent of total employment is in public administration, compared to seven percent across Canada.

Take for example, New Glasgow, N.S., a town with a population of nearly 30,000. This town has a fairly diverse economy, with major employers in the area including a Michelin tire plant, the Northern Pulp Nova Scotia pulp mill, the Aberdeen Hospital, as well as the headquarters of the national grocery chain Sobeys.

Figure 24:

Maritime CMAs and CAs with the Highest Susceptibility to Automation, 2011^{xvii}

	Concen-tration of work with the potential to be automat-ed (location quotient)	Proportion of work with the potential to be auto-mated	Popula-tion	Diver-sity index	Proportion of employment in			
					Retail trade	Manufactur-ing	Agriculture, forestry, fishing and hunting	Accommo-dation and food services
Truro, N.S.	1.033	48%	37,670	6.937	15%	13%	4%	6%
Summerside, PEI	1.032	48%	13,335	9.188	12%	14%	3%	9%
New Glasgow, N.S.	1.023	47%	29,625	8.826	19%	12%	3%	7%
Bay Roberts, Nfld.	1.006	47%	8,950	10.215	16%	6%	5%	6%
Edmund-ston, N.B.	1.004	46%	18,205	8.425	14%	13%	2%	5%

The least susceptible CMAs and CAs in the Maritimes have a high proportion of total employment in public administration, health care and social assistance, as well as educational services. For example, Corner Brook, a small city in Newfoundland, is home to the largest regional hospital in the west of the province, as well as the Grenfell Campus of Memorial University. As a result, over 30 percent of total employment in the city is either in health care, social assistance or educational services, making this city comparatively resistant to automation.

Many of the major cities in the region, including Halifax, N.S., and St. John's, Nfld., also have relatively low concentrations of work activities with the potential for automation. These cities have higher than average employment in public administration, educational services, and health care and social assistance. They are also home to a relatively diverse industry mix, providing a further buffer against negative automation impacts.

xvii. The industries displayed were selected because: a) they are at high or medium-risk of being affected by automation, and b) the proportions of employment in these industries for the CAs and CMAs listed have the largest positive deviations from the national average.

Figure 25:

Maritime CMAs and CAs with the Lowest Susceptibility to Automation, 2011^{xviii}

	Concentration of work with the potential to be auto- mated (loca- tion quotient)	Proportion of work with the potential to be auto- mated	Population	Diver- sity index	Proportion of employment in			
					Public adminis- tration	Health care and social as- sistance	Educa- tional services	Administrative and support, waste manage- ment and reme- diation services
Charlottetown, PEI	0.972	45%	52,505	6.769	16%	12%	10%	4%
Corner Brook, Nfld.	0.970	45%	22,715	7.746	9%	22%	10%	4%
St. John's, Nfld.	0.969	45%	162,995	5.117	12%	15%	8%	5%
Halifax, N.S.	0.968	45%	325,050	4.792	13%	12%	8%	4%
Fredericton, N.B.	0.952	44%	77,585	7.579	18%	11%	10%	4%

xviii. The industries displayed were selected because: a) they are high and medium-risk industries, and b) employment across the top five CMAs and CAs in these industries had the largest positive deviations from the national average.

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