
Canadian Centre for Economic Analysis Toronto

Situational Analysis: Peterborough & the Kawarthas

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Geospatial Data Analysis Group



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1. Introduction

1.1 Overview of Peterborough & the Kawarthas

The region of Peterborough & the Kawarthas encompasses 3,848 sq km in Ontario (Figure 1.1). It consists of 11 census subdivisions (CSDs) and 222 dissemination areas (DAs). Of the 141,357 people that resided in the region in 2016, 62,710 were employed. Across the 57,805 households in the region, the median household income was \$64,437. The median age in the region is 47.0 years old which is greater than the Ontario median of 41.3. The largest employment for residents of the region is within the health care and social assistance sector followed by the retail trade sector.

Some key statistics for Peterborough & the Kawarthas are summarized in Table 1.1. Chapter 2 examines the demographics of the region and investigates the factors driving demographic changes and where people are living. Chapter 3 delves into the industry and employment of Peterborough & the Kawarthas including examining the economic base, sector shifts and commuting flows. Chapter 4 benchmarks Peterborough & the Kawarthas against similar regions across Canada while Chapter 5 provides some forecasts for the region.

1.2 What is a Situational Analysis?

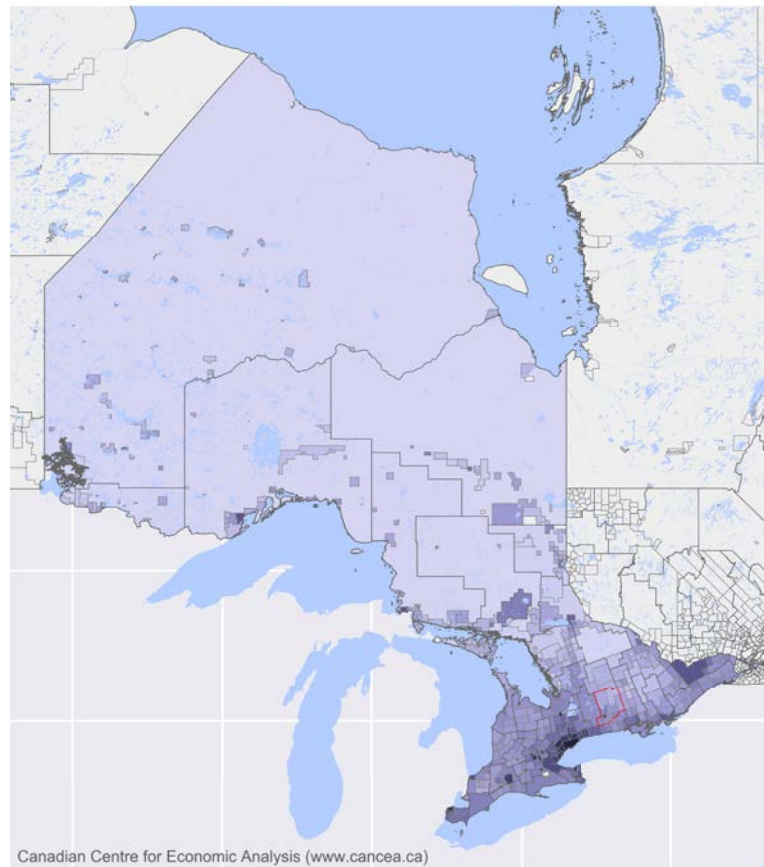
A situational analysis examines the characteristics of a region relative to its surrounding region and other comparable regions in a variety of metrics across demographics and industry. This report is designed to provide a detailed understanding of the population and economy of Peterborough & the

Table 1.1: Characteristics of Peterborough & the Kawarthas in 2016

	Value
Land area (sq. km)	3,848
Number of census subdivisions	11
Number of dissemination areas	222
Total population	141,357
Number of households	57,805
Average household size	2.45
Median age	47.0
Median household income	\$64,437

Figure 1.1: Peterborough & the Kawarthas is indicated by the red outline. Darker regions correspond to higher population density.

Population Density



Kawartha relative to Ontario and other regions. A situational analysis is frequently used as the basis for long term economic development plans since a good understanding of today's population and economy is required in order to design effective strategies for the future.

1.3 Data Sources

The results in this analysis are based on Statistics Canada Census data from 2001 to 2016 along with data from CANSIM, Statistics Canada's key socioeconomic database. In addition, all individual data sources are reconciled into a single Canada-wide consistent dataset using Prosperity at Risk (PaR), Canadian Centre for Economic Analysis (CANCEA)'s agent-based data analysis and simulation platform. PaR generates a list of representative individual people and companies across the country with links between individuals, their household members, and their employers such that they are consistent with all of the available cross-sectional tables. This allows detailed analysis of households, industry, and the overall economy while ensuring consistency of all aspects of the dataset. For example, it is not possible to have an employee in the industry data view without a corresponding individual in the demographic view. All figures and tables in this report were generated by CANCEA based on reconciled data. Refer to Appendix B for more details on PaR.

The geo-spatial structure of the analysis is based on Statistics Canada Standard Geographic Classification system. It is a hierarchical system where each region is subdivided repeated into smaller regions. The hierarchy consists of:

1. Province and Territories
2. census division (CD): Each province is divided into census divisions. There are 293 census divisions across the country.
3. CSD: Each census division is further divided into census subdivisions.
4. DA: Each census subdivision is divided into dissemination areas. Each DA is constructed so that they have approximately equal populations with about 600 people per DA.

2. Demographics

The demographics of a region drive both its character and its economy. Understanding the similarities and differences in the demographics between Peterborough & the Kawarthas and Ontario helps to understand the current and future evolution of the region. Section 2.1 examines the population of Peterborough & the Kawarthas in greater detail, with Section 2.2 presenting the components driving the changes in population. Finally, Section 2.3 examines the structure of households in the region and the type of dwellings households inhabit.

2.1 Population

The total population of Peterborough & the Kawarthas in 2016 was 141,357 which is distributed across 11 CSDs and 222 DAs. Table 2.1 summarizes the population across the region from 2001 to 2016. The largest CSD is Peterborough with a 2016 population of 82,847 which is 58.6% of the entire region. Overall, the region has increased by 10,498 since 2001, a 8.0% increase. This is less than the provincial change of 17.5% over the same period.

Figure 2.1 shows the age and sex distribution of the population in Peterborough & the Kawarthas (filled regions) along with the corresponding Ontario distribution scaled to the same total population

Table 2.1: Total population of Peterborough & the Kawarthas and its census subdivisions

	2001	2006	2011	2016
Asphodel-Norwood	4,118	4,380	4,137	4,213
Cavan Monaghan	8,829	9,117	8,789	9,039
Curve Lake First Nation 35	1,001	1,094	1,023	1,089
Douro-Dummer	6,920	7,251	6,913	6,866
Havelock-Belmont-Methuen	4,555	4,836	4,569	4,627
Hiawatha First Nation	304	0	344	383
North Kawartha	2,236	2,446	2,369	2,521
Otonabee-South Monaghan	6,874	7,180	6,830	6,831
Peterborough	74,611	77,891	80,981	82,847
Selwyn	16,913	17,873	17,239	17,455
Trent Lakes	4,497	5,494	5,299	5,552
Peterborough & the Kawarthas	130,859	137,560	138,494	141,423

2. Demographics

Figure 2.1: Population distribution in 2016 by age and sex. The grey lines indicate the provincial distribution scaled to the same population as Peterborough & the Kawarthas.

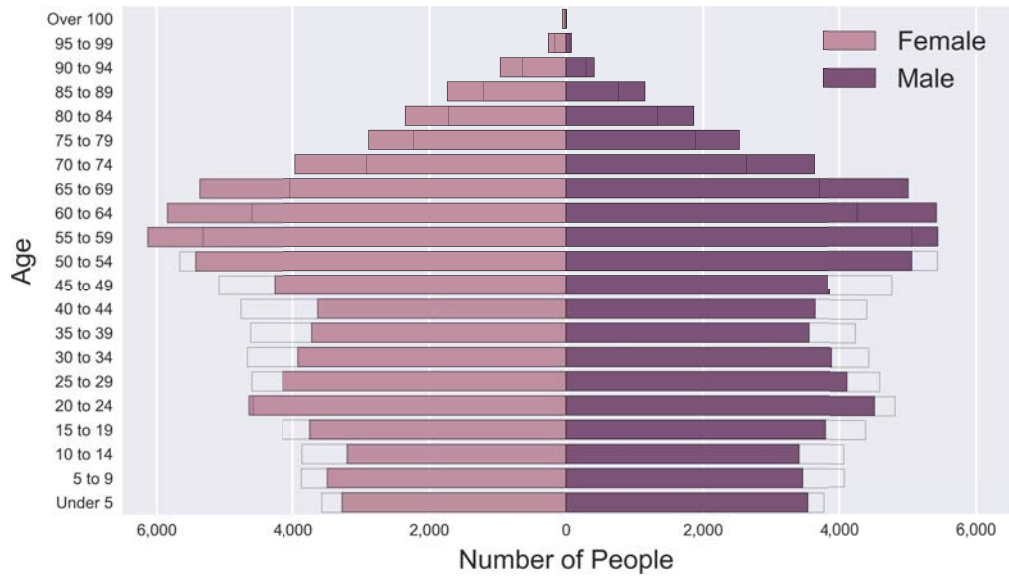


Table 2.2: Population by age group
CSD Population

CSD	Under 5	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to 79	80 to 84	85 to 89	90 to 94	95 to 99	Over 100
Asphodel-Norwood	199	235	235	215	210	210	210	251	230	235	297	389	348	307	230	179	87	77	51	10	10
Cavan Monaghan	470	491	501	532	501	450	445	481	511	562	808	849	695	649	419	266	164	133	87	15	10
Curve Lake First Nation 35	61	77	51	66	66	56	56	51	46	82	92	97	92	82	56	31	5	10	10	0	0
Douro-Dummer	358	386	343	399	358	327	378	322	358	445	588	619	588	516	363	256	148	61	36	5	0
Havelock-Belmont-Methuen	164	210	215	194	164	164	189	205	225	276	353	486	486	450	363	225	153	77	26	5	0
Hiawatha First Nation	20	20	10	26	20	10	26	31	31	20	31	31	36	31	15	10	10	5	0	0	0
North Kawartha	112	97	92	92	102	82	123	82	112	123	220	266	317	266	194	118	72	41	10	0	0
Otonabee-South Monaghan	322	343	317	332	363	378	327	353	312	404	598	675	660	532	399	235	164	82	31	5	0
Peterborough	4167	4111	3783	4571	6304	5660	5118	4535	4371	4637	5593	5905	5568	5327	3998	3124	2700	2066	1007	266	36
Selwyn	767	803	854	931	869	721	752	762	885	1023	1396	1616	1779	1549	1135	700	516	251	112	31	5
Trent Lakes	169	169	184	184	215	199	169	194	205	307	521	639	711	660	440	261	189	92	26	0	0

Figure 2.2: Population density 2016

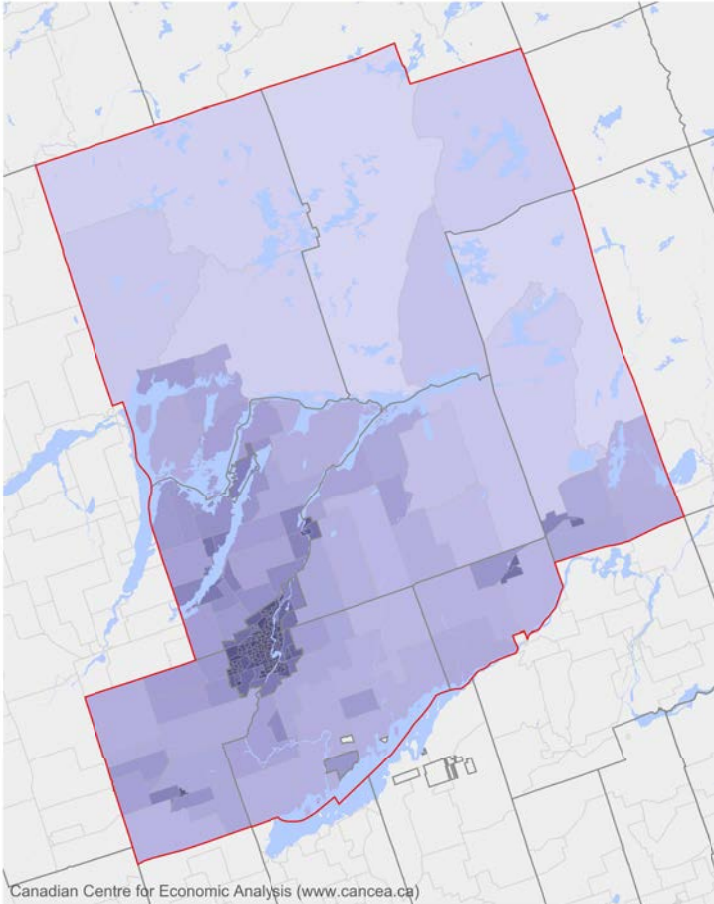


Table 2.3: Components of population growth from 2001 to 2016

	2001 to 2006	2006 to 2011	2011 to 2016	Total
Births	5,454	5,945	6,787	18,186
Deaths	-6,570	-6,758	-7,152	-20,480
Immigrants	1,275	1,199	1,183	3,657
Emigrants	-1,036	-846	-831	-2,713
Net migration from Ontario	3,996	3,727	4,103	11,826
Other migration	3,582	-2,333	-1,227	22
Total	6,701	934	2,863	10,498

for comparison. Within Peterborough & the Kawarthas, the median age is 47.0 years old. This is 5.7 years greater than the Ontario median of 41.3. The single largest cohort of residents within the region is the group of 20 to 24 year olds in Peterborough with 6,304 people. However, within each CSD the greatest concentration of people are the 60 to 64 year olds in Trent Lakes with 12.8% of the CSD's population. Across Ontario, the largest cohort are those aged 50 to 54.

As shown in Figure 2.2, the population density across Peterborough & the Kawarthas varies considerably with a peak population density, measured at the DA level, of 20,816 people per square kilometer¹ and a minimum of 2.0 people per square kilometer (excluding DAs with no reported residents). The average population density across the entire region (3,848 square kilometers) is 36.7 people per square kilometer.

2.2 Components of Population Growth

Since 2001, the population of Peterborough & the Kawarthas has increased by 10,498 people. However, as shown in Figure 2.3, the change in population has not been uniform across the region. In areas with less new development, the population tends to shrink (red regions in the Figure) as children leave their parent's household to form their own or members of existing households die. This occurs both in the less-dense regions in Peterborough & the Kawarthas as well as in the city centres. In contrast, in areas with more development attract greater population (green regions in the Figure) whether through international immigration or moving from other parts of Ontario or Canada. Some DAs have increased by 1,420 people while others have decreased by 346. As each of the DAs are different sizes, the change in population density has also not be uniform. Some DAs have increased by 3,006 people per square kilometer compared to decreases of 1,003 people per square kilometer in others. As shown in Table 2.3, the most significant contributor to net population growth has been the death of residents. However, this decrease in population has been outweighed by the combination of births and migration into the region to result in net increase in population.

¹Note that this is the peak density and occurs for a DA with an area much less than 1 square kilometer. As a result, the population density is greater than the number of people living in the DA.

Figure 2.3: Change in population and population density between 2001 and 2016 by DA

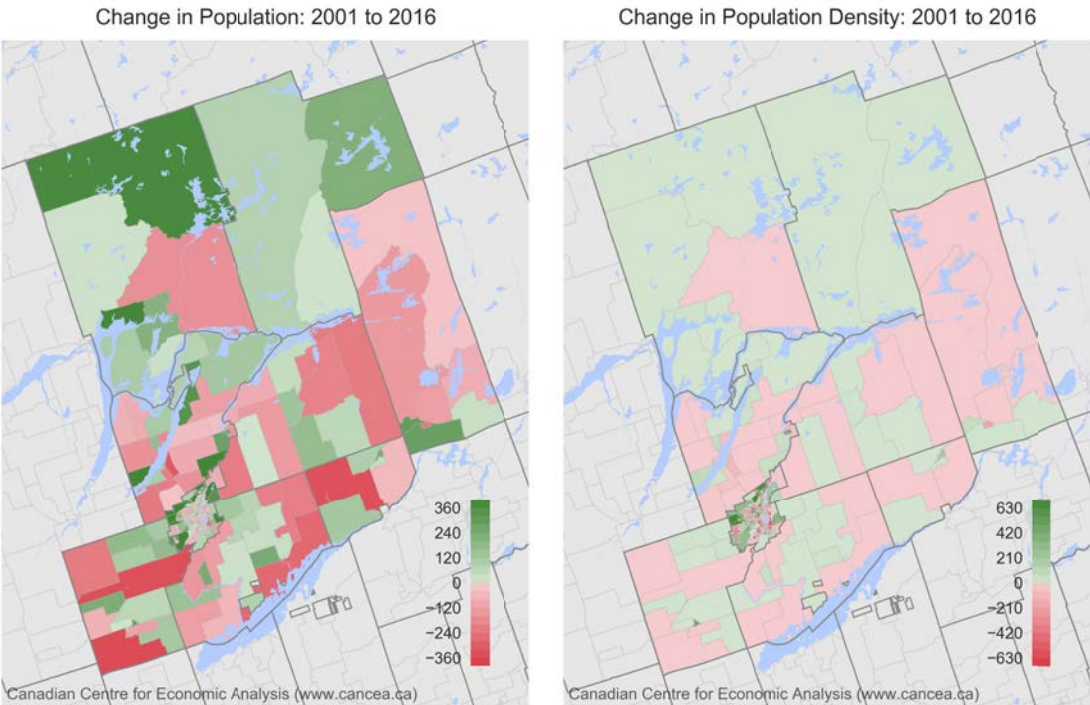
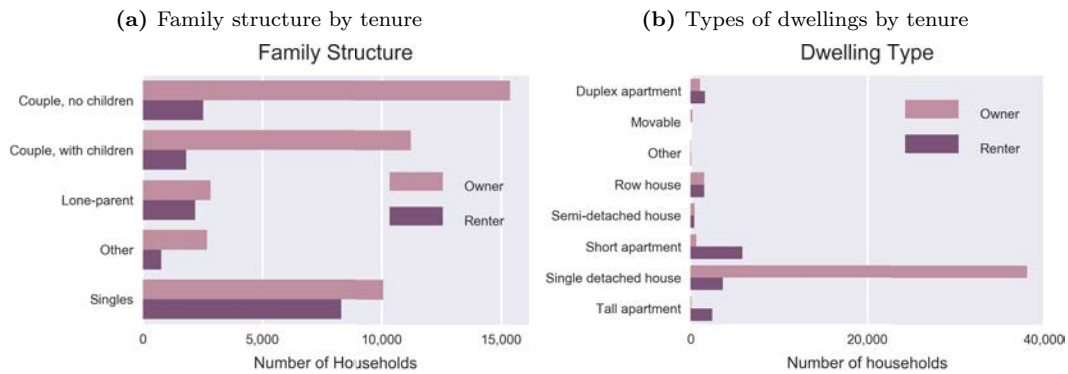


Figure 2.4: Dwellings and household structure



2.3 Dwellings and Households

In 2016, there were 57,805 households in Peterborough & the Kawarthas with an average size of 2.45 people per household. Of the households, the most common are couple households (with or without children) with 30,940 households. Of these households, 86.0% own their place of residence while the remainder rent (See Figure 2.4a). In contrast, 45.2% of single person households (or other non-family households) rent. Overall, 73.0% of households in Peterborough & the Kawarthas own their dwellings. This is greater than the Ontario average of 69.7%.

As shown in 2.4b, the vast majority of dwellings in Peterborough & the Kawarthas are single detached houses (72.2% of all dwellings).

3. Industry and Employment

The industry mix of a region is important to support current residents and as an attractor for future growth. The employment of residents can be viewed from two primary perspectives which are sector of employment (based on the North American Industry Classification System (NAICS)) and type of occupation (based on the National Occupational Classification (NOC)). These two perspectives provide contrasting views to employment by distinguishing the sector in which an employee works and the role that person performs within the sector. For example, a person may work in the manufacturing sector but perform a sales role.

3.1 Employment

Of the 141,357 residents in Peterborough & the Kawarthas, 62,710 were employed in 2016. This is 58.3% of the population over 15 years old. This is less than the Ontario percent of 61.0%. Table 3.1 shows the number of employed residents for each census subdivision in Peterborough & the Kawarthas. While the population has increased by 8.0% since 2001, the number of employed residents has increased by 29.5%. However, it is important to note that an employed resident is not the same as a job in the region. A person may reside in Peterborough & the Kawarthas, but commute to a nearby region. Table 3.2 shows the estimated number of jobs which exist in each

Table 3.1: Overview of employed residents in Peterborough & the Kawarthas

	2001	2006	2011	2016
Asphodel-Norwood	1,524	2,156	1,839	1,945
Cavan Monaghan	3,268	4,487	3,907	4,365
Curve Lake First Nation 35	370	538	455	365
Douro-Dummer	2,561	3,569	3,073	3,350
Havelock-Belmont-Methuen	1,686	2,380	2,031	1,710
Hiawatha First Nation	112	0	153	150
North Kawartha	828	1,204	1,053	1,005
Otonabee-South Monaghan	2,544	3,534	3,036	3,460
Peterborough	27,616	38,337	35,999	36,030
Selwyn	6,260	8,797	7,663	7,975
Trent Lakes	1,665	2,704	2,356	2,355
Peterborough & the Kawarthas	48,435	67,705	61,565	62,710

3. Industry and Employment

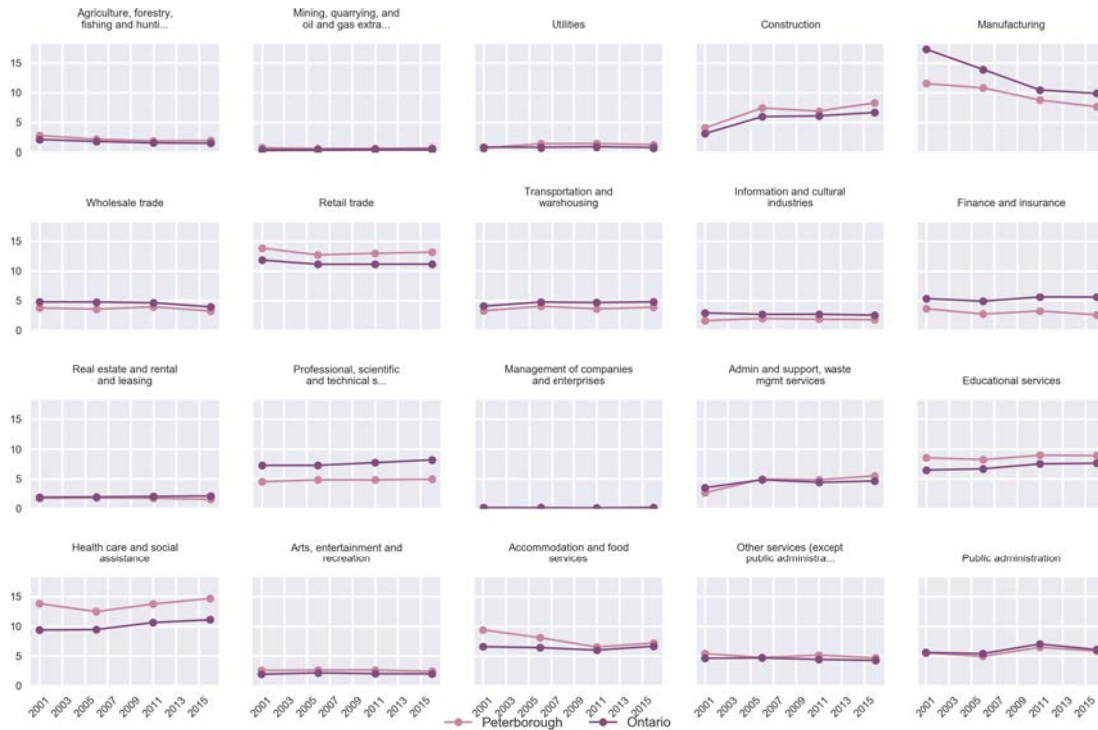
Table 3.2: Overview of estimated jobs in Peterborough & the Kawarthas

	2001	2006	2011	2016
Asphodel-Norwood	864	1,561	1,324	1,210
Cavan Monaghan	1,638	2,907	5,537	3,395
Curve Lake First Nation 35	261	408	365	270
Douro-Dummer	726	1,514	993	1,545
Havelock-Belmont-Methuen	1,361	1,730	2,031	1,490
Hiawatha First Nation	71	0	118	100
North Kawartha	578	1,014	1,053	830
Otonabee-South Monaghan	1,164	1,917	1,254	2,245
Peterborough	35,200	47,256	44,051	44,625
Selwyn	3,087	5,289	4,678	5,490
Trent Lakes	950	1,759	2,356	1,315
Peterborough & the Kawarthas	45,900	65,355	63,760	62,515

Figure 3.1: Employed residents of Peterborough & the Kawarthas by industry sector and occupation

Accommodation and food service...	55	0	680	25	25	40	10	15	3,580	90
Admin and support, waste mgmt ...	320	10	215	290	365	60	65	120	1,680	300
Agriculture, forestry, fishing...	55	0	560	70	400	10	10	0	30	50
Arts, entertainment and recrea...	125	10	115	30	95	515	55	0	535	50
Construction	360	0	535	200	25	20	0	95	90	3,855
Educational services	575	50	360	190	40	245	3,730	10	335	70
Finance and insurance	725	10	240	30	0	10	20	0	615	0
Health care and social assista...	1,210	4,525	405	90	0	30	2,160	10	735	40
Information and cultural indus...	255	0	150	95	0	270	25	10	160	90
Management of companies and en...	0	0	10	0	0	0	0	0	0	0
Manufacturing	385	25	490	550	10	45	45	1,880	360	985
Mining, quarrying, and oil and...	35	0	10	50	95	0	0	40	0	170
Other services (except public ...	370	60	185	70	15	50	570	50	900	685
Professional, scientific and t...	830	155	235	970	0	230	375	35	160	95
Public administration	775	75	340	525	55	40	1,285	80	220	320
Real estate and rental and lea...	355	15	95	0	10	0	10	10	430	45
Retail trade	480	305	1,510	75	20	70	40	45	5,110	595
Transportation and warehousing...	535	0	140	60	0	10	25	20	245	1,400
Utilities	65	0	45	140	20	10	10	150	65	260
Wholesale trade	355	0	375	90	20	30	10	160	465	495

Figure 3.2: Sector share of employment for residents of Peterborough & the Kawarthas and Ontario



subdivision in Peterborough & the Kawarthas. Section 3.2 examines the commuting patterns in greater detail.

The largest employment for residents of Peterborough & the Kawarthas is within the health care and social assistance sector with 9,195 people working in that sector, followed by the retail trade sector. From an occupation point of view, the largest group are sales and service occupations with 15,715 people. In Ontario, the largest sector, in terms of employees, is retail trade with the largest occupation being sales and service occupations. Figure 3.1 shows the complete distribution of employment of residents by sector and occupation for Peterborough & the Kawarthas.

As shown in Figure 3.2, since 2001 the share of employment in manufacturing has decreased from 11.5% of the employed residents to 7.6%, a 34.0% decrease. In Ontario, it has decreased from 17.3% to 9.9%, a 43.1% change. In contrast, the share of employment in construction has gone from 4.1% to 8.3%. Figure 3.2 shows how the sector share of employment has shifted from 2001 to 2016 in Peterborough & the Kawarthas and in Ontario.

3.2 Commuting and Place of Work

As shown in Figure 3.3, the majority of the residents of Peterborough & the Kawarthas (79.4%) have a usual place of work which is less than the Ontario percentage of 81.5%. Approximately

Figure 3.3: Place of work for residents of Peterborough & the Kawarthas

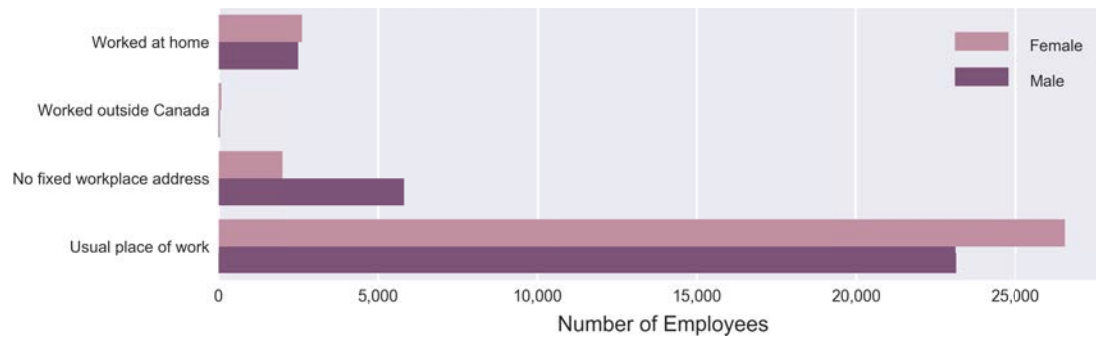
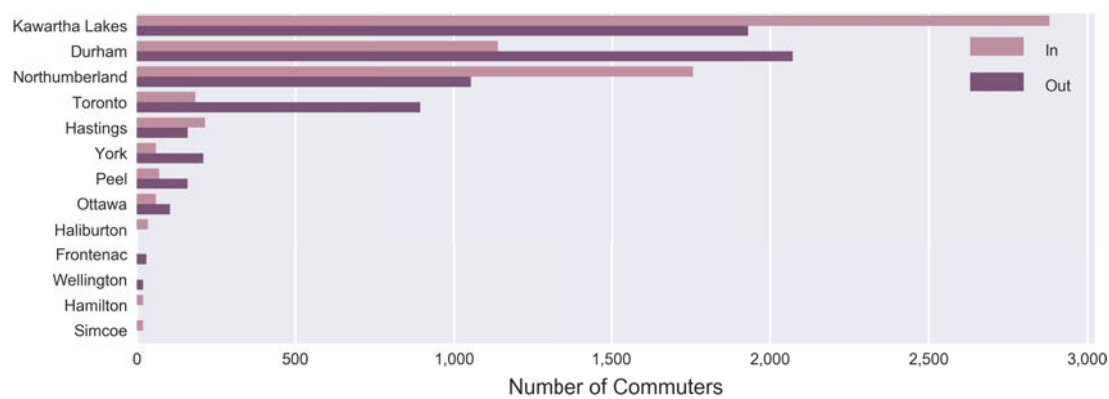


Figure 3.4: Commuting flows into and out of Peterborough & the Kawarthas



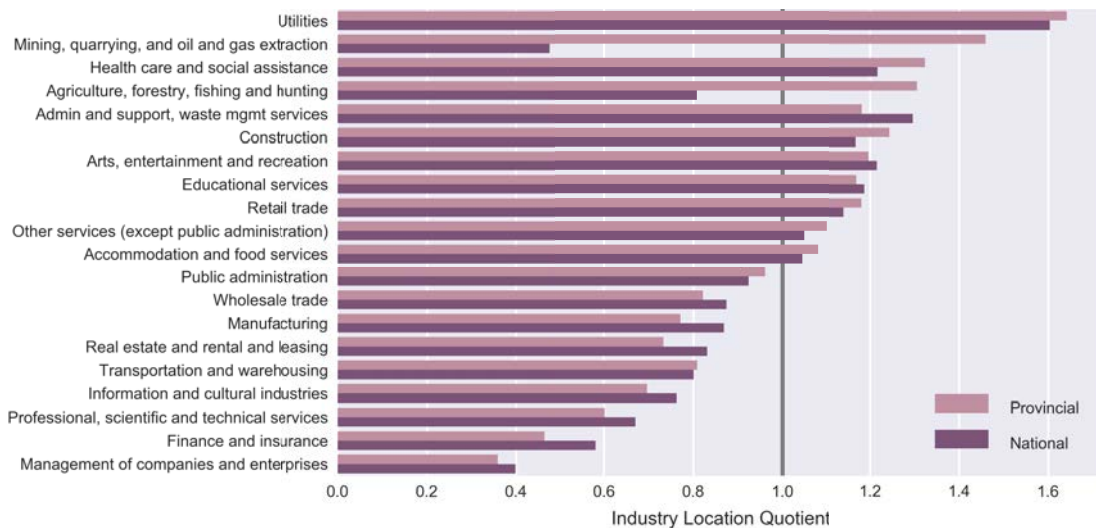
8.2% of employed residents work at home and while 12.5% have no fixed place of work (which could include jobs like construction where work is performed at different sites). This is compared to 7.3% who work at home and 11.2% who have no fixed place of work in Ontario. Of the those with a usual place of work, 13.4% (6,635 people) commute to areas outside of the region (Figure 3.4). However, a total of 6,440 people commute into the region. The net result is that there are estimated to be 62,515 in the region, which is 195 less than the number of employed residents. As a result, Peterborough & the Kawarthas has a fairly balanced flow of commuters.

The most common destination for commuters is Durham with 2,070 people commuting to jobs there. In the other direction, the most common origin for commuters into the region is Kawartha Lakes with 2,880 people arriving for work.

3.3 Location Quotients and Economic Base Analysis

The location quotient is a measure of the concentration of an industry (or other economic measure) relative to a larger region such as its province or country. Economic base analysis identifies the basic (or export) industries in the region by examining the location quotient to determine which sectors are providing a greater economic activity than what would be indicated by the provincial or

Figure 3.5: Industry location quotient relative to Ontario and nationally. Values greater than 1 indicate a concentration of that industry relative to Ontario and Canada.



national averages.

As shown in Figure 3.5, relative to the province and country, Peterborough & the Kawarthas has a greater concentration employees working in sectors of:

- Utilities
- Health care and social assistance
- Construction
- Arts, entertainment and recreation
- Admin and support, waste mgmt services
- Retail trade
- Educational services
- Other services (except public administration), and
- Accommodation and food services

These industry sectors employ more than the Ontario economy suggests and as a result likely provide a net inflow of value into the region. A similar analysis can be undertaken for the types of occupations that employees in Peterborough & the Kawarthas perform. Relative to the province and country, Peterborough & the Kawarthas has a greater concentration employees working in:

- Health occupations
- Trades, transport and equipment operators and related occ.
- Occ. in education, law and social, community and gov. services, and
- Sales and service occupations

Figure 3.6 summaries the remainder of the occupations in the region.

Figure 3.6: Occupation location quotient relative to Ontario and nationally

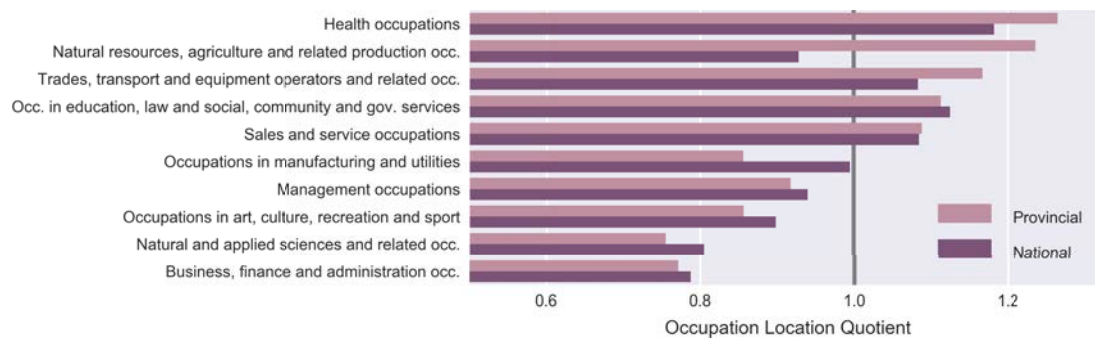
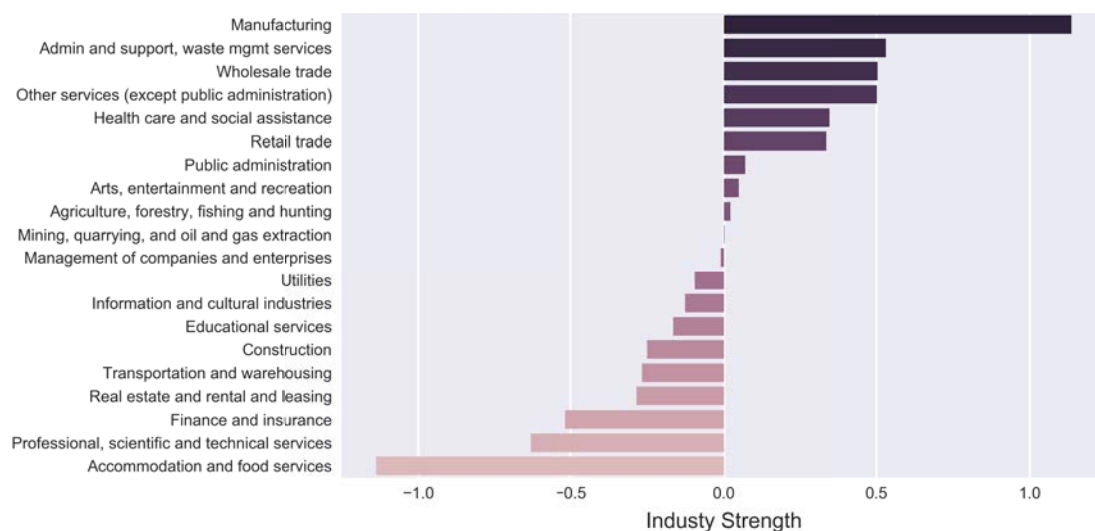


Figure 3.7: Sector strengths relative to Ontario



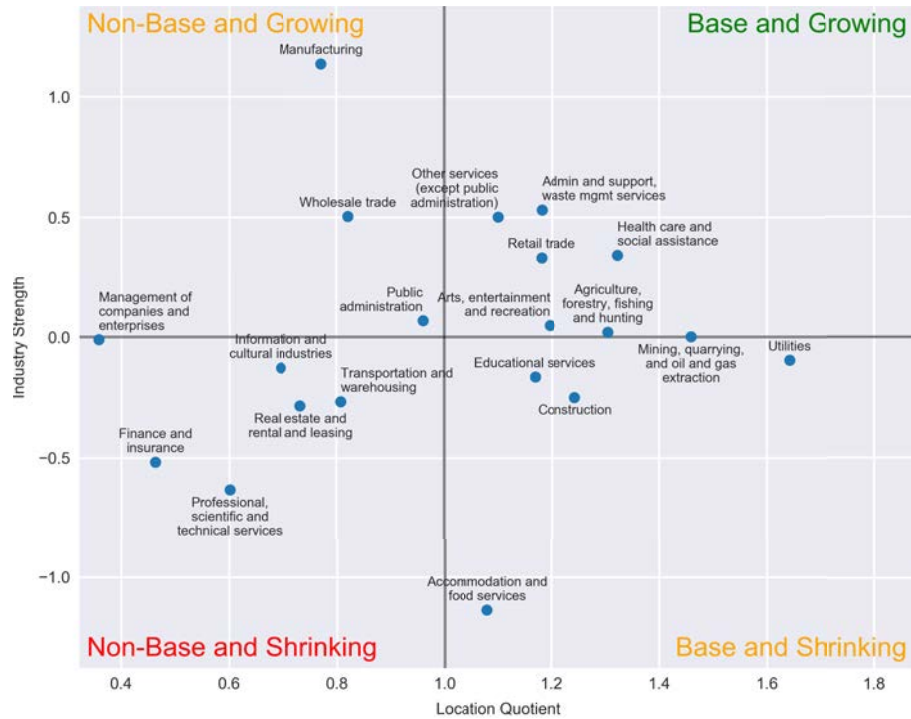
3.4 Sector Shift Analysis

While the location quotient examines the economy at a point in time, the sector shift analysis examines how various industry sectors in Peterborough & the Kawarthas are evolving relative to Ontario. Stronger sectors in the region may be reflected by the share in employment growing faster than surrounding regions, or decreasing less quickly if there are structural changes to the broader economy underway. The strongest sector in Peterborough & the Kawarthas is manufacturing, which has increased its share of employment by 1.1% more than the overall trends in Ontario over the last decade. Figure 3.7 shows the relative strength of the various industry sectors in the region.

The location quotient and sector shift analysis can be combined to highlight which industry sectors in Peterborough & the Kawarthas are performing better than in Ontario overall. The upper-right quadrant of Figure 3.8 show the sectors which are both base industries and growing (relative to the Ontario trends). These industries include:

- Mining, quarrying, and oil and gas extraction

Figure 3.8: Industry sector summary



- Health care and social assistance
- Agriculture, forestry, fishing and hunting
- Arts, entertainment and recreation
- Admin and support, waste mgmt services
- Retail trade
- Other services (except public administration)

In contrast, in the upper-left quadrant, are industries which currently have a lower location quotient, but with a share of employment that has been performing better than in Ontario overall. These industry sectors include:

- Manufacturing
- Wholesale trade
- Public administration

The lower-right quadrant are those with high location quotients, but are shrinking in significance to the local economy. Such industry include the utilities sector. Finally, the lower-left quadrant are those industries, such as professional, scientific and technical services which are non-base and not performing as well as in Ontario overall.

4. Comparisons

Comparison of Peterborough & the Kawarthas to similar regions and Ontario provides a benchmark to understand how Peterborough & the Kawarthas is evolving relative to its peers. Section 4.1 compares key trends in Peterborough & the Kawarthas to Ontario, while Section 4.2 compares the region to similar regions from across the country.

4.1 Ontario Comparison

Table 4.1 highlights many of the key similarities and differences between Peterborough & the Kawarthas and Ontario. The population of Peterborough & the Kawarthas has been growing more slowly than Ontario. However, the number of employed residents has been increasing faster. The median household income in Peterborough & the Kawarthas is 13.3% less than Ontario. As shown earlier in Figure 3.2, the fraction of employment for many types of employment is similar to Ontario, but significant differences exist in key industry sectors such as manufacturing and health care and social assistance.

Table 4.1: Comparison of Peterborough & the Kawarthas to Ontario

Characteristic	Peterborough	Ontario
Population	141,357	13,982,984
Average population density (per sq. km)	36.7	15.4
Median age	47.0	41.3
Average household size	2.45	2.71
Median household income	\$64,437	\$74,287
Employment rate (age 15+)	58.3%	61.0%
Population growth (2001 to 2016)	8.0%	17.5%
Employment growth (2001 to 2016)	29.5%	25.8%

4.2 Regional Comparisons

Table 4.2 highlights many of the key similarities and differences between Peterborough & the Kawarthas and other CDs across Ontario and Canada. (Note that Peterborough & the Kawarthas is repeated in each row for easier comparison.) Peterborough & the Kawarthas tends to have a

lower median income than many of the comparator regions but does have a relatively high median age. As was shown in Figure 2.1, the age distribution tends to be quite bi-modal with a larger number of people over 65 and around aged 20 to 25. The population growth of the region has been slower than most of the comparator regions, with the exception being the Algoma regions which has experienced a population decline.

4. Comparisons

Table 4.2: Comparison of Peterborough & the Kawarthas and selected CDs

Characteristic	Peterborough Ontario	Toronto Ontario	Ottawa Ontario	Middlesex Ontario
Population	141,357	2,876,095	973,481	475,881
Average population density (per sq. km)	36.7	4563.8	348.9	143.5
Median age	47.0	39.3	40.1	40.3
Average household size	2.45	2.58	2.60	2.50
Median household income	\$64,437	\$65,829	\$85,981	\$64,797
Employment rate (age 15+)	58.3%	62.1%	64.3%	57.0%
Population growth (2001 to 2016)	8.0%	11.3%	20.6%	12.8%
Employment growth (2001 to 2016)	29.5%	2.5%	5.7%	18.7%

Characteristic	Peterborough Ontario	Simcoe Ontario	Wellington Ontario	Hastings Ontario
Population	141,357	494,547	226,096	138,659
Average population density (per sq. km)	36.7	101.8	85.0	22.7
Median age	47.0	43.1	40.3	46.4
Average household size	2.45	2.70	2.65	2.43
Median household income	\$64,437	\$76,489	\$81,347	\$61,109
Employment rate (age 15+)	58.3%	66.8%	68.5%	61.8%
Population growth (2001 to 2016)	8.0%	25.9%	16.0%	4.9%
Employment growth (2001 to 2016)	29.5%	72.7%	32.8%	11.7%

Characteristic	Peterborough Ontario	Hamilton Ontario	Algoma Ontario	Division No. 11 Saskatchewan
Population	141,357	561,022	116,201	324,871
Average population density (per sq. km)	36.7	502.1	2.4	19.5
Median age	47.0	41.5	49.0	35.9
Average household size	2.45	2.65	2.28	2.73
Median household income	\$64,437	\$69,024	\$58,664	\$81,913
Employment rate (age 15+)	58.3%	63.4%	51.9%	64.6%
Population growth (2001 to 2016)	8.0%	10.0%	-6.1%	33.7%
Employment growth (2001 to 2016)	29.5%	37.5%	3.9%	43.9%

5. Regional Forecast

Regional forecasts are generated using the Canadian Centre for Economic Analysis' agent-based simulation platform, PaR. The simulation and analysis platform takes into account the intrinsic uncertainty of how a region will evolve to estimate not only the most likely outcomes, but also the range of possible outcomes. Note that the forecasts assume no significant changes in social policy (such as national immigration rates) or transformative technological changes (such as wide-spread adoption of automous vehicles).

5.1 Demographics

As shown in Figure 5.1 the population of Peterborough & the Kawarthas is expected to grow to between 154,000 and 162,300 people by 2041 with an expected value of around 158,200 people. The range of outcomes arises through the random nature of demographic processes such as birth, deaths, and migration, coupled with the requirement that dwellings (houses or apartments) must be build to accomodate the growing population. Even with the same number of dwellings, variation in average household size can yield significant differences.

5.2 Employment

If employment preferences, such as retirement age and the likelihood of pursuing higher education follow recent trends, Figure 5.2 shows the estimated number of employed residents in the region. By 2041, there would be around 68,300 employed residents on the region. The aging of the population results in the average annual growth of employment (0.33%) being slower than that of the total population (0.44%) over that time period.

Figure 5.1: Population forecast for Peterborough & the Kawarthas. The shaded region corresponds to the 95% confidence interval of the possible outcomes. The dotted line indicated the beginning of the simulation.

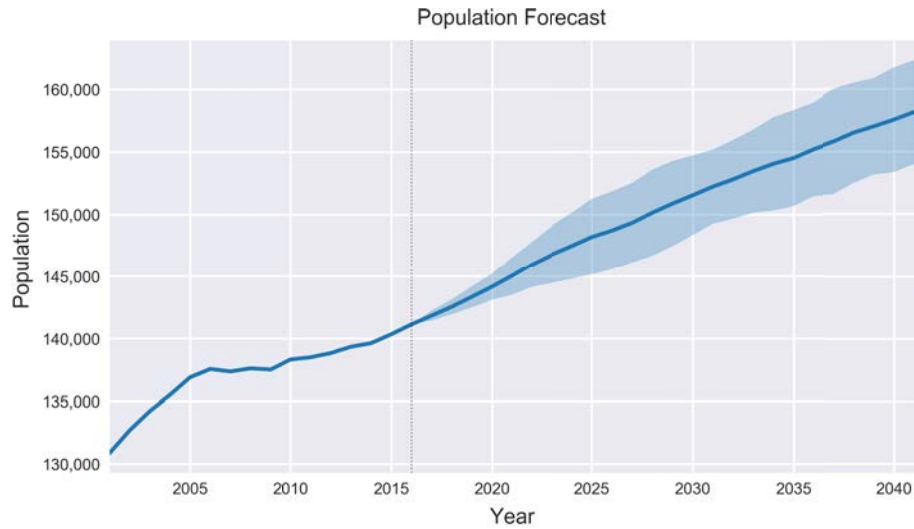
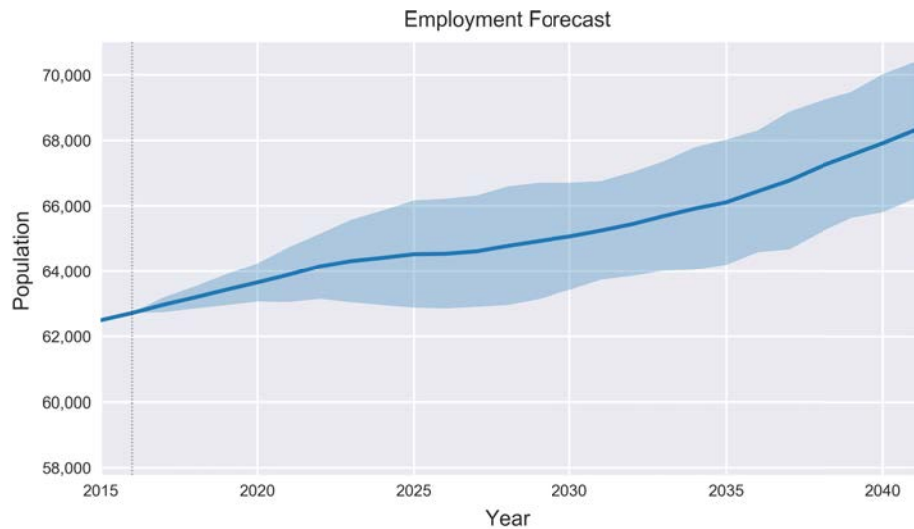


Figure 5.2: Employment forecast for Peterborough & the Kawarthas. The shaded region corresponds to the 95% confidence interval of the possible outcomes. The dotted line indicated the beginning of the simulation.



A. Glossary

CANCEA The Canadian Centre for Economic Analysis.

census division (CD) Each province and territory in Canada is subdivided into census division. In 2016, there were 293 census divisions across Canada. Census divisions frequently align with municipal boundaries. A census division is further divided into census subdivisions..

census subdivision (CSD) A census subdivision is third level of geographic census hierarchy with over 5100 CSDs across Canada in 2016. A census subdivision is further divided into dissemination areas (DAs). There are a total of See also census division (CD)..

dissemination area (DA) A dissemination area is fourth level of geographic census hierarchy with over 56,000 CSDs across Canada in 2016. See also CD and census subdivision (CSD)..

economic base The economic base of a regions are those industries which export goods and services outside of the region..

economic base analysis The process of identifying the industries which export goods or services outside of the local economy. The location quotient is a primary means of identifying such industries..

household A household is group of people living in a single dwelling. They may be related in a census family or unrelated..

location quotient A location quotient is a statistic that measures a regions specialization relative to a larger geographic region. It is calculated as an industrys share of a regional total statistic divided by the industrys share for the larger geographic region. A value greater than 1 indicated a higher than average share in the local region..

National Occupational Classification (NOC) National Occupational Classification.

North American Industry Classification System (NAICS) North American Industry Classification System.

occupation According to the National Occupational Classification (NOC), an occupation refers to the kind of work performed in a job, a job being all the tasks carried out by a particular worker to complete his or her duties. An occupation is a set of jobs that are sufficiently similar in work performed..

population density Population density is calculated by taking the total population of a region and dividing it by the region's geographic area. Note that if the region's area is less than 1 square kilometer, the density will be larger than the population residing in the region..

Prosperity at Risk (PaR) CANCEA's agent-based simulation platform which incorporates individuals, households, industry and government for 56,000 regions across Canada..

B. Prosperity at Risk

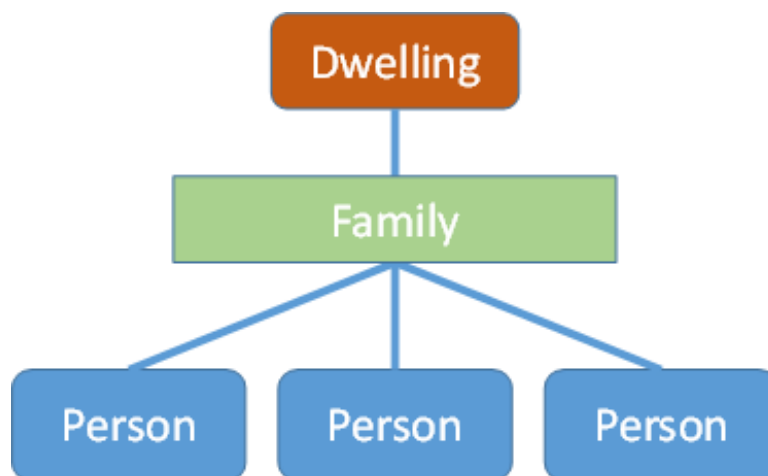
The demographic and employment analysis was conducted using the Canadian Centre for Economic Analysis' Prosperity at Risk data analysis and simulation platform – a cutting-edge, "big data" computer simulation platform that incorporates social, health, economic, financial, and infrastructure factors into a single system in order to serve Canadians policy interests. PaR is a unique, agent-based simulation modeling platform, wherein agents (e.g., individuals, industries, governments and non-residents) are modeled simultaneously as a complete system. These agents have a long list of attributes and behavioural rules including demographic details, financial assets and liabilities, household structure, and employment status. Within the analysis platform, agents interact with each other, resources, the infrastructure, and the economy in accordance with their behavioural rules. Prosperity at Risk (PaR) captures over 56,000 Canadian geographic areas that are linked through population, dwellings, infrastructure, socioeconomic policy and industry development. As the system evolves, agents make random choices based on distributions estimated historical behaviours or exogenous distributions. Due to the random nature of the behaviour decisions in the platform, instead of a single value for a forecast, Prosperity at Risk yields a distribution allowing an estimation of upper and lower bounds of all outputs.

The demographic and labour force model uses over 200 Statistics Canada tables, census microfile data, and extensive data cleaning algorithms in order to estimate long term behaviours of individuals, governments and corporations in over 20 industry sectors.

Overall, the agent-based, event-driven micro-simulation platform unifies demographics, labour force dynamics, government finances, private capital investment, and the complicated interdependencies of production to allow Canadian Centre for Economic Analysis (CANCEA) to produce detailed analyses of various scenarios. CANCEA was invited to present at the 2016 Canadian Economics Association conference about how agent-based modeling presents a more realistic approach for economic models and forecasts.

Demographic forecasts are a fundamental component of all of CANCEA's projects. PaR is capable of modeling the expected population growth in Canada, its provinces, and sub-regions for both the short and long term. Within PaR, each resident of a region is a single agent. Each person has numerous properties including birth date and sex. Each family is also treated as a distinct agent in the system with associated family members. Depending on the family structure, households could be single individuals, lone-parents, or couples (with or without children). This approach allows consistent estimated of household properties such as family income by summing the

Figure B.1: Illustrative example of the connections between people and households in PaR



income of its members while allowing decisions still to be made at both the individual and family level. Finally, each family requires a dwelling in which to reside. Dwellings have fixed locations, and are associated with families. (Note that it is possible to have multiple families residing in a single dwelling.) Newly formed families require a dwelling in which to reside and new construction can continue according to the local trends, demands, and constraints. Figure B.1 illustrates the connections between people, families and dwellings.

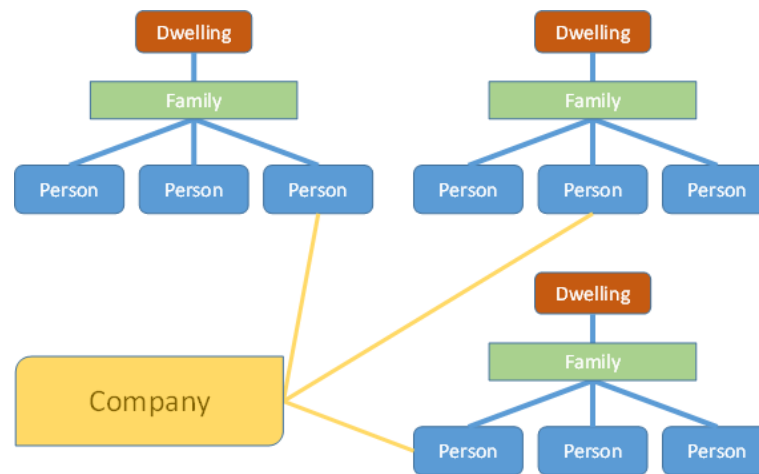
PaR is capable of modelling the entire population of Canada with 34 million people (growing to over 50 million by 2050) with their corresponding families and dwellings. Demographic processes create agents, destroy agents, or alter the links between agents. The key demographic processes include:

- Birth (based on fertility rates, family size, age, location, etc);
- Death (based on age, location, etc);
- Migration (based on age, location, employment, unemployment, etc); and
- Family Formation (based on age, location, etc).

Births create new agents in an existing family. Deaths will remove agents from an existing household and also remove the family if there are no more members. (The dwelling then becomes vacant.) Migration is applied at the family level by altering the links between families and dwellings. Finally, family formation involves one person leaving an existing family to form a new family, and removal of any families that result being empty. The demand for housing can then be estimated from preference profiles for the modelled families.

The probability distributions for birth, death, and migration are based on a detailed analysis of historical trends and factors. Other factors such as immigration policy, which would impact a regions population now and into the future, are also considered. A characteristic of the platform is the ability to perform sensitivity, scenario and policy intervention analysis. Different scenarios on

Figure B.2: Illustrative example of the connections between a single company and households in PaR



population growth, agent movement, immigration policies, for example, can be undertaken within PaR (international, provincial, and sub-regional). The platform is stochastic allowing estimates of the upper and lower values of population and economic states to be obtained. Moreover, PaR regularly goes through an extensive cross-model validation process to ensure that results could be reproduced and are consistent with other projections, such as those produced by provincial ministries or Statistics Canada. For example, aggregate demographic projections for Ontario and its major regions align (within the stochastic bounds of the simulations) with Ontario Ministry of Finance projections.

The basic demographic and housing model can be expanded by adding industry agents to the platform which provide goods and services to the economy and employ people. Each employed person has a link to one (or more in the case of part-time work) employer with an associated wage. Sector-specific input-output tables are used to estimate the commodity dependency for each industry agent to calculate the intermediate goods and labour required. As people age and retire or migrate in the system, companies are required to hire new employees to maintain their level of output. The probabilities of each behaviour are based on extensive analysis of historical Statistics Canada industry and Labour Force Survey data. In addition, as consumer demand grows with the population, additional employees might be required to meet the additional demand. Figure B.2 illustrates the connection between companies and employment in PaR.

It is important to note that PaR captures the regional variation in industry sectors across the country and province. These regional differences play an important role in the growth of employment demand in the forecasts.