Policy Innovation Initiative

Supporting Job Creation in the Face of Increasing Automation

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Abstract

For better or for worse, automation is likely to cause significant labour displacement in Canada. Policymakers, consequently, are in search of innovative ways that displaced workers across the country can easily trained for jobs of the future. This report focuses the conversation about automation to Ontario's many different regions.

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Ontario

FutureSkills

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On behalf of the PII team: thank you, Dr. Linda White, Alix Janson, George Poulakidas and Chris Lau for your guidance and support.

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Executive Summary

For better or for worse, automation is likely to cause significant labour displacement in Canada. Policymakers, consequently, are in search of innovative ways that displaced workers across the country can easily trained for jobs of the future. This report focuses the conversation about automation to Ontario's many different regions. In it, we find the following:

1. There are considerable differences in the overall size and occupational distribution of Ontario's labour force by region.
2. The diversity of automation risk and readiness across Ontario's regions, while not extreme, is sufficient to merit different policy approaches in certain regions while other regions will benefit from general training programs. Guelph and Waterloo ranked high on total automation readiness while municipalities such as Barrie and Niagara showed overall greater automation risk. Other regions such as London, Hamilton, Kitchener and Thunder Bay exhibited moderate levels of risk and readiness.
3. Canada's Labour Market Development Agreements (LMDA) have historically been effective in boosting employment levels in Canada but may not be effective for today's technologies, industries and labour needs. Currently, many participants in LMDA-funded programs are trained in careers that are at the highest risk of automation. In the program years observed, Alberta's programs had the largest impacts on both employment and earnings. Ontario's programs had a positive but more moderate impact while the impacts of Saskatchewan's programs were only significant for certain years.
4. Data algorithms presents an opportunity to keep Canada's LMDA's effective by making identification of viable career changes easier for program entrants and shifting resources towards training implementation.

Part I: A Review of Automation

In 2019, Employment and Social Development Canada announced the creation of "Future Skills", a government laboratory tasked with updating the skills of Canadians nationwide and ensuring that Canadians are ready for tomorrow's occupations. The government has pledged $225 million dollars over four years as well as $75 million for each year after to support this initiative. Future Skills Canada will carry out this initiative by 1) raising awareness about labour market trends related to skills among Canadians, 2) monitor the performance of the Future Skills Center, an independent

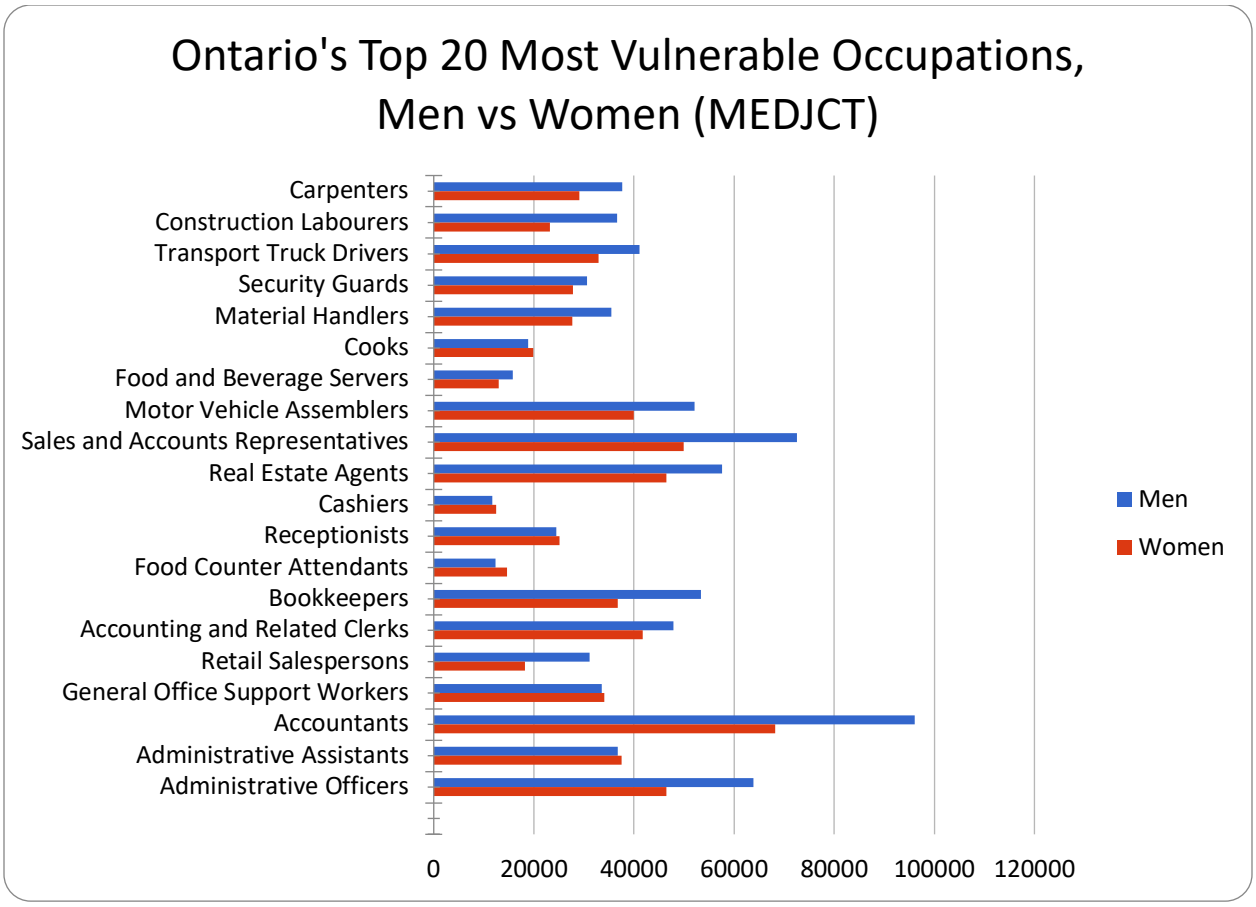
research center, and 3) work with the provinces and territories to support adoption of policies to help prepare Canadians for this labour market change.[i]

The establishment of Canada's Future Skills laboratory is rooted in a rapidly growing body of academic and think-tank literature raising alarms about how automation may affect the lives of Canadians nationwide. Canada's Advisory Council of Economic Growth, for instance, projected that automation could displace more than 10% of the Canadian labour force from at-risk occupations.[ii] The World Development Report added to the conversation on automation by highlighting that the actual level of risk faced by a country depends on a variety of different factors including technological uptake, the proportion of employment in non-cognitive routine occupations, the ability of certain industries such as healthcare to adequately substitute human labour with machines, and the growth and redevelopment of industries such as tourism.[iii] On the impacts of automation, technological pessimists warn that automation could potentially depress wages for generations to come[iv] and diminish the quality of work for humans.[v]

The prescriptions experts make for societies to prepare for automation are highly diverse. Khan 2018, for instance, believes that automation might necessitate the adoption of job splitting.[vi] Sorgner 2018 views the growing trend of entrepreneurism globally as natural response to automation trends already underway.[vii] Regarding the role of government, McKinsey & Company has made a variety of recommendations how Canada's economy can be prepared for automation including but not limited to rescaling mid-career training opportunities, modernizing public education, improving collection of labour economic data.[viii] In exploring the impacts of automation in Ontario, this report will focus on changing program foundations rather than small-scale experimental solutions.

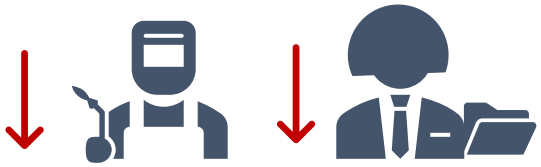
Part II: Ontario's Top 20 Most Vulnerable Occupations

At the start of this report, we were lucky enough to gain vital insights into the Ontario labour market through the Ontario Ministry of Economic Development, Job Creation and Training (MEDJCT). More specifically, we were given Ministry insights into the top 20 occupations in the province most at risk of automation within the next 10 years. A replication of the data we were given can be observed in **figure 1**.



The data provided by MEDJCT suggests the following:

1. The impacts of automation will likely fall unevenly on men and women depending on the occupational area it affects. More specifically, impacts on men are expected to be larger in occupations related to manufacturing while



women are more likely to be more impacted in occupations related to administration.

2. Blue collar occupations are not exclusively vulnerable to automation. White collar positions that are relatively non-routine and cognitive such as accounting face a similar risk.

Part III: Regional Analysis

Risk and Readiness

In conducting the regional analysis of automation's projected impacts in Ontario we followed a 2018 study by Rosalie Wyonch of the C.D. Howe Institute.[ix] Wyonch's report used two specific measures to determine how provinces would be affected, namely Risk and Readiness. Risk was defined as the proportion of jobs in high-risk occupations and the polarization of these jobs within certain industries. Readiness, on the other hand, was defined as a province's respective capacity to shift terminated workers into new occupations easily, a function of adult literacy, adult numeracy and problem solving ability in a technology rich environment. In attempting to adapt Ontario's available data to Wyonch's methodology, we define our measures in the following way:

- **Risk:** the proportion and overall number of a region's workers in high-risk occupations in each region (management occupations are excluded from this analysis).
- **Readiness:** the proportion of individuals with a bachelor's degree or higher in each region.

Ontario's Regions

For the regional analysis, a macroeconomic scan was conducted, of eight different cities categorized into four different regions:

- **Northwestern Ontario:** Thunder Bay
- **London:** London
- **Hamilton-Niagara Peninsula:** Hamilton and Niagara
- **Kitchener-Barrie-Waterloo Region:** Barrie, Kitchener, Waterloo, Guelph

Industrial Analysis (NAICS 2012)

The first component of analysis is conducted to have a picture of the industrial composition of each of these cities. To do this, 2012 data North American Industrial Classification System (NAICS), was used. The industries of concern, at highest risk of automation include:

- Manufacturing
- Transportation and warehousing
- Retail trade

- Construction
- Real estate
- Accommodation and food services
- Administrative and support, waste management and remediation services
- Wholesale trade

The size of these industries for each region are in **Figure 2.** This data shows the following:

1. Hamilton dominates retail-related positions.
2. Accommodation and food service-related positions are dominated by Niagara.
3. Kitchener and Waterloo dominates manufacturing-related positions.
4. While Thunder Bay and Guelph differ considerably in certain aspects, they have roughly the same number of jobs in both retail trade and accommodation and food services.
5. In most regions, wholesale trade is roughly one-third the size of retail trade.
6. By number of occupations, real estate and rental and leasing consistently ranks as smallest industrial category.
7. Hamilton, Kitchener and Waterloo have approximately the same number of jobs in construction-related positions as well as in transportation and warehousing positions

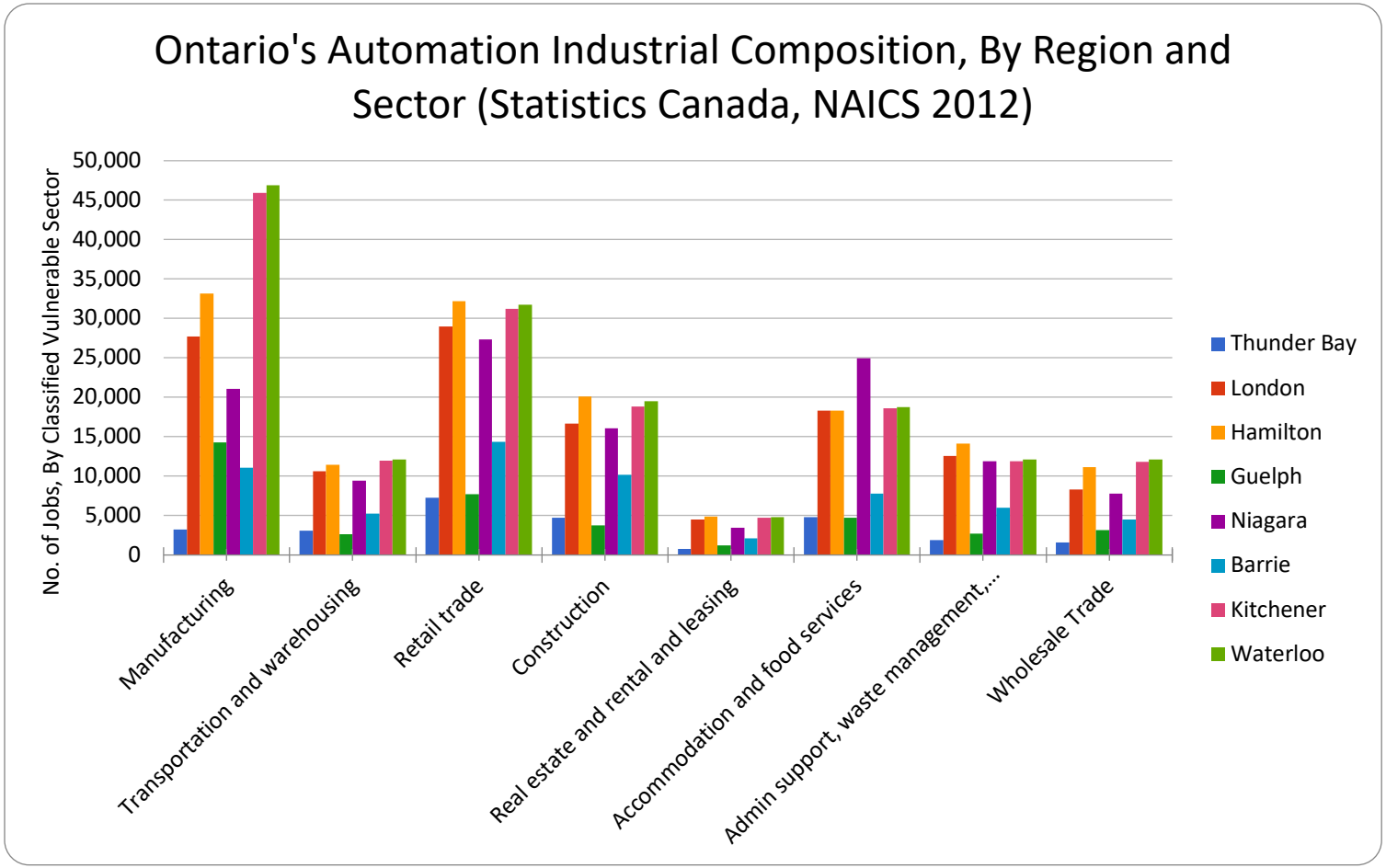


Figure 2: Ontario's automation risk as measured through the North American Industrial Classification System from the Canadian 2016 census.

Industrial Analysis (NOCS 2016/2018)

The second component of the regional analysis includes conducting a granular macroeconomic scan of these eight cities. To do this, data from the 2016 as well as 2018 data from the National Occupational Classification System were used. Unlike NAICS, NOCS is based on Canadian measures and is used to measure the size of occupations rather than industries. More importantly, NOCS distinguishes between positions at a supervisory or management level and regular labour positions. The non-managerial occupational categories used for this analysis include:

- Sales representatives and salespersons – wholesale and retail trade
- Sales support occupations
- Sales support and other service occupations, n.e.c.[1]
- Office support occupations
- Finance, insurance and related business administrative occupations
- Distribution, tracking and scheduling co-ordination occupations
- Assemblers in manufacturing
- Transport and heavy equipment operator and related maintenance occupations
- Harvesting, landscaping and natural resources labourers
- Processing and manufacturing machine operators and related production workers
- Labourers in processing, manufacturing and utilities
- Trades contractors, construction labourers and related occupations
- Other installers, repairers and material handlers

Although 2018 NOCS data was available, this analysis required adjusting the parameters to accommodate for differences in regional data. There is, for example, no data in the 2018 data set on Thunder Bay but rather on North Western Ontario which includes Thunder Bay. This difference also meant that Hamilton and Niagara were combined in the Hamilton-Niagara peninsula data set and Guelph was amalgamated into the Kitchener-Barrie-Waterloo region. The breakdown of the 2018 NOCS dataset is shown in figure this data is in Figure 3. The data show the following:

[1] From Statistics Canada: "This unit includes other support occupations, not elsewhere classified, primarily concerned with the provision of services. Those in occupations in this unit are employed by a wide range of establishments, and may be self-employed."

1. Occupations related to retail sales outnumber jobs in other occupations by a significant margin. Retail-related occupations, for example, outnumber manufacturing positions roughly 2:1 across the examined regions.
2. The Hamilton-Niagara peninsula holds the highest number of occupations in the areas related to retail as well as in occupations related to equipment operation and transportation.
3. The Kitchener-Waterloo-Barrie region (including Guelph), holds the highest number of occupations in areas related to finance, insurance and business administration; distribution and tracking; and processing and machine operation in manufacturing.
4. The Hamilton-Niagara peninsula and the Kitchener-Waterloo-Barrie region are roughly tied for occupations related to office support, labour in processing, trades contractors and installers and repairers.
5. London ties with the Hamilton-Niagara Peninsula in occupations related to distribution and tracking.
6. North Western Ontario ranks lowest in all the occupational areas and follows a similar distribution across all the area.

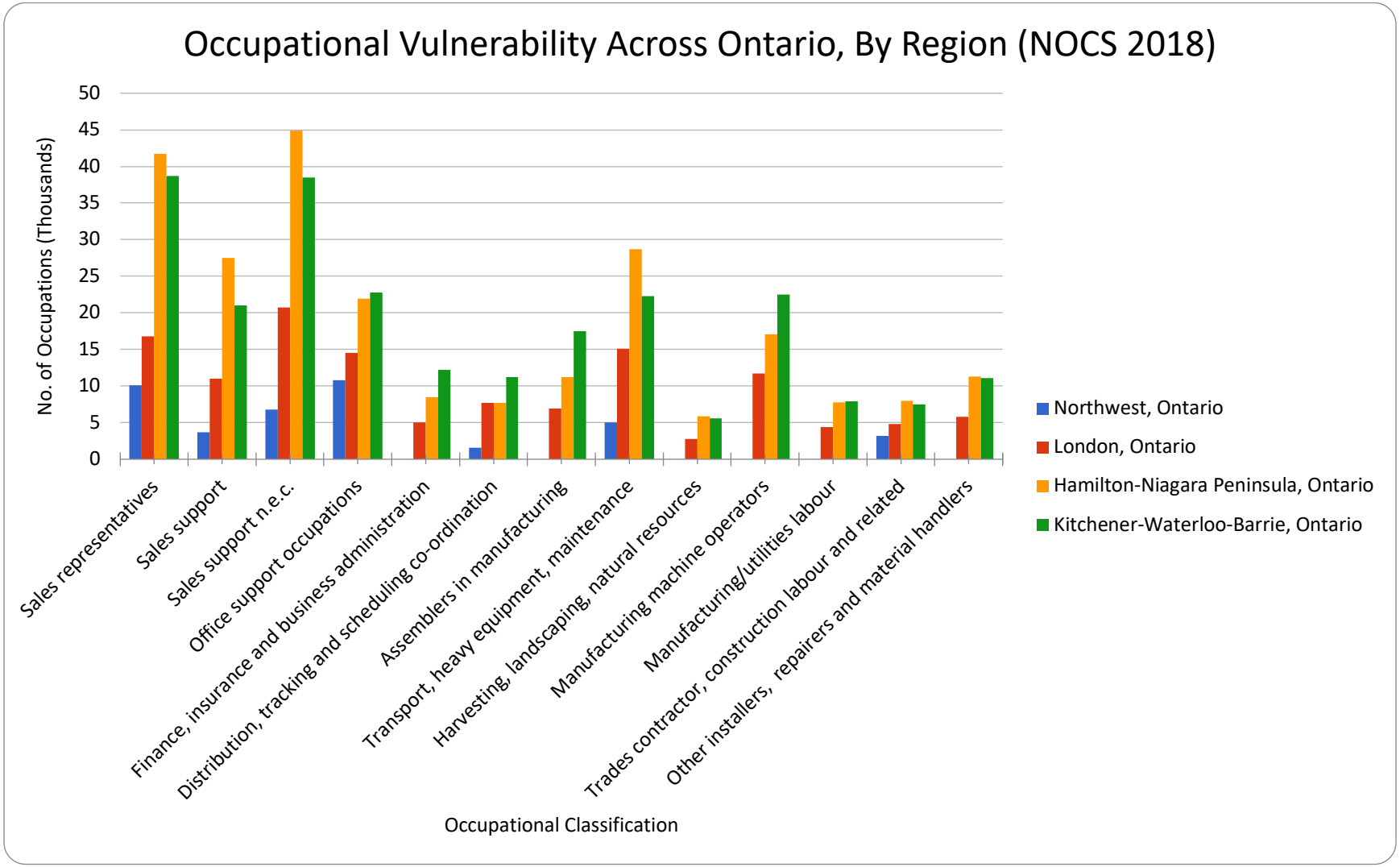


Figure 3: Automation risk as measured through occupational data from the Canadian 2016 census.

The third component of this regional analysis encompasses more depth in measuring level of risk and readiness in each of the eight Ontarian cities. To do this, 2016 NOCS data related to both employment and educational attainment were used. The rankings on both risk and readiness can be observed in **Table 1** and **Table 2** respectively. Detailed descriptions of each region's risk and readiness can be observed in this report's appendix.

– Low Automation Risk, By Occupational Category/Education Level

– Medium Automation Risk, By Occupational Category/Education Level

– High automation Risk, By Occupational Category/Education Level

Table 1: Ontario's Risk: Occupational Vulnerability by Region (Statistics Canada, NOCS 2016)								
Regional Ranking	1 (Lowest)	2	3	4	5	6	7	8 (Highest)
8 Natural Resources, Agriculture and Applied Sciences (%)	Guelph (1.4%)	Barrie & Kitchener (1.5%)		Waterloo and London (1.6%)		Hamilton (1.7%)	Thunder Bay (2.1%)	Niagara (2.6%)
7 Trades, Transportation and Equipment Operators and Related Occupations (%)	Guelph (12.3%)	London (13.7%)	Kitchener (14.2%)	Waterloo (14.3%)	Niagara (14.9%)	Hamilton (15%)	Thunder Bay (15.9%)	Barrie (17.3%)
6 Sales and Service Occupations (%)	Guelph (21.7%)	Waterloo (22.3%)	Kitchener (22.4%)	Thunder Bay (24%)	Hamilton (24.5%) London (24.5%)		Barrie (24.9%)	Niagara (29.1%)
1 Business, Finance and Administrative Occupations (%)	Niagara (13.2%)	Guelph (13.6%)	Barrie (13.8%)	Hamilton (14.3%)	Thunder Bay (14.4%)	London (14.5%)		Kitchener and Waterloo (14.9%)
9 Occupations in Manufacturing and Utilities (%)	Thunder Bay (2.5%)	Niagara (4.6%)	Barrie (5.3%)	London (5.9%)	Hamilton (6%)	Kitchener and Waterloo (8.6%)	Guelph (11%)	

Table 2: Ontario's Readiness: Educational Attainment Comparisons by Region (Statistics Canada, NOCS 2016)[2]								
Regional Ranking	1 (Lowest)	2	3	4	5	6	7	8 (Highest)
No Certificate, Diploma or Degree (%)	Guelph (9.13%)	London (10.06%)	Niagara (10.20%)	Hamilton (10.31%)	Barrie (10.69%)	Kitchener (11.13%)	Waterloo (11.55%)	Thunder Bay (12.66%)
Secondary Education Only (%)	Guelph (22.30%)	Hamilton (24.94%)	London (25.15%)	Thunder Bay (25.86%)	Waterloo (25.90%)	Kitchener (26.00%)	Barrie (29.08%)	Niagara (29.83%)
Bachelor Degree Only (%)	Barrie (14.32%)	Niagara (14.34%)	Thunder Bay (16.62%)	London (17.51%)	Waterloo (18.67%)	Kitchener (18.82%)	Hamilton (19.05%)	Guelph (22.30%)
Postgraduate Degree (%)	Barrie (5.53%)	Niagara (6.40%)	Thunder Bay (6.69%)	Hamilton (9.39%)	Waterloo (10.02%)	Kitchener (10.11%)	London (10.21%)	Guelph (13.29%)

[2] Note: when reading table 2, it should be remembered regions with low proportions of individuals with no education or only secondary education have higher proportions of individuals in some form of postsecondary education. Because of this, the readiness gradient is inverted for the table's first two rows.

Region	Readiness Score Total	Risk Score Total	Total Automation-Ready Rank
Guelph	18	13	5
Barrie	14	23	-9
Niagara	15	24	-9
Thunder Bay	18	24	-6
Hamilton	17	26	-9
Waterloo	22	24	-2

Part IV: Ontario's Regional Risk-Resilience Ratio

In addition to wanting to examine the risk faced by Ontario's regions by type of occupation, we also wanted to find the total proportion of jobs in each of the eight cities that could potentially be automated. We derived our estimates using 2016 NOCS data from the following occupational classifications:

- Business, finance and administrative occupations
- Occupations in manufacturing and utilities
- Natural resources, agriculture and related occupations
- Trades, transport and equipment operation and related occupations
- Sales and service occupations

These classifications best represent the type of occupations included in the MEDJCT's top 20 list of most at-risk occupations. The types of occupations classified as resilient to automation, at least in the short-run include the following:

- Management occupations
- Natural and applied Sciences and related occupations
- Health occupations
- Occupations in education, law and social, community and government services
- Occupations in art, culture recreation and sport

Using data occupations from each of these categories, **we derived an average automation risk level of 0.61,** meaning that over half of all occupations in each region could potentially be automated. A more thorough breakdown on each region's risk-resilience ratio can be observed in **Figure 4**. A few disclaimers should be made regarding this finding. First, while the classifications used by NOCS were the most granular form of data we could use in this analysis, they are not sufficiently focused to account for differences in levels and diversity of work experience within each occupation category. The risk: resilience ratio, therefore, may be overstated and should not be taken at face value. Second, the risk: resilience ratio cannot account for the differing ability of firms to uptake the types of capital required for automation to occur. Our ratio, therefore, should be viewed as a perfect-world estimate rather than one that will map perfectly onto real automation trends.

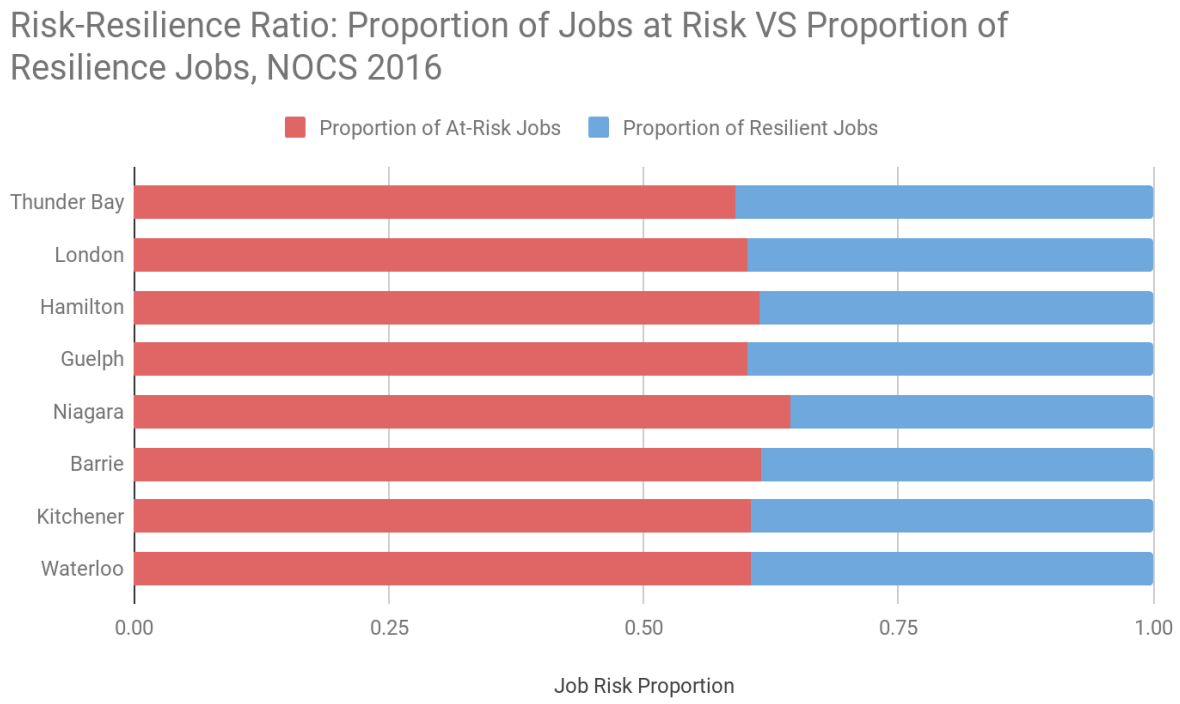


Figure 4: proportions of occupations at risk of job automation vs proportions of occupations likely to be resilient to automation.

Part V: The Impact of Canada's Labour Market Development Agreements

In our final analyses, we have aimed to do more than simply make economic projections. Instead, we wish to gauge the effectiveness of one of Canada's longest-standing tools of retraining, namely Labour Market Development Agreements. Recognizing the labour market disruptions that had begun to occur in the 1990s, the Government of Canada formed funding agreements with each of the provinces and territories to provide Canadians with the necessary support to participate in a changing economy.[X] These agreements generally included a suite of programs consisting of:

1. A skills development program as well as an apprenticeship version of the same program

2. A targeted wage subsidy program to aid Canadians in obtaining on-the-job experience
3. Job creation partnerships
4. A self-employment support program and,
5. A general job-seeking assistance program

Data from the evaluations of these labour market agreements shows that these programs generally tended to improve both the rate of incidence of employment as well as annual earnings for active EI participants, but that the impact could vary not only by jurisdiction but also by program participant characteristics.[xi] It was observed that for certain programs former EI claimants of older age usually retired soon after going through the training, accounting for employment *decreases* following participation in certain programs.

This report does not compare the impacts of Canada's LMDAs on all the country's provinces and territories but rather only on three that were of interest to the ministry: namely Ontario itself, Alberta and Saskatchewan. The latter two provinces were chosen because of their comparability with one another. They were also chosen because, despite their similarity, Alberta and Saskatchewan had highly different prospects for job automation in Wyonch's C.D. Howe report. For the compared provinces in this report, the employment impacts of the labour market development agreements can be observed in **Table 3** and **Table 4** respectively.

Table 3: Gains in Employment Resulting from Canada's LMDAs in Post-Program Period, Active EI Participants, By Province			
	Ontario	Alberta	Saskatchewan
Skills Training	+3.8-5.1%	+8.3-10.8%	+4.9-6.8%
Targeted Wage Subsidies	+6.4-6.7%	+5.4-6.4%	+4.8% (only in first year)
Job Creation Partnerships	+5.2-8.0%	+8.4-12.6%	N/A[3]
Employment Assistance	+1.4-1.7%	+1.5-3%	+1.6%

[3] The Saskatchewan LMDA doesn't include a Job Creation Partnership program.

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Table 4: Gains in Income Resulting from LMDAs in Post-Program Period, Active EI Participants, By Province			
	Ontario	Alberta	Saskatchewan
Skills Training	+$817–$3,711	+$887–$5,680	+$1,943–$9,864
Targeted Wage Subsidies	+$2,223–$4,507	+$3,654–$4,827[4]	N/A[5]
Job Creation Partnerships	+$2,396–$5,155	+$2,429–$4,720	N/A[6]
Employment Assistance	+$657–$802	N/A[7]	+$5,337

Main Findings From LMDAs

It's important to note that employment gains for certain years in the post-program period were not statistically significant, as noted in Table 4. All of Ontario and Alberta's programs, by contrast, were statistically significant in all post-program years. The impacts of each province's programs as part of their LMDA's can be seen in Figures 5-12. The findings of our comparative analysis reveal the following for the period of 2002–2005:

- For provincial training programs, Alberta had the highest impact on incidences of employment, but Saskatchewan had the highest impact on earnings. Ontario ranked lowest of both these measures.
- For provincial targeted wage subsidies, Alberta had the highest impact on incidences of employment for certain years but either tied or was overshot by Ontario in other years. Alberta had the highest impact on earnings in the final observed year and Saskatchewan's impacts were not statistically significant.

[4] Results were only significant after fourth and fifth post-program year.

[5] Results for earnings impact for Saskatchewan targeted wage subsidies not statistically significant

[6] The Saskatchewan LMDA doesn't include a Job Creation Partnership program

[7] Results for earnings impact for Alberta employment assistance not statistically significant

- For provincial job creation partnerships, Alberta consistently had a higher impact on incidences of employment than Ontario. Alberta and Ontario roughly tied in terms of their impacts on earnings and Saskatchewan's impacts were not statistically significant.
- For provincial employment assistance, Alberta had the highest impact on incidences of employment in all years except the fourth post-program year. Saskatchewan's impacts were only statistically significant in years 3-5, ranked lowest. Saskatchewan had the highest impact on earnings in all years while Ontario's impacts were only statistically significant in years 4 and 5.

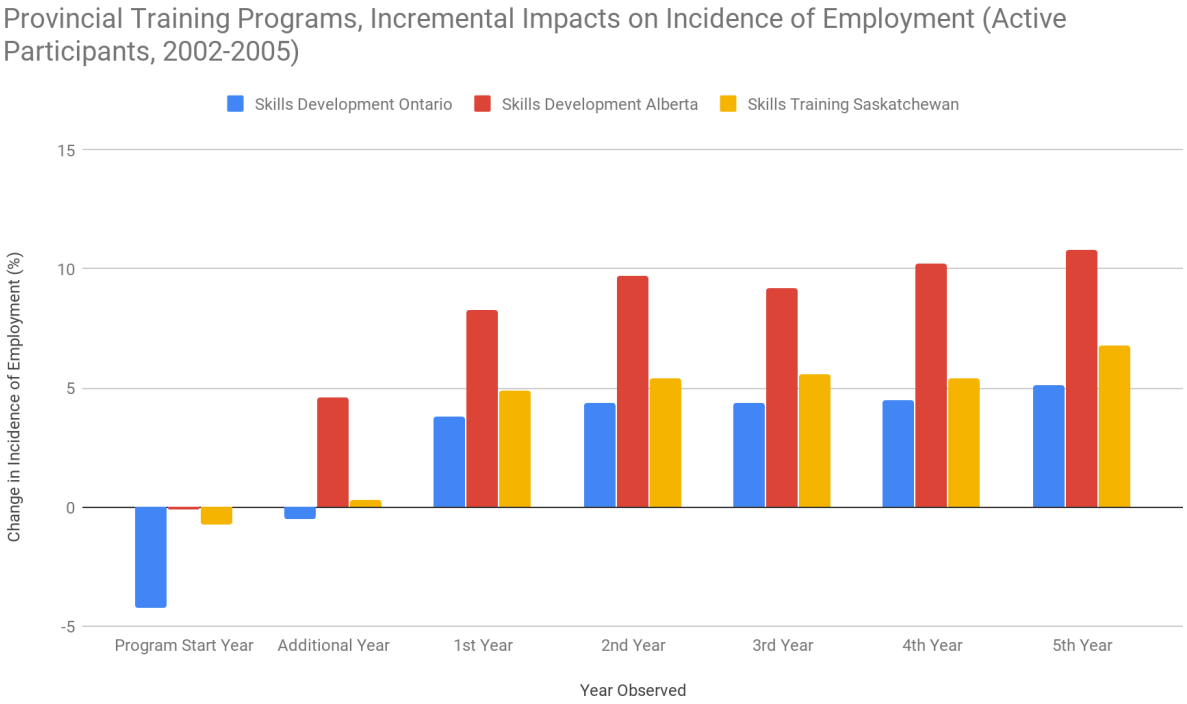

Figure 5: Skills training program impacts on incidences of employment.

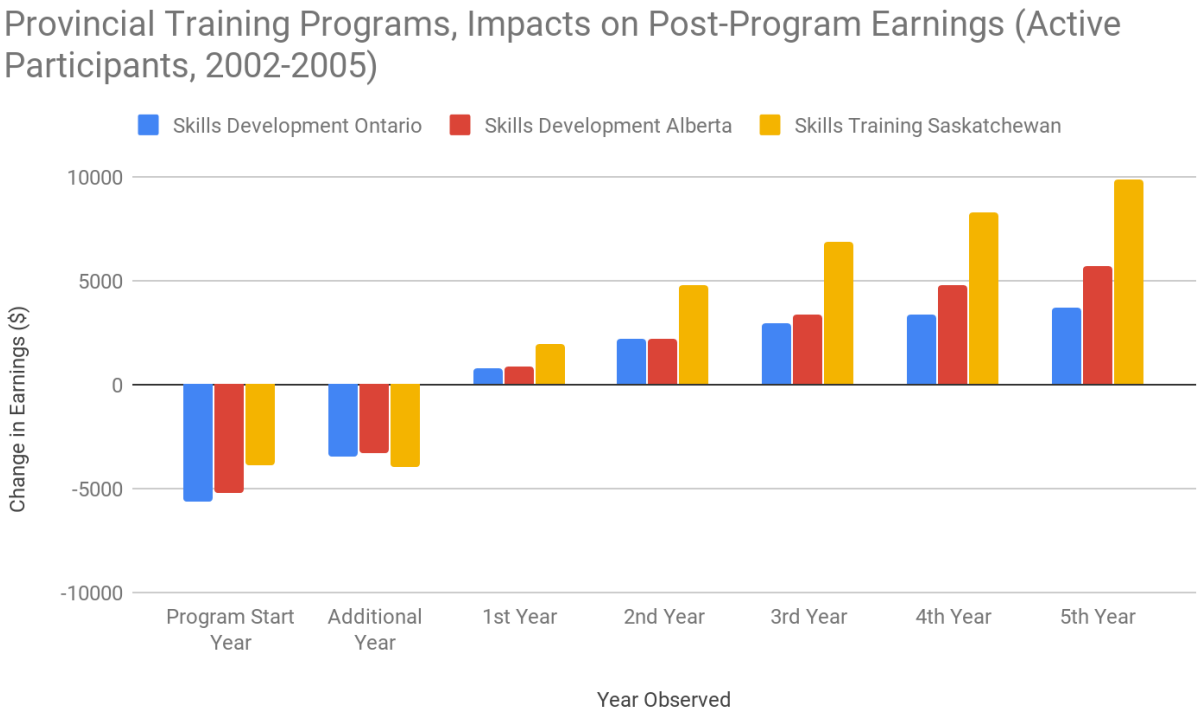

Figure 6: Skills training program impacts on earnings.

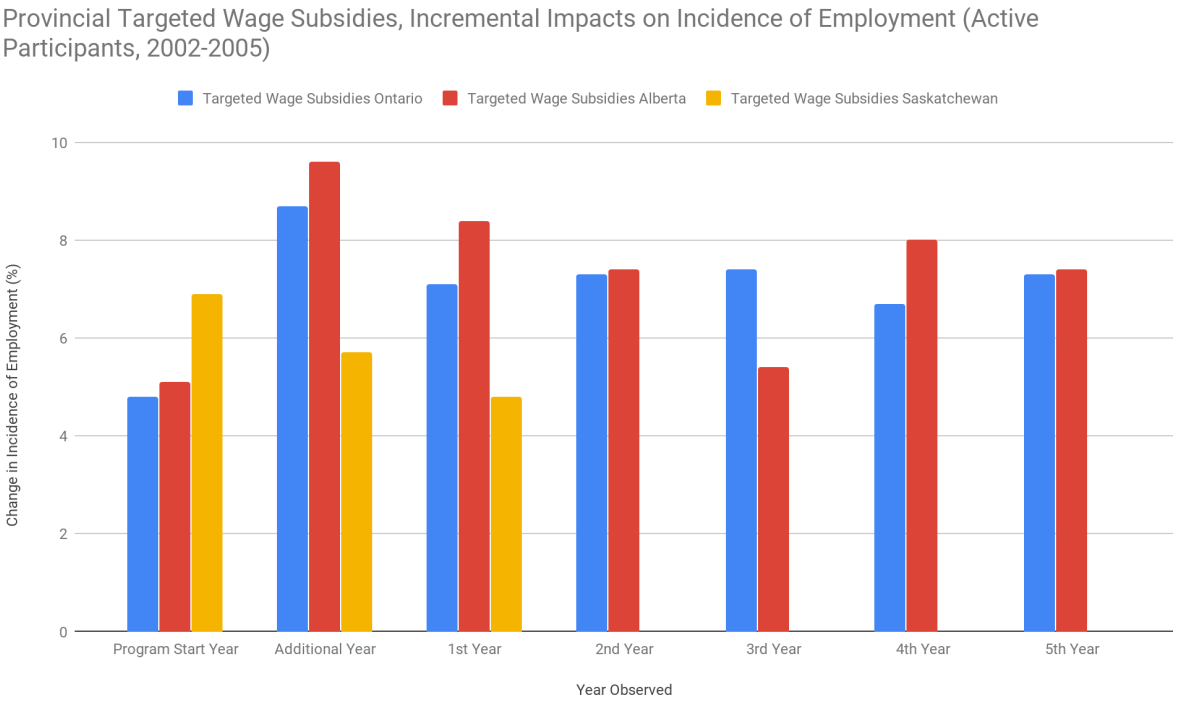

Figure 7: Provincial targeted wage subsidies impacts on incidences of employment.

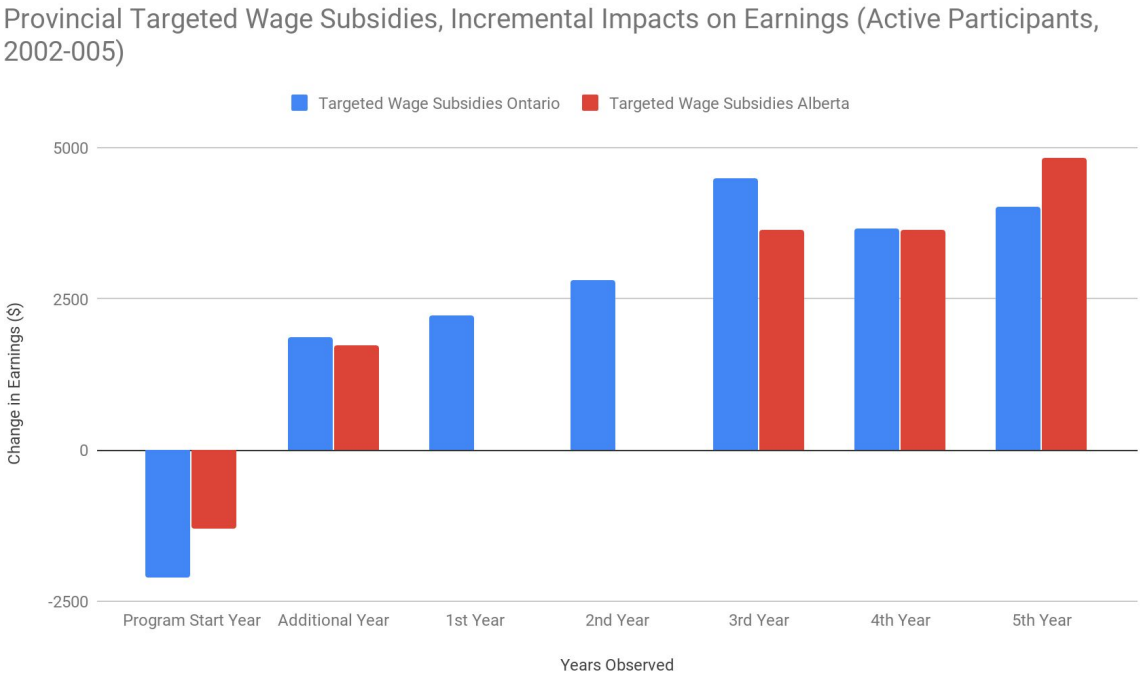

Figure 8: Provincial targeted wage subsidies impacts on earnings.

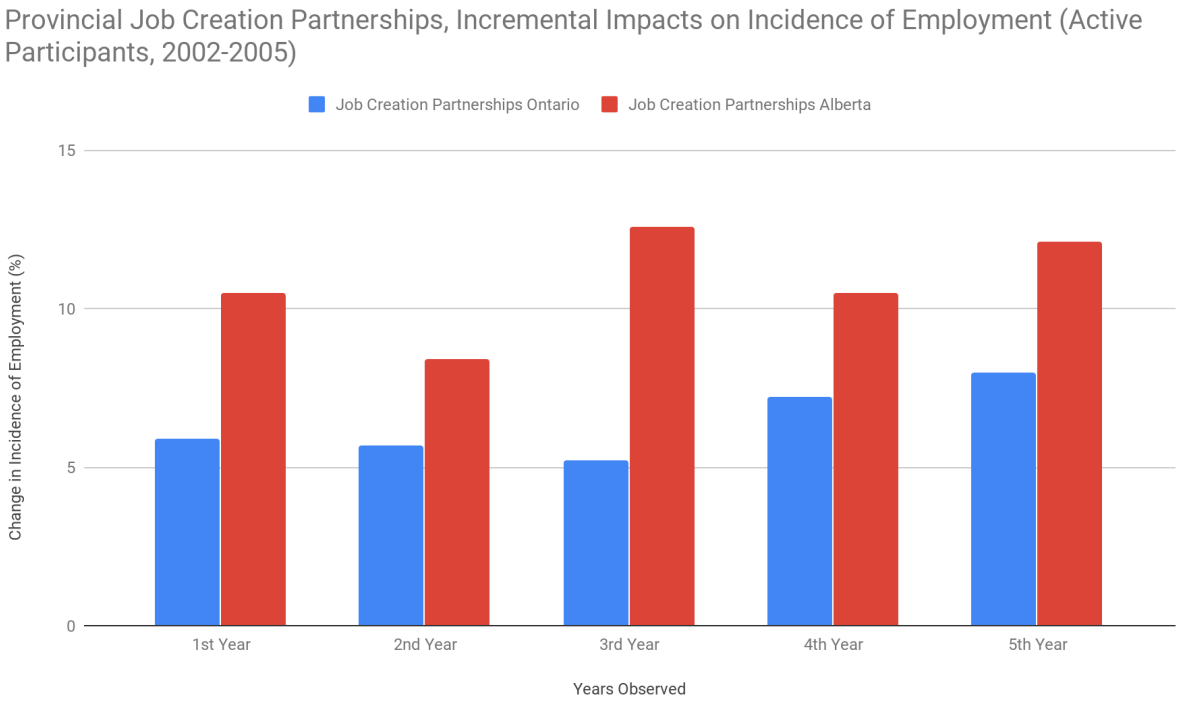

Figure 9: Provincial job creation partnership impacts on incidences of employment.

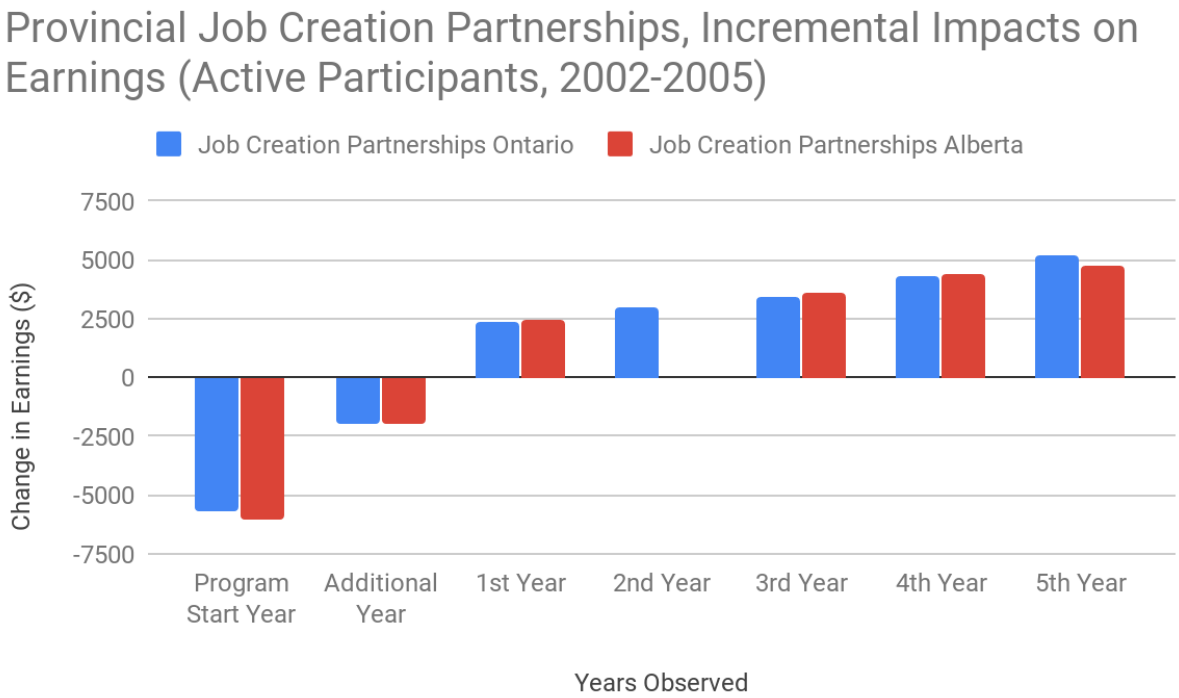

Figure 10: Provincial job creation partnership impacts on earnings.

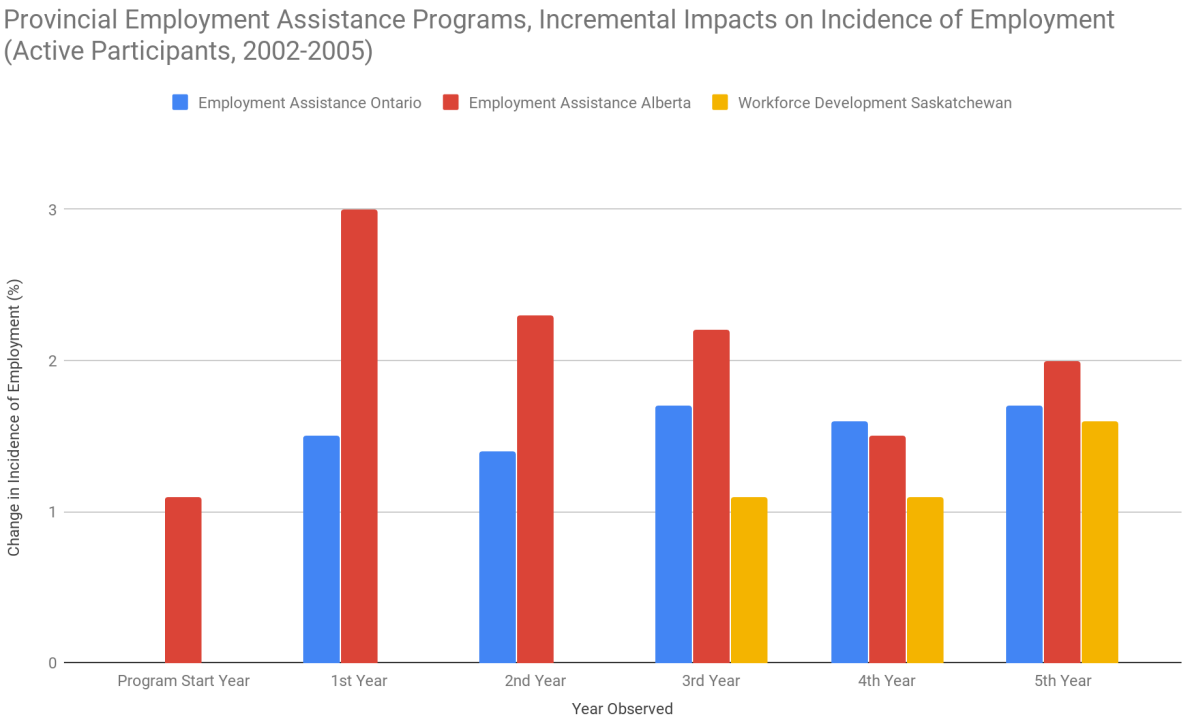

Figure 11: Provincial employment assistance programs impacts on incidence of employment.

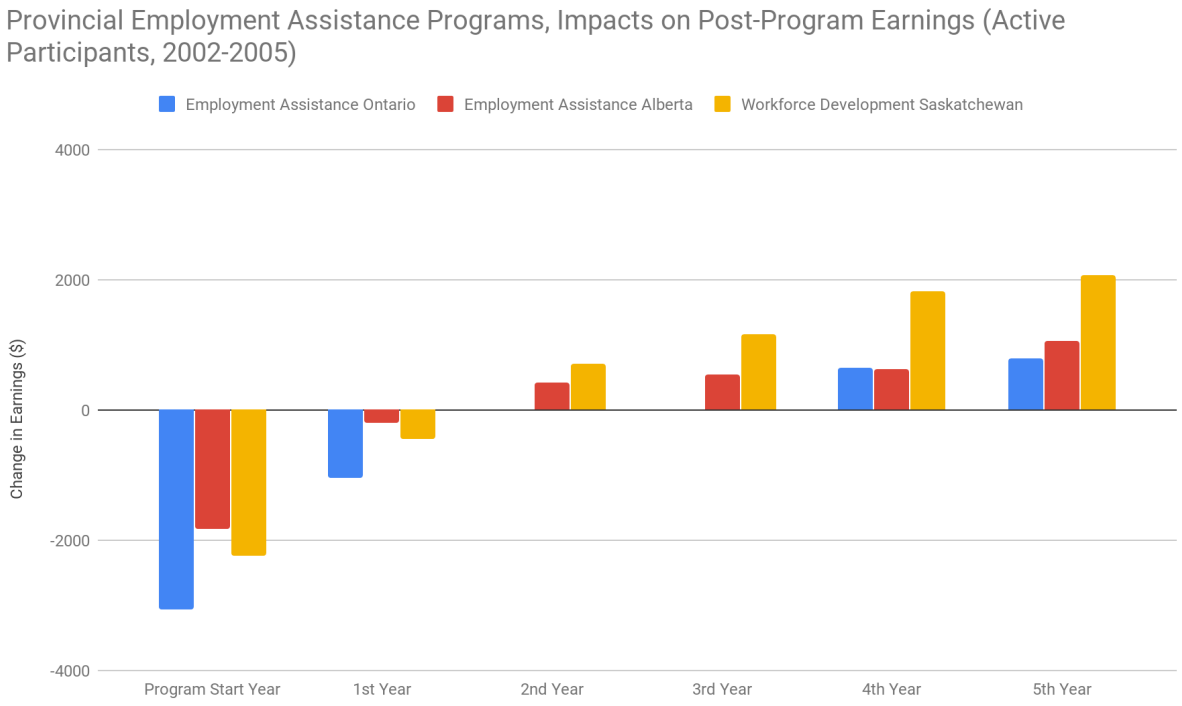

Figure 12: Provincial employment assistance programs impacts on earnings.

The findings of this comparison present a mixed picture of the performance of LMDAs during the observed period. Because the labour supply in Ontario is much larger than that of Saskatchewan, it is unsurprising that program participants in Ontario generally experience middling results on the job market both in terms of incidence of employment. Alberta's high results, by contrast, might possibly be explained by the beginning of the commodity boom of the early 2000s, as the growth of commodity prices and employment opportunities would have promoted high returns to retraining programs that sent workers into the oil sector. Saskatchewan's results show a mixed story. In the case of provincial training programs, impacts on incidence of employment were relatively low but impacts on earnings were very high. This may be explained by a labour shortage in the province in certain sectors which granted more leverage to appropriately skilled labourers. Even though no concrete findings can be presented regarding the self-employment programs supported by Canada's LMDAs, the potential of the programs deserves recognition in our discussion. Most of the provinces have a self-employment

program that provides both financial assistance as well as planning advice to aspiring entrepreneurs, but results of these programs are highly unclear. Most individuals who enter the program experience decreased earnings in the post-program period, but an increase in household value. The evaluations of these programs explain these results by speculating that program participants reinvest their earnings into their business. The growth of self-employment globally, and the potential resilience of self-employment to automation implies that the Canadian government should develop better indicators for measuring the success or failure of self-employment programs.

Discussion I: Summary of Ontario's Risk and Readiness

Overall, the eight cities of Ontario examined in this report do not differ radically from one another in terms of the respective proportions of the workforce at risk to automation. There is, however, enough of a difference in key occupational categories to suggest that that these regions of the province are likely to be impacted differently depending on which occupations are automated sooner, more heavily or both. The following are implications from our data analysis:

Regional Risk:

1. While Thunder Bay is best known for its natural resources industries such as forestry and mining, the city is likely to be affected worse by automation if more of the jobs that are lost are within trades, transportation and machine operation positions.
2. Niagara shows the highest level of automation risk for sales and service occupations as well as in occupations related to natural resource agriculture and related occupations. The region has a moderate-to-low risk for all other at-risk occupations.
3. Guelph generally ranked low in terms of risk for all the occupational areas examined, as a larger proportion of the population is employed in areas having to do with natural or applied science. The region, however, shows considerable risk for occupations in manufacturing and utilities.
4. Kitchener and Waterloo generally share the same level of automation risk. Both regions are only at moderate risk for occupations in all occupational categories

except business, finance and administrative occupations as well as occupations in manufacturing and utilities where they show a higher level of risk.

5. Barrie generally shows a moderate level of risk except for occupations in trades, transportation and equipment operation positions in which it is at higher risk.
6. Hamilton shows a moderate level of automation risk across all occupational categories examined.
7. Finally, London's level of risk varied considerably across the occupational categories. For instance, London shows moderate to low risk for natural resources, agriculture and related occupations; trades, transportation and equipment operation occupations; and manufacturing and utilities occupations, but medium to high risk in sales and service occupations and business, finance and administrative occupations.

Regional Readiness:

- Thunder Bay has the highest proportion of individuals with no recognized level of education. The implication of this is that Thunder Bay faces a particularly acute retraining challenge and that individuals in this city may experience longer periods of unemployment if displaced by automation.
- Niagara has a particularly high proportion of individuals with only secondary education. This may be accounted for by a large section of the working population who began their careers many decades earlier and whom are close to retirement. Automation is likely to be less of a concern for these individuals.
- Guelph is by far the best placed to retrain displaced workers. It has both the highest proportion of individuals with only a bachelor degree and the highest proportion of individuals with a postgraduate degree, meaning workers in Guelph likely already can easily shift into non-routine, cognitive occupations.
- Kitchener Waterloo and Barrie each have a moderate proportion of individuals with only a secondary education or lower. Barrie, however, deviates from the others in that it has a very low proportion of individuals with only a bachelor's degree or a postgraduate degree while the other two regions have moderately high proportions in each category.

- Both London and Hamilton have a medium level of readiness based on education levels. Hamilton has a higher proportion of individuals with only a bachelor's degree while London has a higher proportion of individuals with a postgraduate degree or higher. The implication is that both areas are generally well-off in terms of their retraining capacity.

Discussion II: Policy Implications

By combining our findings from the NOCS 2018 dataset and the NOCS 2016 dataset, we produced findings to help guide policymakers on where and how resources should be spent on retraining programs in Ontario. Our implications are as follows:

- Ontarians living in the Hamilton-Niagara peninsula are divided significantly by educational attainment education and are working predominantly in retails sales and equipment operation occupations. This means the training needs of people living in this area are polarized.
- Ontarians living in the Kitchener-Waterloo-Barrie region generally have medium to high levels of education (except for Barrie) and are working in occupations related to business and office administration as well as manufacturing. While the retaining capacity for this region is generally high, programs shouldn't underestimate impact automation may have on white collared positions such as accounting.
- Ontarians living in London also have a medium to high level of education and London's labour force is spread across all the at-risk occupation categories without dominating any one of them. Consequently, people who live in this region are likely to benefit from more general training services.
- Northwestern Ontarians such as those living in Thunder Bay face an acute risk of automation due to generally lower levels of education and a concentration of jobs in resource-dependent sectors. Retraining services in this region will likely need to be tailored heavily to account for the region's unique labour force vulnerabilities.

Discussion III: LMDAs as a Tool for Retraining

While Canada's LMDAs have been shown through evaluations to have a generally positive impact on both income and earnings, the effectiveness of the programs included in these agreements are constrained by the following factors:

- Budgets: Funding shortages were frequently reported as a reason for why spaces in programs provided by the LMDAs needed to be reduced. As Budget 2019 has promised much needed $2 billion more to these programs, policymakers should be wary to strategically transition these programs to stop retraining for occupations at the highest risk of automation.
- Accessibility: Some participants cannot physically access to the facilities and services needed to succeed in the program.
- Staffing: There are often tight limits on the overall number of people working on these programs as well as the number of specialists for each program.
- Public Awareness: Many Canadians are not aware of the existence of these programs.
- Incentives: Stringent reporting requirements have dissuaded some participants from staying in their program.
- Employer Mismatches: Sometimes the skills obtained participants fail to match the needs of employers.
- Local Economic Conditions: factors such as the market cycle and the geographic location of the participation can reduce results even when training is effective.
- Participant Personal Constraints: Some participants experience personal limitations on their ability to succeed within the program such as financial constraints or cognitive disabilities.

It is important to note that the success of LMDAs will be affected by their ability to train Canadians for jobs of the future rather than jobs that will soon disappear. This is an issue for the LMDAs since they have traditionally trained participants for occupations such as equipment operation and trades. They do, however, help Canadians prepare for certain non-routine, cognitive careers such as early childcare educators. There is a risk, that program administrators will struggle to ensure that training pathways stay relevant to economic conditions.

That's where technology comes in. Algorithmic software and labour data together can send program participants on fruitful career paths much faster than program administrators ever could. The example we highlight in this report is a tool currently being developed by the MaRS Center called the Employment Pathway Platform. The tool maps out career development pathways to guide individuals out of occupations at high risk of automation and to areas with relatively low risk. Furthermore, the employment pathway platform maps these pathways through commonalities in an individual's skill set to those of a potential future career. For example, consider the career path of a person currently working in retail sales, an occupation currently facing a 38% risk. Since retail positions emphasize interpersonal skills, the tool recommends the occupations of real estate agent, preschool teacher or event planner as matching careers at a considerably lower risk of automation. While the tool is currently development and only works with a limited number of career starting points, a fully developed version will be able to produce career pathways for hundreds of different occupations. The significance of this development is that technology will allow program administrators to more efficiently guide trainees into the right career paths. While before considerable time would be spent identifying the right pathway for a program entrant, now most resources can be spent on the training and education component itself.

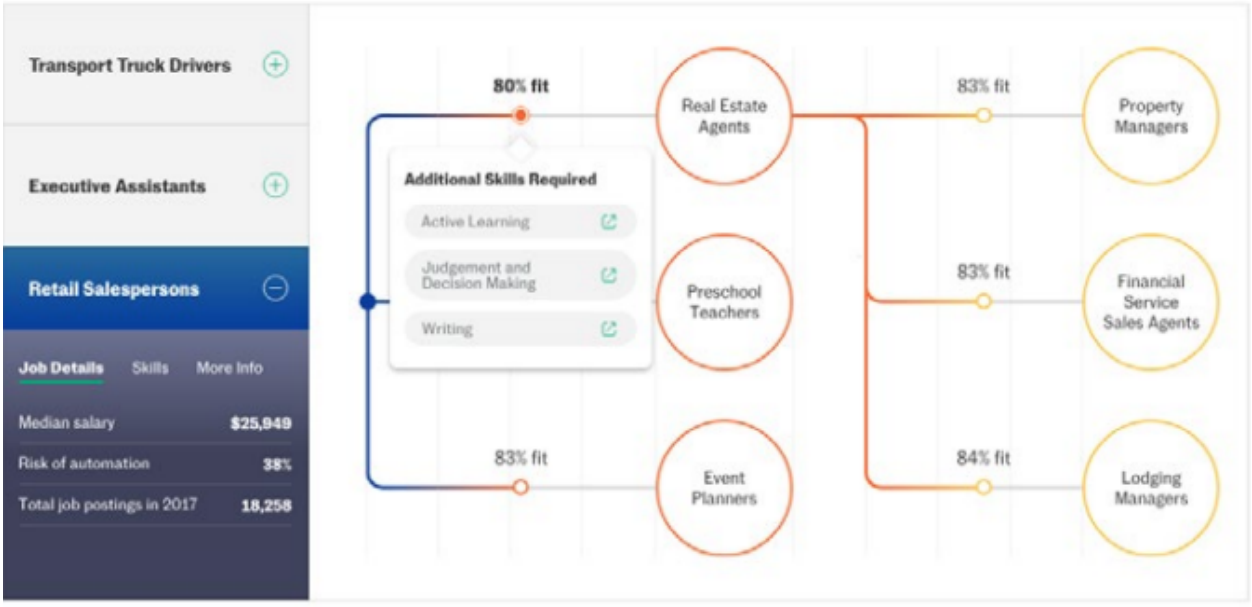

Figure 13: A functional demo of MaRS's Employment Pathways Platform, applied in to the occupation of retails sales.

Discussion IV: Future Directions

On March 27, 2019, we presented our findings at an innovation symposium hosted by the Ontario Ministry of Economic Development, Job Creation and Training. During this event, we gained highly valuable feedback on what variables related to automation were missing from our study and which could help produce an enriched picture of automation's impacts. Our findings represent only half of the total research that will be conducted on this highly important policy area at the Policy Innovation Initiative. These are some of the areas which we'd like to further investigate in greater detail.

1. Age: Age is likely to affect level of risk and level of readiness of individuals in a diversity of ways of which we are not fully aware. For instance, many individuals in older age cohorts (45-65) are more likely to inhabit positions without postsecondary education which today would require such an education. A future installment should account for regional age differences to account for invisible differences in knowledge and skills levels.
2. Sex/Gender: As shown by the data provided by the Ministry in figure 1, Ontario's most at-risk occupations are filled by the sexes in different proportions. Women dominate most administrative occupations while men usually dominate manual labour-related fields. A potential issue that arises, especially when considering the function of retraining programs, is that this sorts the sexes into different starting points for retraining pathways. The second installment of this report could, along with going into more depth on gender differences in automation impacts, address this factor in making recommendations for training program effectiveness.
3. Area of Study: One of the most frequent questions we received regarding our methodology was whether it accounted for differences in area of study in postsecondary education. The average bachelor's degree is generally a good measure of contributing factors to automation readiness, but a focus specialization could shed light on which individuals are gaining extra experience or unique skills. Co-ops, internships, student societies, and club activities all represent learning opportunities that could specific to certain specializations but not others. Graduates are not likely to be equally endowed in this regard, and there is room for a major contribution to be made in analyzing this factor.

4. **Automation Capacity:** The last, but equally important direction for this project are the differences in the capacity of firms to adopt the necessary capital for job automation. Just because the technology is available, it doesn't necessarily mean that firms will have the financial resources and understanding required to acquire and implement these technologies as part of their production processes. What this means is there could be miscalculations in the timeline of automation for the provinces as well as for the individual regions. Attitude survey data from Ontario's business sector could be a guiding light in making such an analysis possible for this report.

Conclusion

While it is difficult to know for certain how automation will change the lives of workers living in Ontario, we can make educated guesses based on the ways people in the province are living and working today. This report serves as a first step for the Policy Innovation Initiative in addressing an issue as complicated as automation. What we have found is that Ontario's economic diversity leaves some regions better off to adjust to automation and some worse off and that the differences between these regions are highly intricate. There is unlikely to be a silver bullet for automation retraining, but knowing how these regions differ in terms of both risk and readiness leaves the Ministry in a stronger position to develop more responsive and more well-tailored programs. Finally, provincial policymakers would be wise to incorporate effective use of data and digital technologies in programs such as those currently offered under Canada's LMDAs, as keeping these programs relevant to today's job market is critical to ensuring Canadians are on track to work in jobs of the future.

Appendix: Regional Risk and Readiness in Brief

THUNDER BAY

In Brief:

- Thunder Bay is home to jobs within the following sectors: information and communication technologies, health sciences, manufacturing, forestry, mining, aircraft transportation and equipment manufacturing, and tourism.
- The region ranks second highest in the size of its natural resources (2.1%), agriculture and related occupations and has the largest proportion of its employed labour force working in trades, transport and equipment operation positions (15.9%).
- In sales and service occupations, Thunder Bay ranks roughly in the center (24.0%) as well as in occupations in business, finance and administration (14.4%).
- The region ranks lowest on the proportion for manufacturing and utilities jobs (2.5%), two times smaller than that in London, ON and four times smaller than that in Guelph.
- Among the five regions examined, Thunder Bay has the highest proportion of individuals with no certification, diploma and degree (12.66%) but ranks fourth among those with only a secondary education (25.86%). It ranks third lowest among those with only a bachelor degree (16.62%) and among those with a graduate degree as its highest level of education (6.69%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 1,285
- Trades, Transportation and Equipment Operators and Related Occupations: 9,670
- Sales and Service Occupations: 14,565
- Business, Finance and Administrative Occupations: 8,715
- Occupations in Manufacturing and Utilities: 1,530

LONDON

In Brief:

- London's key sectors include food processing, professional services, healthcare, manufacturing, and creative services.

- London ranks in the center for occupations in natural resources, agriculture and related occupations (1.6%), tying with Waterloo and second lowest in trades, transportation and equipment operated occupations (13.7%).
- London ties with Hamilton in its proportion of occupations in sales and services (24.5%) but ranks second highest in occupations in business, finance and administrative occupations.
- London ranks in the center for occupations in manufacturing and utilities (5.9%)
- London has the second lowest proportion of individuals with no certification, diploma or degree (10.06%) and it ranks third among individuals with only a secondary education (25.15%). It ranks fourth among those with only a bachelor degree (17.51%) and seventh among those with a postgraduate degree as its highest form of education (10.21%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 4,155
- Trades, Transportation and Equipment Operators and Related Occupations: 34,510
- Sales and Service Occupations: 61,760
- Business, Finance and Administrative Occupations: 36,540
- Occupations in Manufacturing and Utilities: 14,940

HAMILTON

In Brief:

- Hamilton's key industries include advanced manufacturing, agribusiness and food processing, creative industries, finance, insurance, real estate, transportation, information and communication and life sciences.
- Hamilton ranks in the center for occupations in natural resources, agriculture and related occupations (1.7%) and for occupations in trades, transportation and machine operation occupations (15.0%).
- For occupations in sales and services, Hamilton ties with London (24.5%) and ranks in the center for occupations in business, finance and administration (14.3%).
- Hamilton ranked in the center for occupations in manufacturing and utilities (6%)

- Among the examined regions, Hamilton has the fourth highest proportion of individuals with no certification, diploma or degree (10.31%) and the second lowest proportion of individuals with only a secondary education (24.94%). It ranks seventh among those with only a bachelor degree (19.05%) and fourth among those with a postgraduate degree as a highest education (9.39%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 4,685
- Trades, Transportation and Equipment Operators and Related Occupations: 40,685
- Sales and Service Occupations: 66,560
- Business, Finance and Administrative Occupations: 38,810
- Occupations in Manufacturing and Utilities: 16,270

GUELPH

In Brief:

- Guelph's key sectors include advanced manufacturing, agri-technology, information and communication technology and clean technology.
- Guelph ranks lowest all three occupational areas of natural resources and agriculture (1.4%), trades, transportation and machine operation (12.3%); and sales and service (21.7%). It ranks second lowest in occupations in business, finance and administration (13.6%)
- Guelph ranks highest for occupations in manufacturing and utilities (11%)
- Guelph ranks lowest among the five regions for both proportions of individuals without any certification, diploma or degree (9.13%) as well as lowest for the proportion of individuals with only a secondary education (24.63%). It ranks highest for both the proportion of individuals with only a bachelor degree (22.30%) and the proportion of individuals with a postgraduate degree (13.29%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 1,025
- Trades, Transportation and Equipment Operators and Related Occupations: 9,170
- Sales and Service Occupations: 16,195
- Business, Finance and Administrative Occupations: 10,150
- Occupations in Manufacturing and Utilities: 8,205

NIAGARA

In Brief:

- Niagara's key industrial sectors include Manufacturing, Agribusiness, Transportation & Logistics and Tourism.
- Niagara ranks highest in both the occupational categories of natural resources and agriculture (2.6%) as well as in sales and services (29.1%).
- For occupations in trades, transportation and machine operation, Niagara ranks third (14.9%) and it ranks lowest in occupations in business, finance and administration (13.2%).
- Niagara ranks second lowest for the proportion of individuals in occupations in manufacturing and utilities (4.6%)
- Niagara ranks third among the examined regions for individuals without any certification, diploma or degree (10.20%) but highest among those with only a secondary education (29.83%). It roughly ties with Barrie among both those with only a bachelor degree (14.34%) as well as among those with a postgraduate degree as its highest level of education (6.40%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 5,785
- Trades, Transportation and Equipment Operators and Related Occupations: 33,180
- Sales and Service Occupations: 64,735
- Business, Finance and Administrative Occupations: 29,220
- Occupations in Manufacturing and Utilities: 10,200

BARRIE

In Brief:

- Barrie has the second lowest proportion of individuals in occupations in natural resources, agriculture and related occupations (1.5%), tying with Kitchener. It has the highest proportion of individuals in trades, transportation and equipment operator positions (17.3%).
- Barrie ranks second highest for sales and services occupations (24.9%) but third lowest for occupations in business, finance and administration (13.8%).
- For occupations in manufacturing and utilities, Barrie also ranks third lowest (5.3%)

- Barrie ranks number five among individuals without any certificate, diploma or degree (10.69%) and seventh among those with only a secondary degree (29.08%). It ranks lowest both among those with only a bachelor's degree (14.32%) and among those with a postgraduate degree as their highest form of education (5.53%), trying roughly with Niagara.

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 1,645
- Trades, Transportation and Equipment Operators and Related Occupations: 18,780
- Sales and Service Occupations: 26,985
- Business, Finance and Administrative Occupations: 14,885
- Occupations in Manufacturing and Utilities: 5,780

KITCHENER

In Brief:

- Kitchener ties with Barrie for the proportion of individuals in natural resources, agriculture and related occupations (1.5%) and ranks third lowest for occupations in trades, transportation and equipment operation (14.2%).
- Kitchener ranks third lowest for occupations in sales and service (22.4%) but ties with Waterloo for the highest proportion of individuals in business, finance and administrative occupations (14.9%).
- Kitchener also ties with Waterloo for occupations manufacturing and utilities (8.6%).
- Kitchener consistently ranks sixth among the regions in all four categories of education: no certificate, diploma or degree (11.13%); secondary education only (26%); bachelor's degree only (18.82%) and postgraduate degree (10.11%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 4,240
- Trades, Transportation and Equipment Operators and Related Occupations: 40,350
- Sales and Service Occupations: 63,915
- Business, Finance and Administrative Occupations: 42,510
- Occupations in Manufacturing and Utilities: 24,555

WATERLOO

In Brief:

- Kitchener ranks in the center for the proportion of individuals in natural resources, agriculture and related occupations (1.6%), tying with London. It also ranks in the center for occupations in trades, transportation and equipment operators (14.3%).
- For sales and services occupations, Waterloo ranks second lowest (22.3%), but it ties with Kitchener in ranking highest for occupations in business, finance and administrative positions (14.9%).
- Waterloo also ties with Kitchener at second highest for the proportion of individuals in manufacturing or utilities occupations (8.6%).
- Waterloo ranks seventh among individuals with no certificate, diploma or degree (11.55%) and fifth among individuals with only a secondary education (25.15%). It also ranks fifth among those with only a bachelor's degree (18.67%) and those with a postgraduate degree (10.02%).

Total Jobs at Risk:

- Natural Resources, Agriculture and Related Production Occupations: 4,760
- Trades, Transportation and Equipment Operators and Related Occupations: 41,480
- Sales and Service Occupations: 64,855
- Business, Finance and Administrative Occupations: 43,305
- Occupations in Manufacturing and Utilities: 24,980

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