The Impact of an Ageing Population on a Labour Market in Canada

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1.INTRODUCTION

It is known that our global population is ageing at an unprecedented rate. Canada is not an exception, as researchers and analysts have observed that demographic structure of Canada is changing rapidly. These changes will modify profoundly the age profiles of the country's population over the coming decades.

There are different forecasts, but some of the major projections demonstrate that, due to declining birth rates, growth in the population traditionally considered to be of working age will slow and then essentially cease. Furthermore, the average age of the workforce will rise, as will its average level of education. The proportion of female workers will increase. And people past traditional retirement age may make up a larger share of the employment pool. As the baby-boom generation will make the rapid shift into retirement, the prospect of the population ageing rises major concerns about the ability of Canadian society to meet the large anticipated additions to health care, pensions, and other costs associated with the increase in the older population.

The baby boom generation is now in middle age. In the next decade its oldest members will be taking early retirement. By 2031 all of its members will have reached the age of 65 and, if present trends continue, the fraction of the population 65 and over will be far greater than previously experienced in Canada, or indeed in any modern industrial nation. Changes in the demographic structure due to the ageing population will influence labour supply and demand, consumption behaviour, the growth of national income, private and public saving rates, and other aspects of the economy. As a result, households, producers, investors, and governments will have to adjust their behaviour due to the demographic changes.

Most of the previous studies on this subject focused on macroeconomic effects that appear due to the ageing population. However, this major paper mostly focuses on changes in the labour market induced by the ageing population. The goal of this research is to examine the inter-regional, inter-sectoral, and occupational effects of aggregate consumption demand shifts that will be experienced by the population due to its ageing.

In order to be able to introduce different experiments, a computable general equilibrium model has been built that includes six Canadian regions , about twenty-five different occupational groups that we distinguish by ten types of professions and five levels of qualifications. The model has also an overlapping generations structure with six age groups in each region. The model is calibrated in Canadian data. After that we simulate the inter-regional, inter-sectoral, and occupational effects considering the upcoming structural changes of the population and the consumption preferences of the six age groups with respect to the fourteen sectoral goods. To be more precise, I analyze the inter-regional, inter-sectoral and occupational effects that occur from the shift in the consumption demands due to the ageing population. It is known that the consumption behaviour of households changes over their lifetime. Hence, the composition of the demand for goods and services alters as the population ageing. These alterations will influence shifts in the structure of the labour market, changes in the production of various sectors, as well as bring some changes in the economic performance of Canadian regions.

Section 2 demonstrates demographic projections in Canada, including topics such as ageing of a Canadian workforce, more female workers, immigration flows, and other demographic factors such as fertility and mortality. In Section 3, labour issues by occupations, with subsections such as low-skilled workers versus high-skilled workers and potential solutions, are discussed. Section 4 describes the model. Calibration and data are shown in the Section 5. In Section 6, the simulation results are reported. Finally, the conclusion follows in Section 7.

2. DEMOGRAPHIC PROJECTIONS IN CANADA

At the beginning of this twenty-first century, population ageing is about to emerge as a worldwide phenomenon. In many countries around the world, the combination of lowered fertility rates, improvements in the health systems, and longevity have increased proportions of older population. Canada is one of these countries.

According to the Statistics Canada, seniors are one of the fastest-growing population groups in Canada. In 1998, there were an estimated 3.7 million Canadians aged 65 and over, up almost 60% from 2.4 million in 1981. In fact, the senior population has grown more than twice as fast as the overall population since the early 1980s. As a result, more than one out of every 10 Canadians is now a senior. In 1998, 12% of the total population were seniors; up from 10% in 1981 and 8% in 1971; it is also more than twice the figure in 1921, when only 5% of people living in Canada were seniors.

The rapid growth in the size of the senior population is also expected to continue well into the future, particularly when those born during the baby boom years from 1946 to 1965 begin turning 65 early in the second decade of the new century. Statistics Canada has projected, for example, that by 2021 there will be almost 7 million seniors, who will represent 18% of the total population, and that, by 2041, there will be almost 10 million seniors, who will make up an estimated 23% of the population.

The senior population in Canada, however, is not a homogeneous group. At least from a broad statistical perspective, people aged 65-74 more closely resemble those in age groups under age 65 than they do those aged 85 and over, while people in the 75-84 age range appear to be in a period of transition. The population aged 85 and over, on the other hand, is the most likely to be characterized by many of the conditions associated with old age such as heavy consumption of health care. This is particularly significant, because the population aged 85 and over is the fastest-growing segment of the overall senior population.[1] (See Table 1 below)

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[1] http://www.hc-sc.gc.ca/seniors-aines/pubs/factoids/en/factoid.htm

Table 1. Population aged 65 and over (Statistics Canada).

Year	Population aged 65 and over			As a % of the Canadian population
	Men	Women	Total	
	000s			
1921	215.0	205.3	420.2	4.8
1931	294.6	281.5	576.1	5.6
1941	390.9	376.9	767.8	6.7
1951	551.3	535.0	1086.3	7.8
1961	674.1	717.0	1391.1	7.6
1971	790.3	972.0	1762.3	8.0
1981	1017.2	1360.1	2377.3	9.6
1991	1349.8	1867.4	3217.2	11.4
1996	1515.3	2066.7	3582.0	12.1
1998	1588.5	2147.2	3735.7	12.3
Projections				
2016	2591.2	3302.9	5894.3	15.9
2021	3050.7	3840.6	6891.1	17.8
2026	3558.1	4438.8	7996.9	20.0
2031	3976.5	4960.1	8936.5	21.7
2036	4166.6	5261.0	9427.6	22.4
2041	4244.8	5424.6	9669.6	22.6

Source: Statistics Canada, 2000.

In has been said that due to the ageing population, Canadian labour market is about to experience some tremendous changes. Why such changes will occur? The major reason is the shift of the baby-boom generation into retirement. This prospect of ageing population raises some questions, such as what economic costs will the retirement of baby-boomers bring? Will Canada experience a shortage of labour after the baby-boomers move into retirement? What policies should be drafted in order to cope with the aging of baby-boomers?

In order to answer the questions that might arise due to the retirement of the baby-boomers, it is necessary to take a look at the demographic prospects, especially at the age distribution changes. First of all, I would like to give a definition of baby-boomers: the baby-boom generation is the generation of those who were born during the two decades following the Second World War.

On October, 2002, according to Statistics Canada, the population estimate reached the 31,485,623 mark. From July 1, 1999 to July 1, 2000, the population increased by 256,700 people, compared to an increase of 245,500 the year before. The change in these figures was due to an increase in immigration. In the year 2000, around 205,000 immigrants arrived in Canada. The impact of natural population growth – which we define as the difference between the number of births over the number of deaths –continues to decrease as a factor in overall population growth. In the years 1999-2000, Canada had 5,000 fewer births and 6,600 more deaths compare to the previous years. [2]

A study of the distribution of the Canadian population by age over various periods highlights the ageing of the population and the decrease in the number of youth as a proportion of the population . In 1956, 46.7% of the Canadian population was under 25 years of age. In 2000, young people under 25 made up less than one-third of the population. By 2026, they will represent only one-quarter of the population. By contrast, those aged 65 or older made up less than 10% of the population in 1956, compared to 12% in 2000, and 20% by 2026. Based on Statistics Canada's projections for ageing, half the population of Canada will be over 43.6 years of age in 2026, a marked increase over the figure of 36.8 for 2000. [3]

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[2] *The Daily*, Statistcs Canada , September 26, 2000.

[3] *The Daily*, Statistics Canada, March 13, 2000.

relative to the number of working-age people, will strongly influence social security programs such as public pension plans, and social programs such as the health care system .

According to Beaujot (2001), the long term assumptions used for the level of fertility, life expectancy, and net immigration are the following: fertility of 1.6 births per woman, life expectancy of 85, and net immigration of 0.47 per 100 population. Close to the year 2026, there will be fewer than three persons aged 20-64 for each person aged 65 and over. According to medium term projections, the proportion 20-64 to 65+ will change from 4.9 in 2000 to 2.2 in 2100. It is interesting to know that ageing of the baby-boomers will influence the "ratio of potential support" (defined as a number of working-age people per older person). According to Statistics Canada, from 2001 to 2026, this ratio will fall from five working-age people for every elderly person, to three per elderly person.[4]

Demographics take on a new meaning in a welfare state, as there is interest in determining the relative well-being of different components of the population, and to plan for improvements. Population projections become more important for Canada. And its effects would be felt in a lot of activities of the welfare state and tremendous repercussions for the financing of those programs, such as health, education and social securities, and others.

AGEING OF THE CANADIAN WORKFORCE

As the Canadian population ages, the effect of it is felt primarily in the labour market. One of the main changes of the shift in the composition of the working age population is its increasing age. It is interesting that not only is the average age of workers within the usual group rising, but the share of people of ages 64 and up as potential employees increasing. As it has been mentioned before, the average age of the workforce will rise, as will its average level of education. The number of female workers will grow and people past traditional retirement age will make up larger share of the employment pool. As could be expected, some sectors may be more affected than others by this ageing of the workforce. For instance, as reported in Table 2, ageing has a more definitive effect on sectors such as utilities, transportation and warehousing, education services, health services and social assistance, and public administrations.

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[4] Schetagne, Sylvain, "Building Bridges Across Generation in the Workplace", 2001.

definitive effect on sectors such as utilities, transportation and warehousing, education services, health services and social assistance, and public administrations.

Table 2: Industry Composition and Distribution by Age Groups, Canada, 2000

Year 2000	Employees		
	(000)	%	%
	Aged 15+	**15-24 yrs**	**45+ yrs**
Total employees	12,488 .3	17.4%	29.9%
Goods-producing sector	3,200	13.2%	30.1%
Agriculture	123.6	35.6%	23.6%
Forestry, fishing, mining, oil & gas	234.3	11.2%	32.1%
Utilities	116.3	3.1%	42.4%
Construction	538.3	16.0%	29.2%
Manufacturing	2,187.5	12.0%	29.9%
Services-producing sector	9,288.3	18.8%	29.8%
Trade	2,000.8	29.6%	23.5%
Transportation & warehousing	638.2	9.0%	35.9%
Finance, insurance, real estate & leasing	736.2	10.7%	30.2%
Professional, scientific & technical services	619.2	12.4%	20.9%
Management of companies & administrative & other support services	385.8	23.8%	26.7%
Educational services	929.4	7.5%	44.0%
Health care & social assistance	1,32.8	8.6%	36.5%
Information, culture & recreation	569.5	25.3%	23.1%
Accommodation & food services	862.6	45.9%	15.0%
Other services	458.2	16.6%	33.0%
Public administration	761.7	7.2%	40.8%

Source: Prepared by the Canadian Council on Social Development using Statistics Canada's Labour Force Historical Review, 1976-2000, cat. 71F004XCB

As could be observed from the table above, the percentage of workers 45 years old and over has the highest level in education services (44.0 %), followed by 42.4 % in the utilities industry, 40.8 % in public administration, 36.5 % in health care and social assistance industry, and 35.9% in transportation and warehousing.

Generational change in the workplace will therefore be more noticeable in these sectors over the next few years as they are characterized by a high proportion of 45+ of age in the labour force, as we observe the ageing affects not only of a general population over the coming years but also of the active population. As it has been predicted by various analysts, the active population aged 45 years and older will increase considerably over the next two decades.

In 1996, one of every five Canadians active in the labour market was aged 45 to 54, and one in 12 active Canadians was between 55 and 64 years of age. These proportions should increase until 2021, when one of every four active Canadians will be 45 to 54, and one in seven will be 55 to 64 years of age, after which their numbers will begin to decrease as the baby boomers leave the workforce at retirement.[5] In the coming decades , fewer young people will enter the workforce, growth in the population traditionally considered to be of the working age is expected to slow or even reverse, and people past today's common retirement ages will almost certainly make up a larger share of the pool from which employers must draw.

These changes that are about to start in the Canadian labour market due to the coming retirement of a major part of the labour force could have a number of potential consequences. They could be the following: a general labour shortage and/or a shortage of skilled labour; a decrease in the productivity and competitiveness of Canadian companies as a result of the loss of experienced and competent personnel; increases in social costs due to the smaller number of workers; and a drop in levels of financing for social programs. For the arguments given above, hiring and constructing strategies, work scheduling, human capital development, compensation and job assignment practices, business structures, and workplace technologies will all require adaptations for a relatively smaller, older, and more female workforce.

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[5] Schetagne, Sylvain, "Building Bridges Across Generation in the Workplace", 2001.

MORE FEMALE WORKERS

Moreover, the older workforce will be increasingly female. Since statistics shows that women live longer than men, the composition of the older population is always titled toward women. A generation ago, women were a relatively small share-one quarter to one third of the workforce, and now they are approaching half the total of the workforce. About twenty five years ago, fewer than one in three Canadian workers ages 55 to 64 were women; now two in five are. The share of over- 65 workers who are females has risen from one-quarter to almost one -third in Canada.[6] However, some authors, such as Schetagne (2001), claim that feminization of the labour market may lessen the threat of a potential labour shortage. He says that the ageing of female baby boomers, combined with the high participation rate of younger women (aged 25 to 45), may contribute to an increase in the participation rate of all women in the labour market, and especially that of older women. As a result, it may help mitigate the potential labour shortage.

IMMIGRATION

As a part of a demographic projection one has to talk about the influence of immigration on demographics. Immigration might play an important role in population growth and can be an effective tool to avoid population decline. With the world changing around us, people often move from one place to another or, some times, stay all their lives in the same place. People move for different reasons. Some do it because they have to leave for school, for the job, for the family, for the retirement. There is also some movement between the countries. Here one would talk about international migration. It is known that there are various barriers between places of origin and potential places of destination. More often these barriers are represented by policies. Someone needs to appreciate that levels of immigration as a function of things happening within Canada and others happening outside of the country, both in the short and long terms.

One may ask a question such as "what causes immigration?" It is obvious that there is no shortage of a potential pool of people who want to come to Canada, and these outside pressures are constantly increasing. For Canada the factors that have been analyzed have been in particular

[6] Robson, William, B.P. and BNAC Statement, "Aging Populations and the Workforce", 2002.

economic and demographic, but we should remember about social and political factors as well. Many times, it has been proposed that Canada requires immigrants not only for purposes of economic growth, but also to address demographic stagnation. It could be said that immigration is very useful to economic growth. It can sustain demographic growth and to some degree help with a problem of population ageing.

Denton et al. (1997) used immigration levels in 100,000 increments ranging from zero to 500,000, with fertility coefficient of 1.64, showing projection results every five years. The zero and 100,000 immigration assumptions imply a population decrease after 2016, while other immigration quotas project continuous growth to the end of the projection period in 2036. In the zero assumption, the 2036 population is by 0.7 percent smaller than that of 1996, in the 100,000 assumption the overall growth is 15.5 percent up to 2036, and these numbers show 31.7 percent with 200,000 immigrants, 47.8 with 300,000, 64.0 with 400,000 and 80.2 with 500,000.

Based on a constant age structure of immigrants on arrival. Denton et al. (1997: 41) produced the following proportions over 65:

Table 3. Immigration level and percentage of immigrants over 65 for the years 2016 and2036.

Immigration level inflow per year	Percentage of immigrants over 65 (out of entire pop'n)	
	Year 2016	Year 2036
zero	18.1	29.1
100,000	17.3	26.7
200,000	16.6	24.8
300,000	16.0	23.4
400,000	15.5	22.2
500,000	15.0	21.3

Source: Denton, Frank, Christine Feaver and Byron Spencer, 1997, "Immigration, labour force and the age structure of the population" McMaster University: QSEP Research Report No. 335.

From the table, it is indicated that in 2016, each additional 100,000 immigrants would have reduced the proportion over 65 by some 0.6 percentage points, which could be compared to the ageing that occurs over about four years in current conditions. In 2036, each 100,000 immigrants would have reduced the proportion over 65 by 1.6 percentage points. Even though the impact is larger as one moves further into the future, the assumption of a constant age structure of immigrant arrivals becomes not very realistic. However, possibilities described above involve a population that ages quite rapidly. With 500,000 immigrants per year, the proportion over 65 would increase to15 percent in 2016 and 21.3 percent in 2036. Hence, demographic projections show how important immigration is for the future population composition. For instance, international immigration is expected to rise from its recent level of approximately 200,000 annually to about 277,00 by the year 2020. Allowing a slight rise in out-migration, net immigration is forecast to increase from its current level of 140,000 to 208,000 by the 2020. Hence, it might become a dominant source of population growth. [7] However, Beaujot (2000) said that, "Demographic arguments alone cannot be used to justify the level of Canadian immigration. Even in demographic terms, there is nothing magical about the orientation to maintain population growth or avoid population decline."[8]

CANADIAN BORN PEOPLE

In the next section we talk about influence of Canadian born to demographic changes. In order to comprehend this part, one should talk about the fertility and mortality rates.

Fertility

First of all, the total fertility rate should be defined. The total fertility rate for a year represents the average number of children that would be born to a woman in her lifetime if she were to experience the age-specific fertility rates observed in, or assumed for, that year. Since the late 1950s the total fertility rate has decreased a lot. In recent years it has generally been just under 1.70 for Canada overall. The decrease occurred due to the various reasons, including: changes in a variety

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[7] The Conference Board of Canada, Draft of "Fiscal Prospects for the Federal and Provincial/Territorial Governments", 2002.

[8] Beaujot, Rederic and Matthews, Deborah, "Immigration and the Future of Canada's Population", 2000.

of social, medical and economic factors. It has been assumed that the total fertility rate for Canada will increase slightly from its 1995 level of 1.64, to an ultimate level of 1.70 in 2016 .

Mortality

According to the projections of the Conference board of Canada, the death rate in Canada will rise over the next twenty years. As a result, the natural increase in the population (which is defined as births minus deaths) is projected to fall from about 115,000 in 2000 to 51,000 in 2020.

Life expectancy in Canada has increased considerably during this century, despite the differences in the numbers provided by different sources. The life expectancy at birth according to Statistics Canada (1996) is 75.7 years for males and 81.4 years for females. On the other hand, the ultimate life expectancy underlying the 17th revision of the Canada Pension Plan is 80.2 for men and 87.7 for women.[9] And, finally, according to Beaujot (2001), figures are equal to 83.5 for men and 86.5 for women. Mortality improvements are expected to continue in the future due to the advancement in the medical technology, medical and scientific research, drugs, rise in the living standards, nutrition, and others.[10] The improvements are expected to result in the following life expectancies:

Table 4. Projected Trends in Life Expectancy - Canada

	1991	**2000**	**2050**	**2100**
At birth				
males	74.6	76.2	79.4	82.0
females	80.9	82.2	85.2	87.7
At age 65				
males	15.7	16.5	18.4	20.2
females	19.9	20.7	22.8	24.8

Source: "Canada Pension Plan", 17th Actuarial Report ,1997.

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[9] Office of the Superintendent, 1998:20; 1993:35.

[10] Canada Pension Plan, "Seventeenth Actuarial Report",1997.

3. LABOUR GRADES BY OCCUPATION

As it was mentioned above, some sectors will be more affected than others by the process of the aging population. These sectors would be construction, transportation and warehousing, education services, health services and social assistance. When we talk about the labour issues, it is important to take a look at the current and future labor market conditions in Canada.

CURRENT LABOUR MARKET CONDITIONS

If we take a look across all occupations, according to Human Resources Development Canada (HRDC), current labour market conditions are considered to be fair. The ranking of the conditions is the following: "good"(for occupations and skill levels, where it is relatively easy to find a job), "fair" (not so easy to find a job, but possible), and "poor"(very hard to find a job). This rating is consistent for all skill levels (education and training groupings) except management, where conditions are good, and occupations at lower levels of education and training, where the situation is poor. Grouped by broad industry type, workers of all occupations are facing fair labour market conditions except in health and art, culture, recreation, sport, trades, transport and equipment operators.

Human Resources Development Canada (HRDC) and Job Futures in their report show that rating vary within broad skill groupings.[11] For instance, at the professional skill level (university education), the overall skill rating is fair while conditions are considered good for some of these occupations (like human resource professionals, systems analysts, doctors, dentists, electrical and electronic engineers and lawyers) and poor for others (such as life science professionals, including biologists, and creative and performing artists). In sales and service occupations, overall conditions are also considered fair. However, within this skill type, conditions are good for police and firefighters and poor for chefs and cooks, child-care and home support workers, and cleaners.

In general terms, the current labour market conditions for recent graduates from the formal school system are fair. Looking at fields of study, overall conditions are fair, although the ratings vary from poor for arts graduates to good for physical science graduates. This is due largely to the recent positive conditions being faced by computer science graduates.

[11] www.hrdc-drhc.gc.ca/sp-ps/arb-dgra/publications/bulletin/volun2/elv4n2_03e.shtm

It is possible to expect that in the near future, the number of new job openings will exceed the number of people who seek for a job for management occupations and occupations requiring post secondary education. Hence, there will be an excess demand for the occupations that require post secondary education. Examples of occupations in these two categories include financial managers, human resource managers, chemists/chemical technologists, geologists/geological technicians, machinists and electrical trades and telecommunications workers. The opposite will be true for occupations requiring high school completion or less. Future labour market conditions are expected to worsen for such occupations as mail and message distributors; cashiers; attendants in travel, accommodation and recreation; and machine operators and related workers in metal and mineral products processing.

Notice that emerging shortages or surpluses will not necessarily translate into unfilled vacancies or unemployment. Adjustments in wages and salaries, training, inter-occupational mobility and changes in production plans will all contribute to resolving these expected imbalances. Looking at skill types, labour market conditions are expected to remain unchanged in all business, finance and administration occupations except for mail and message distribution, where conditions will deteriorate from fair to poor. Conditions in natural and applied sciences are expected to improve from fair to good on the strength of computer scientists, engineers and professional and technical occupations in the physical sciences.

Even though the number of new job seekers is expected to exceed the number of new job openings in the health sector, the only occupation group in this sector that is expected to experience worse conditions is therapy and assessment professionals. In social sciences, education, government services and religion, the rating deteriorates from fair to poor for psychologists, social workers, counselors and ministers of religion.

The largest movement toward a labour surplus occurs in the art, culture, recreation and sport sectors, where conditions worsen from fair to poor for announcers and other performers, athletes, coaches, referees and related occupations. Conditions in the sales and service sector are expected to remain fair, although there will be a deterioration from fair to poor for cashiers and attendants in travel, accommodation and recreation.

In the trades and transport sectors, conditions will improve for machinists, electrical trades and telecommunications workers. In the primary sector, labour market conditions are expected to improve for supervisors in logging and forestry, logging machine operators, and mining occupations, and remain poor or worsen for occupations related to agriculture and fishing. Conditions in the processing, manufacturing and utilities sector are expected to improve for central control and process operators and worsen for machine operators in the metal and mineral products industry.

LOW -SKILLED WORKERS VERSUS HIGH-SKILLED WORKERS

Will there be a shortage of skilled and unskilled labour in Canada? It could be seen that certain sectors are already experiencing labour shortages that may be attributable to the massive and premature departure of a good portion of the aging workforce.

In a recent analysis, Boothby and Gingras (1998) look at the changing labour market conditions for Canada's work force. Their analysis does not show any deterioration of labour market conditions for low-skilled Canadian workers in the 20 to 54 age group. Nevertheless, some data suggests that there has been a relative decline in access to the labour market and to employment for low-skilled workers 55 years of age and older. Boothby and Gingras divide the Canadian workforce into two groups: low-skilled workers (those without a post-secondary diploma) and high-skilled workers (post-secondary graduates). They later inspect a number of labour market indicators to find out whether the relative labour market conditions for the low-skilled workers have deteriorated over the last two decades.

According to the authors, the proportion of low-skilled individuals in the labour force has been steadily declining. In 1976, for example, the low-skilled labour force in the 20 to 54 age group was three times larger than the high-skilled labour force in relative terms. In 1997, the high-skilled labour force aged 20 to 54 years was larger than the low-skilled labour force in the same age group. For individuals 55 years of age and older, the low-skilled labour force has declined from five times as large as the high-skilled labour force in 1976 to less than one and a half times as large in 1997.

The changing ratios between the low-skilled and high-skilled labour forces have been decomposed into the part attributable to changes in the participation rate of each group and the part attributable to changes in the respective populations. For individuals in the 20 to 54 age group, the decline in the relative size of the low-skilled labour force is attributable entirely to the decrease in the size of the low-skilled population, not to an increasing exclusion from the labour market, as is shown by the ratio between participation rates. For individuals 55 years of age and older, the decrease in the relative population size accounts for more than 83 percent of the change in the relationship between the low-skilled and high-skilled labour forces.

In order to get a better understanding, it would be useful to take a look at the Appendix 1. Graph 1 depicts the "Relative Size of Low-skilled Labour Force" and Graph 2 depicts the "Participation Rate Ratio". One knows that the employment rate for a group is the proportion of the population in the group that holds a job. Hence, a decline in the ratio of the employment rate of the low skilled to the rate for the high skilled may mean that low-skilled persons are having more trouble finding employment. As is the case for differences in the labour force ratios, changes in the low-skilled share of total employment in the two groups are primarily due to changes in the relative size of the low-skilled and high-skilled populations. In the case of workers 55 years of age and older, the relative deterioration in the employment rate of low-skilled workers also contributed to the decline in their share of employment. (Appendix 1. Graph 3).

Another factor that might be disadvantageous to low-skilled workers is the wage they can command for their work. Between 1981 and 1994, there was a slight upward movement of the wage ratio between low-skilled and high-skilled workers in the 20 to 54 age group, a trend which was briefly interrupted by downturns following the recessions of 1981 and 1991.Changes in the Labour

Force Survey make it difficult to compare educational levels after 1989 with the earlier years. Consequently, no firm conclusion should be drawn from trends in relative earnings capacity for low-skilled workers 20 to 54 years of age. There is much more variability in the ratio of weekly earnings for the 55 to 64 age group, making it difficult to identify any trend.

To conclude, some data suggests that there has been a decrease in access to the labour market and to employment for low-skilled individuals 55 years of age and older. [12] However, the early leaving of the baby boomers from the labour market may reveal shortages in certain sectors- such as in the areas health and social services, as well as professions that suffer the consequences of poor planning, or those that are not esteemed by youth may also experience labour shortages.

POTENTIAL SOLUTIONS

So, if the shortage of labour occurs, is there is anything that could be done in order to smooth the consequences of the ageing population? There are certain means of action that could be taken. Some of them are indicated below.

Changes in Public Policy

The prospect of an ageing population is leading public policy makers to begin to react in some areas. Many countries have already reformed their tax and other regulations affecting private pensions, but there is a lot more to be done. For instance, firms have to start recruiting more aggressively. In addition to the old methods of recruitment, new ones occur, such as internet job board, job fairs, evolvement of the employees of the companies in bringing people they know to work, and searching for employees among the students of universities, colleges, and high schools.

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[12] http://www.hrdc-drhc.gc.ca/sp-ps/arb-dgra/publications/bulletin/vol4n2/e/v4n2_02e.shtml

Another strategy that will become very important is searching for talent abroad. Both immigration and outsourcing across borders will be important .

Retaining older workers at the work place

In order to keep older workers at the workplace, some people suggest increasing the age at which older workers can access public retirement funds, or modifying public policies in order to ensure that they do not favour the early retirement of older workers. Another way to retain older workers is to improve the environment in which they work. A less physically and psychologically demanding environment might help keep older workers on the job longer. According to the statistics, younger workers are less likely to remain with a firm for a long time, which is why it is important to keep older worker at the work place. Unfortunately, the reality is if the firm facing a downsizing, it's most likely to lay off the older workers than the young ones.

Changing work schedules and providing flexible hours for older workers

Fewer hours and flexible scheduling are widespread desires among older workers. If employees want to keep their older workers longer at the work place, they should try to adapt the work schedule that is more convenient for the older employers. In addition, flexible hours should be more widely available.

Retirement plans

Retirement plans are some of the most important factors of the employer-employee relationship affecting older workers. In the past, flexibility in retirement plans was mainly keyed to inducing the retirement of the older workers . Because both private and public pensions appear to have helped to lower the average age of retirement in the past, there are reason to think that changes to existing practices could help modify it again in the future. The main goal will be to retain more employees until normal retirement age or past it, allowing those for whom full time work is no longer attractive or possible to stay in the work force on a less demanding basis.

Another option of a potential solution to the ageing labour force could be training and retraining workers.

Training and retraining workers

Technological changes forces companies to make training and retraining available for older and younger workers. Older workers are not necessarily slower learners. As older workers become better educated, their skills can be a source of competitive advantage to firms. It is very important to point out the influence of education on the labour market.

Table5. Educational attainment of the labor force ages 45-64 in Canada, 1995-2015

	Canada
1995	
Less than upper secondary	27.7
Upper secondary	24.8
Tertiary (above secondary level): non-university	29.3
University	18.2
2015	
Less than upper secondary	14.1
Upper secondary	30.1
Tertiary: non-university	33.8
Tertiary: University	21.9

Source: William B.P. Robson and BNAC Statement, "Ageing Populations and the Workforce, p.36.

It is known that people with more education stay in the workforce longer than less educated people. At the same time, changes in earnings after layoff and re-employment show that better educated workers typically experience less of a setback, suggesting greater adaptability to new environments and responsibilities. In a way, it implies that if the level of education to be raised, then eventually, it might raise the number of older workers in the workforce. Hence, it might help to alleviate the labour shortage.

Using older workers as trainers/Transfer of knowledge from older to younger workers

A very important strategy should be the one that favours the transfer of knowledge and skills between generations of workers. They may take the form of tax credits for training, or an income support program within a mentoring program between an older worker and a younger worker. These strategies and policies should make the transfer of knowledge and skills from workers near retirement to their younger successors easier. What could save the company some money would be using older and more experienced workers as trainers for the younger ones. By "trainers" one means older workers to take on special duties, mentoring and ensuring the transfer of knowledge and skills to the younger workers.

Considering new models for pensions

One of the possibilities would be to shift away from the defined-benefit model, where pension plans are structured in a way so that their richest accruals take place at the end of the career of employees . For instance, as it has been proposed by William B.P. Robson and BNAC (British-North American Committee)(2001) - is cash-balance and pension equity plans, which provide employees with current valuation while employers bear the risk of maintaining sufficient funding to cover their benefits. There is also an alternative of mixed pension plans, with a core defined benefit retirement component-possibly with less heavily back-loaded accruals than have been typical in the past- and defined contribution add-ons.

Making changes in the workplaces/Techno and Ergonomics and working closer to home for older workers

Scarce labour from an economy- wide perspective will not only increase wages, but it will also increase capital investment, as firms supplement the supply of human capital with the supply of machines. A lot of people think that more capital intensive workplace is hostile to older workers. What could be done in the workplace for the older workers is the following. Ageing workers have lessened muscle strength and flexibility, so reducing the need to lift or carry over distances will help in manual jobs. Ergonomic work spaces can reduce standing time and give less physically flexible workers more working room. Insulation from excessive noise can help workers whose hearing is less than acute to cope with distraction. In office jobs, adjustable chairs and work surface, large video displays, and hands- free, volume adjustable telephone equipment, eye- friendly computer screens are among the items that can make older workers more productive. Another possibility to retain older workers from the early retirement would be letting them work at home or closer to home. In part, relocation is simply a matter of reducing the time and inconvenience of commuting.

Creating a Regulatory Environment

The extensive involvement of government in labor markets and retirement-income systems means that successful strategies in work scheduling will depend critically on the policy environment. Discussions with policymakers will be more productive if employers who seek changes can address concerns about undermining the objectives of the income replacement system and about fairness. Best-practice models are an effective way to demonstrate to policymakers the virtues of appropriate legislation. And because policy changing takes a long time to implement, companies now thinking they might want to implement programs with unusual provisions in 5 years should start discussions with policymakers immediately.

In conclusion, even though it is known that demographic forces are changing the workforces of Canada, the consequences of such process are still not fully understood, and reactions to it are uneven. Labour market is changing slowly but inevitably. Employers who do not start adapting to a changing workforce will lose their edge in recruiting, and find frustrated younger workers and pensioned older workers leaving for competitors. Government and employers will have to adapt new policies if they want to be ready when the time comes.

4. THE MODEL

In this section I describe the model developed by Mercenier and Mérette (2002). I use this model in order to investigate the inter-regional, inter-sectoral and occupational effects of a change in aggregate demand due to the population ageing. A lot of studies on a topic of an ageing population have focused on the national and macroeconomic effects of population ageing. After doing a literature research, it came to my attention that the number of other studies that concentrate on microeconomic effects of the ageing population is close to zero. Hence, one of the major reasons why I chose the model that Mercenier and Mérette worked on, is that their study, as well as mine, investigates the microeconomic effects of population ageing.

There are six regions plus the rest-of-the-world in this model with six different age groups (from fifteen to eighty five years old), fourteen sectors, and approximately twenty five different occupations that are separated by professional categories and different skill levels. Households work the first five periods of their life and during the last period households retire. We assume that the financial capital market is perfectly integrated. The computable general equilibrium model has been built in order to calibrate on a number of sources of Canadian data. Then inter-regional, inter-sectoral, and occupational effects are simulated, taking into account the structural shift in the Canadian population due to its ageing and the preferences change in consumption of the six age groups with respect to the fourteen sectoral groups. Simulations used in this paper will permit to analyze what outcomes (consequences) will occur due to the differences in the aging process across various regions.

We have different types of economic agents in each regions. The first one is a FIRM that produces one differentiated good. The second is a GOVERNMENT that supplies public goods by issuing government bonds and controlling taxes. The third one is six different age groups that represent HOUSEHOLDS. The fourth one is INVESTORS. And finally, we have the REST OF THE WORLD.

It should be mentioned that on the one hand there are producers that maximize profits by minimizing their costs subject to technological constraints. To be precise, the demand of labour is distinguished by different types of labour services from different professions with a different level of qualification. On the other hand, there are households that try to maximize the utility subject to the constraint of wealth. As could be expected, economic behaviour, specifically consumption, of the households changes as individuals age. For instance, younger generation of Canadians borrow to invest in human capital (i.e. education). Canadians of the middle age work a lot in order to earn assets for the current and future consumption. Finally, older Canadians consume a considerable amount of leisure and use a lot of health care services. As for the government, it issues government bonds, supplies public goods, and acquires revenues from capital taxes, consumption, and labour. Before we start describing the model in details, we should make readers familiar with the preliminaries on sets and indices.

EQUATIONS OF THE MODEL

First of all, the economy in Canada is separated into I fully endogenous and symmetric regions denoted by i, or j $(i=1,...I)$. These regions are complemented by the rest of the world indexed by row with a subset denoted *RoW*. The set of the regions is denoted II and indexed by *ii* or *jj* $(ii=1,...II)$. Hence, what we have is : $II=I \cup RoW$.

Various sectors of production in each region are denoted by s, ss $(s=1,...S)$.
Labour is separated by qualifications within different occupations or professions which we group in different types or classes. We name the set of qualifications by *Iqual,* where $(iqual=1,...Iqual)$, the set of occupation by *Iprof* $(iprof=1,...Iprof)$, and the set of labour types by *Itype* $(itype=1,...Itype)$. In addition, we use the subscript t to represent a time period. At each time period there G $(g=1,....G)$ generations that coexist together. The working generation is indexed by gj $(gj=1,...GJ)$, and the generation that is retired by gm $(gm=Gj+1,...G)$.

We start from the household behaviour, where relative equations will be shown and explained.

Household behaviour

The model is built on the life-cycle theory of saving behaviour. Household lives six periods of ten years and goes into retirement after 5 periods. In each period, the oldest generation dies and the new generation enters a labour force. This implies that at any point in time six generations are alive. Younger generation starts working at the age of 15 years old, while agents of the older generation go into retirement at the age of 64 and die at the age of 74 years old. The children that are under the age of 15 and assumed not to enter the labour force, are completely dependant on their parents to whom they do not bring any extra burden nor provide any felicity.

We assume that every generation in each region has a problem of maximizing an inter-temporal felicity function U of consumption and bequest subject to a lifetime income.

Our felicity function is of CES (Constant elasticity of substitution) form, and is time-separable:

$$(1) U_{j,t} = \frac{1}{1-\theta} \sum_{g=1}^{6} \left(\frac{1}{1+\rho} \right)^{g} \left[\left(Con_{j,g,t+g-1}^{1-\theta} + \beta_g^{\theta} RBeq_{j,g,t+g-1}^{1-\theta} \right) \right] \theta > 0, \beta_{g \neq 6} = 0, \beta_{g=6} > 0$$

where $Con\, j,g,t$ is consumption of an individual living in region j of age group g at time t, ρ the pure rate of time preference, θ the inverse of the inter-temporal elasticity of substitution, β_g is a constant parameter and $RBeq_{j,g,t}$ is a bequest. The equation above says that the welfare of an individual is a weighted sum of 6 periods of consumption from the age group $g=1$ at period t to age group $g=6$ at $t+5$, plus the (positive) utility to bequest for $g=6$ in period $t+5$. We do not include leisure into the utility function because the labour supply of the individual is assumed to be exogenous.

The bequest specification follows Blinder (1974) and brings up the rise to inter-generational transfers and to public old-age pension benefits, which implies that felicity from bequest does not depend on the present value of cash receipts that extends beyond the death of the current generation. As a result, the timing of the expenses of the government has an effect on the utility of the current generation.

Lets W be the present value of household income which is the discounted sum of lifetime labour income $Linc_{j,g,t}$ net of taxes not including public old-age pensions (which we call - $Pens_{j,g,t}$) and inheritance (which we name- $Inh_{j,g,t}$). Lets also assume no borrowing constraints and perfect capital markets. In the following equation, let *Rint* be the rate of interest, τ^K and τ^w - the tax rates on capital and labour income respectively, and CtR_t be the contribution rate on the Canadian pay-as-you-go public pension program. Then, intertemporal income can be expressed as

$$W = \sum_{g=1}^{6}\left(\frac{1}{1+R\text{int}_{t+g-1}(\tau^K)}\right)^t$$

$$(2)\ ((Linc_{j,g,t+g-1}(1-\tau^w_{j,t+g-1} - CtR_{t+g-1}) + (1-\tau^w_{j,t+g-1})Inh_{j,g,t+g-1} + Pens_{j,g,t+g-1})$$

Next, labour income, which we write down as a $LInc$ depends on the individual's age-dependent productivity (earnings) profile that is assumed to be identical across regions and depending on age. To understand the equation better, we write the earnings profile (EP_g) as a quadratic function of age (g) that can be shown in the following formula:

$$(3)\quad EP_g = \gamma + \lambda g - \psi g^2; \gamma, \lambda, \psi \geq 0$$

After we defined the earnings profile, we may define the labour income of some individual in the working age group *gj* during the time period *t*, where $L^{\sup}_{j,itype,iprof,iqual,gj,t}$ is the amount of the supplied labour service.

$$(4) \quad LInc_{j,gj,t} = \sum_{\substack{itype\\iprof\\iqual}} W^{qual}_{j,itype,iprof,iqual,t} L^{\sup}_{j,itype,iprof,iqual,gj,t} EP$$

The above equation that defines the labour income suggests that our labour income has a concave shape. In our model, parameters of the earnings profile function will be picked out in a way that the most important earnings from labour will occur at middle age over the lifetime period.

Next equation shows that pension benefits of the retirees (*Pens*) are proportional to their labour earnings over the lifetime. *PensR* is a pension replacement rate, which is a fraction assumed to be identical everywhere in Canada.

Pension benefits of the retirees *(PensR)* are demonstrated in the equation below:

$$(5) \quad Pens_{j,gm,t} = PensR\frac{1}{5}\sum_{gj} LInc_{j,gj,t-5+gj}$$

Now if we differentiate the household utility function (1) with respect to individual's lifetime budget constraint we will get the following first-order conditions for consumption and bequests:

$$(6) \quad Con_{j,g+1,t+g} = \left[\frac{\left(1+R\,\text{int}_{t+g}(1-\tau^K)\right)}{(1+\rho_j)}\frac{PCon_{j,g,t+g-1}}{PCon_{j,g+1,t+g}}\right]^{(1/\theta)} Con_{j,g,t+g-1}$$

$$(7) \quad Beq_{j,g,t} = \beta_g Con_{g,t}$$

Equation *(8)* demonstrates equal distribution of inheritance among all working generations. Bequests comes from the oldest generation and is generated at the end of life of each generation. In the equation below $Pop\ j,g,t$ means the number of people of age group g that lives in the region j at time period t. Population growth rate as exogenous in the model.

$$(8)\quad Inh_{j,gj,t} Pop_{j,gj,t} = \frac{1}{5} P^{Con}_{j,gn,t} RBeq_{j,gn,t} Pop_{j,gn,t}$$

For the next step of their optimization problem, households distribute their consumption expenditures among the available final goods, defined by s. We are going to use a CES function again to represent the inter-regional preferences of households. Now, the inter-regional first-order conditions demonstrate that a household consumes a good s produced in region j for the price of $P^{c}_{j,s,t}$ at age g could be demonstrated by the following equation:

$$(9)\quad \begin{cases} {P^{Con}_{j,g,t}}^{1-\sigma^{Con}_{j,g}} = \sum_{s} \alpha^{ConS}_{j,s,g} {P^{c}_{j,s,t}}^{1-\sigma^{Con}_{j,g}} \\ ConS_{j,s,g,t} = \alpha^{ConS}_{j,s,g} \left(\frac{P^{Con}_{j,g,t}}{P^{c}_{j,s,t}} \right)^{SigCon_j} Con_{j,g,t} \end{cases}$$

where $ConS_{j,s,g,t}$ shows household's consumption of good s.

It is important to know that the older population consumes more health services compare to the younger generation. It happens due to the variations of the composition of a consumption basket across generations. Hence, the aggregate consumer price index is dependent on a generation.

We assume that financial markets are efficient and perfectly integrated. Households in our model living in region j invest in physical capital $Kij_{j,g,t}$ and bonds $Bij_{i,j,g,t}$ that the government and firms issue everywhere in Canada. We assume that both asset holding of local residents are represented by home bias (that is captured by portfolio shares). The structure of household's wealth is without consequence, except on impact after the unexpected shock, due to the assumption that all assets are perfect substitutes and traded on fully integrated international markets.

Investors at time t of region j

It is known that capital goods are built by using an investment technology. The latter permits the substitution between different market goods. By choosing the optimal constituting mix, the following conditions are obtained:

$$(11)\quad \begin{cases} {P_{j,t}^{Inv}}^{1-\sigma_j^{Inv}} = \sum_s \alpha_{j,s}^{InvS} {P_{j,s,t}^{c}}^{1-\sigma_j^{Inv}} \\ InvS_{j,s,t} = \alpha_{j,s}^{InvS} \left(\dfrac{P_{j,t}^{Inv}}{P_{j,s,t}^{c}} \right)^{\sigma_j^{Inv}} Inv_{j,t} \end{cases}$$

Next we denote the regional stock of physical capital as $Kstock_{j,t+1}$, which increases with investment $Inv_{j,t}$ but decreases with the depreciation at the constant rate $DepR_j$. The equation of the physical capital is shown below:

$$(12)\quad Kstock_{j,t+1} = Inv_{j,t} + (1 - DepR_j) Kstock_{j,t}$$

The rate of return on a unit of physical capital ($RRet\, j,t$) that is bought at time period *t-1*, is a function of the rental (*Rent*) subtracting depreciation rate (*Depr*), adding the capital gains:

$$(13) = \quad RRet_{j,t} = \frac{Rent_{j,t} + (1 - DepR_j) P_{j,t}^{Inv}}{P_{j,t-1}^{Inv}}$$

Producers s of region j at time t

In our model producers use factor of productions and intermediate input goods from sectors

ss in the amount , $X_{ss,j,s,t}$ in order to produce good s in amount $Z_{j,s,t}$. Production factor inputs include capital services which we mark as $K^{dem}_{j,s,t}$ and different types of labour services that come from various professions that require different qualifications, which we mark as $L^{Qual}_{j,s,itype,iprof,iqual,t}$.

We assume that each input should be bought at the market prices , denoted respectively $P^{c}_{j,ss,t}$, $\mathrm{Re}\,nt_{j,t}$,and $w^{Qual}_{j,itype,iprof,iqual,t}$. The assumption is that primary factor prices should be the same for all sectors but specific to each region. We assume that factors are mobile between sector but not between regions. Hence, producers have to solve the following problem:

(14)

$$\underset{XS_{ss,j,s,t},K^{dem}_{j,s,t},L^{dem}_{j,s,itype,iprof,iqual,t}}{Minimize} \quad \sum_{ss} P^{c}_{j,ss,t} XS_{ss,j,s,t} + \mathrm{Re}\,nt_{j,t} K^{dem}_{j,s,t} + \sum_{\substack{itpe\\ iprof\\ iqual}} w^{Qual}_{j,itype,iprof,iqual,t} L^{Qual}_{j,s,itype,prof,iqual,t}$$

subject to the constraints that characterize the technology of the firms written below:

(15)

$$Z_{j,s,t} = CD(X_{j,s,t} Q_{j,s,t}; Sc^{z}_{j,s,t}, \alpha^{Q}_{j,s} \ldots\ldots\ldots\ldots\ldots\ldots (P_{j,s,t})$$

$$X_{j,s,t} = CES(XS_{ss,j,s,t}; \alpha^{XS}_{ss,j,s}, \sigma^{X}_{j,s}) \ldots\ldots\ldots\ldots\ldots\ldots (P^{X}_{j,s,t})$$

$$Q_{j,s,t} = CD(K^{dem}_{j,s,t}, L^{dem}_{j,s,t}; Sc^{Q}_{j,s,t}, \alpha^{K}_{j,s}) \ldots\ldots\ldots\ldots\ldots\ldots (P^{Q}_{j,s,t})$$

$$L^{dem}_{j,s,t} = CES(L^{Type}_{j,s,itype,t}; \alpha^{Ltype}_{j,s,itype}, \sigma^{Ldem}_{j,s}) \ldots\ldots\ldots\ldots\ldots\ldots (Wage_{j,s,t})$$

$$L^{Type}_{j,s,itype,t} = CES(L^{\mathrm{Prof}}_{j,s,itype,iprof,t}, \alpha^{Lprof}_{j,s,itype,iprof}, \sigma^{Ltype}_{j,s,itype}) \ldots\ldots\ldots (w^{Type}_{j,s,itype,t})$$

$$L^{\mathrm{Prof}}_{j,s,itype,iprof,t} = CES(L^{Qual}_{j,s,itype,iprof,iqual,t}; \alpha^{Lqual}_{j,s,itype,iprof,iqual}, \sigma^{\mathrm{Prof}}_{j,s,iprof}) \ldots (w^{\mathrm{Prof}}_{j,s,itype,iprof,t})$$

In the equations above we denote a Cobb-Douglas form (that is parameterized by the scaling parameter Sc ad the expenditure shares α) by CD(.; Sc, α) and by CES (.; α, σ), which is a constraint-elasticity-of-substitution form (where α is a share parameter and σ is a substitution elasticity). As a result, the production of output $Z_{j,s,t}$ needs to combine, in fixed expenditure shares, intermediate inputs and value added, respectively in amount $X_{j,s,t}, Q_{j,s,t}$ .Then the aggregate intermediate input is a CES combination of market goods and quantities $XS_{ss,j,s,t}$ itself.

Value added is produced by using $K^{dem}_{j,s,t}$ and $L^{dem}_{j,s,t}$ amounts of capital and aggregate labour services with fixed expenditure shares. Next, the aggregate labour service is a CES mixture of different types of labour denoted $L^{Type}_{j,s,itype,t}$, each of which is a different CES mix of professions denoted $L^{\Pr of}_{j,s,itype,iprof,t}$ that is a product of a CES combinations of different qualifications $L^{Qual}_{j,s,itype,iprof,t}$. All of the above multilevel CES aggregation structure shows the heterogeneous nature of labour inputs. In brackets we show shadow prices because they are associated with the constraint of the firms' cost minimization problem.

The problem of the firm can be divided in few steps. In the first step, firms choose between value added of factors and intermediate goods. Then, the origins of the intermediate good are chosen where the labour demand takes a form by type, profession, and qualification.

Equations below demonstrate the optimization conditions of the problem of the firm:

$$\begin{cases} Z_{j,s,t} = Sc^{Z}_{j,s} X_{j,s,t}^{1-\alpha^{Q}_{j,s}} \\ P^{X}_{j,s,t} X_{j,s,t} = (1-\alpha^{Q}_{j,s}) P_{j,s,t} Z_{j,s,t} \\ P^{Q}_{j,s,t} Q_{j,s,t} = \alpha^{Q}_{j,s} P_{j,s,t} Z_{j,s,t} \end{cases}$$

$$\begin{cases} {P^{X}_{j,s,t}}^{1-\sigma^{X}_{j,s}} = \sum_{ss} \alpha^{XS}_{ss,j,s} {P^{c}_{j,ss,t}}^{1-\sigma^{X}_{j,s}} \\ XS_{ss,j,s,t} = \alpha^{XS}_{ss,j,s} \left[\dfrac{P^{X}_{j,s,t}}{P^{c}_{j,ss,t}} \right]^{\sigma^{X}_{j,s}} X_{j,s,t} \end{cases}$$

$$\begin{cases} Q_{j,s,t} = Sc^{Q}_{j,s} {K^{dem}_{j,s,t}}^{\alpha^{K}_{j,s}} {L^{dem}_{j,s,t}}^{1-\alpha^{K}_{j,s}} \\ \mathrm{Re}\,nt_{j,t} K^{dem}_{j,s,t} = \alpha^{K}_{j,s} P^{Q}_{j,s,t} Q_{j,s,t} \\ wage_{j,s,t} L^{dem}_{j,s,t} = (1-\alpha^{K}_{j,s}) P^{Q}_{j,s,t} Q_{j,s,t} \end{cases}$$

$$(16)\begin{cases} wage_{j,s,t}^{1-\sigma^{Ldem}_{j,s}} = \sum_{itype} \alpha^{Ltype}_{j,s,itype} {w^{Type}_{j,s,itype,t}}^{1-\sigma^{Ldem}_{j,s}} \\ L^{Type}_{j,s,itype,t} = \alpha^{Ltype}_{j,s,itype} \left[\dfrac{wage_{j,s,t}}{w^{Type}_{j,s,itype,t}} \right]^{\sigma^{Ldem}_{j,s}} L^{dem}_{j,s,t} \end{cases}$$

$$\begin{cases} {wage^{Type}_{j,s,itype,t}}^{1-\sigma^{Ltype}_{j,s,itype}} = \sum_{iprof} \alpha^{Lprof}_{j,s,itype,iprof} {w^{\mathrm{Pr}of}_{j,s,itype,iprof,t}}^{1-\sigma^{Ltype}_{j,s,itype}} \\ L^{\mathrm{Pr}of}_{j,s,itype,iprof,t} = \alpha^{Lprof}_{j,s,itype,iprof} \left[\dfrac{{wage^{Type}}_{j,s,itype,t}}{w^{\mathrm{Pr}of}_{j,s,itype,iprof,t}} \right]^{\sigma^{Ltype}_{j,s,itype}} L^{Type}_{j,s,itype,t} \end{cases}$$

$$\begin{cases} {wage^{\mathrm{Pr}of}_{j,s,itype,iprof,t}}^{1-\sigma^{Lqual}_{j,s,iqual}} = \sum_{iqual} \alpha^{Lqual}_{j,s,itype,iprof,iqual} {w^{Qual}_{j,s,itype,iprof,iqual,t}}^{1-\sigma^{Lprof}_{j,s,iprof}} \\ L^{Qual}_{j,s,itype,iprof,iqual,t} = \alpha^{Lqual}_{j,s,itype,iprof,iqual} \left[\dfrac{{wage^{\mathrm{Pr}of}}_{j,s,itype,iprof,t}}{w^{Qual}_{j,s,itype,iprof,iqual,t}} \right]^{\sigma^{Lprof}_{j,s,iprof}} L^{\mathrm{Pr}of}_{j,s,itype,iprof,t} \end{cases}$$

Government at time t region j

The government issues bonds and levies taxes on labour earnings and individual consumption expenditures to finance its spendings. Not only it has public expenditures *(Gov)*, health care *(GovH)* and education *(GovE)* expenditures, but also the government has to pay public debt.. Government 's consumption spendings is distributed across sectors using a CES aggregation:

(17)

$$\begin{cases} {P^{Gov}_{j,t}}^{1-\sigma^{Gov}_j} = \sum_s \alpha^{GovS}_{j,s} {P^{c}_{j,s,t}}^{1-\sigma^{Gov}_j} \\ GovS_{j,s,t} = \alpha^{GovS}_{j,s} \left[\dfrac{P^{Gov}_{j,t}}{P^{c}_{j,s,t}} \right] Gov_{j,t} \end{cases}$$

In order to stay within government's budget constraint when tax revenues is not enough, the government issues bonds. So the government budget constraint may be written as :

(18)

$$P^{Gov}_{j,t} Bond_{j,t+1} + \sum_g Pop_{j,g,t} \left(\begin{array}{l} \tau^{w}_{j,t}(LInc_{j,g,t} + Pens_{j,g,t}) + \tau^{Con}_{j,t} P^{Con}{}_{j,t} Con_{j,g} \\ + \tau^{K}_{j,t} \sum_i \left(\dfrac{R\operatorname{int} J_{i,t-1} P^{Gov}_{i,t}}{P^{Gov}_{i,t-1}} - 1 \right) P^{Gov}_{i,t-1} Bij_{i,j,g,t} + \tau^{K}_{j,t} \sum_i (R\mathrm{Re}\, t_{j,t-1} - 1) P^{Inv}_{i,t-1} Kij_{i,j,g,t} \end{array} \right)$$

$$= P^{Gov}_{j,t} Gov_{j,t} + \left(\frac{R\operatorname{int} J_{j,t-1} P^{Gov}_{j,t}}{P^{Gov}_{j,t-1}} \right) P^{Gov}_{j,t-1} Bond_{j,t}$$

It is assumed that pay-as-you-go pension benefits would be financed by contribution from the wage earnings of the individuals. Naturally, we would expect that with the aging of the population this contribution rate would increase. The following equation determines the pensions program:

$$(19)\ \sum_j Pop_{j,gn,t} Pens_{j,gn,t} = CtR_t \sum_j \sum_{gj} Pop_{j,gj,t} LInc_{j,gj,t}$$

Where *CtR* is the national contribution rate for the pay-as-you-go program.

Regions j's foreign trade in goods at time t

At price $P^c_{j,s,t}$ all our agents in the region *j* utilize a composite good *s*. In order to obtain an aggregate demand for this good from all of our agents, we have to add all the individual demands. When we do this, we get the following equation:

$$(20)\ \sum_{ss} XS_{s,j,ss,t} + \sum_g Pop_{j,t,g} ConS_{j,s,g,t} + InvS_{j,s,t} + GovS_{j,s,t}$$

In order to allocate our demand in between the regions we use the traditional Armington assumption. It says that although each individual producer is a microscopic price taker, goods from the sector s are assumed to be differentiated in demand by their geographic origin. So the importer selects the optimal basket of international and domestic goods from each sector, by using a CES ($E_{ii,j,s,t;}\alpha^E_{ii,j,s}, \sigma^c_{j,s}$) aggregator.

Hence, we may re-write our price $P^c_{j,s,t}$ as a function of each supplying region's producer price $P_{j,s,t}$:

$$(21)\ P^{c\,1-\sigma^c_{j,s}}_{j,s,t} = \sum_{ii} \alpha^E_{ii,j,s} P^{1-\sigma^c_{j,s}}_{ii,s,t}$$

the above equation should go together with the associated demand system equation that is shown below:

$$(22)\ E_{ii,j,s,t} = \alpha^E_{ii,j,s} \left[\frac{P^c_{j,s,t}}{P_{ii,s,t}}\right]^{\sigma^c_{j,s}} \left\{\sum_{ss} XS_{s,j,ss,t} + \sum_g Pop_{j,t,g} ConS_{j,s,g,t} + InvS_{j,s,t} + GovS_{j,s,t}\right\}$$

The rest of the world at time t

In our model we describe the rest of the world in the reduced form because it serves us to close the model. In order to do so we have to hold its prices and income exogenously constant. Hence, its demand for good s in the region j relies on the competitiveness of the sectors in the region:

$$(23)\ E_{j,row,s,t} = Sc^{E}_{j,row,s}\left[\frac{P_{row,s,t}}{P_{j,s,t}}\right]^{\eta_s} \quad \eta_s > 0$$

Moreover, we assume that the rest of the world does not borrow or lend internationally. As a result of this assumption, the rest of the world trades with the Canadian economy as a whole, which is calibrated as balanced, and stays like this at any point of time:

$$(24)\ \sum_{ii}\sum_{s} P_{ii,s,t}E_{ii,row,s,t} = \sum_{s} P_{row,s,t}\sum_{ii} E_{row,ii,s,t}$$

Equilibrium Conditions

The first one is the market clearing for goods:

$$(25)\ Z_{j,s,t} = \sum_{ii} E_{j,ii,s,t}$$

The second one is full employment of labour:

$$(26)\ \sum_{gj} Pop_{j,gj,t}L^{\sup}_{j,itype,iprof,iqual,gj}EP_{g,j} = \sum_{s} L^{qual}_{j,s,itype,iprof,iqual,t}$$

The third one is full employment of capital:

$$(27)\ Kstock_{j,t} = \sum_{s} K^{dem}_{j,s,t}$$

Rate of substitution among assets implies that rate of returns on government bonds equal returns on capital assets:

$$(28)\ \frac{R\text{int}\,J_{j,t}P^{Gov}_{j,t+1}}{P^{Gov}_{j,t}} = R\text{Re}t_{j,t+1};$$

Fully integrated assets' market implies that rates of returns are the same for all regions in Canada.

$$(29)\ R\text{int}_t = \frac{R\text{int}\,J_{j,t}P^{Gov}_{j,t+1}}{P^{Gov}_{j,t}}$$

We may check that our model implies asset market clearing at any time period t:

$$(30)\ \sum_{j}\sum_{g} Pop_{j,g,t} Lend_{j,g+1,t+1} = \sum_{j} P^{Gov}_{j,t} Bond_{j,t+1} + P^{Inv}_{j,t} Kstock_{j,t+1}$$

In addition, we choose prices of the rest of the world as a numeraire. If we set t-1=t=t+1 in all equations, we may find a static (steady state) version of the model.

5. CALIBRATION AND DATA

To simulate the model, we need to build a Social Accounting Matrix (SAM) that is constrained on the preference patterns of different age groups, sectoral and regional production, and distribution of different professions and skills. However, it is a difficult task because macroeconomic long run steady state has to be consistent with microeconomic details. In addition, Social Accounting Matrix must be consistent with regional output, consumption, investment, inter-regional trade data flow (which are macroeconomic aggregates). Moreover, the calibration procedure has to assure an inter-temporal consistency of the model due to the model being dynamic and characterized by an overlapping generations structure. Savings and consumption decisions of the households should be compatible with aggregate inter-temporal prices. Additionally, the amount of savings has to be enough to pay for the stocks of assets in the economy. Next, the data sources and calibration procedure are explained in details.

The seven regions in the model are: ATL- Atlantic provinces that include Newfoundland, New Brunswick, Nova Scotia, and Prince Edward Island; QUE- the province of Quebec; ONT- the province of Ontario; PRA- the Prairies that include Saskatchewan, Manitoba, North West Territories, Nunavut; ALB- the province of Alberta; BCO- British Columbia region that includes a province of British Columbia and Yukon; RoW- the rest of the world.

Information on flows of inter-regional trade has been taken from the Interprovincial and International Trade Flows Matrix calculated by Statistics Canada in 1999. The model includes 14 sectors in each region, so the trade flows that are reported for over 50 sectors have been aggregated into 14.

Then we use the input-output table of Statistics Canada to determine the intermediate demands of the firms. And for the inter-provincial trade flow date, an aggregation of sectors was operated on the input-output tables in order to make them consistent with the sectors of the model.[13].

In the model we divide labour into various categories of profession and skills. The categories have been taken from the National Occupational Classification Matrix of year 2001 from Human Resources and Development Canada (HRDC). In the next table, we show 10 different professions and 5 different skill levels of the matrix. The allocation between the sectors of professions and skills have been taken from the Labour Force Survey. For instance, occupations of Type 1 refer to Professions 1, 4, 10. Occupations in Profession 1 are defined by Skill levels 2,3,4. Occupations in Profession 4 are distinguished by Skill level 2 and 3. And for the Profession 10 we have Skill level 1. Next, Professions 2,3,5,6 refer to the occupation of Type 2. As

[13]Mercenier and Merette,"The Economic Impact of Ageing on Production Secotors and Occupations in Six Canadian Regions", 2002, p. 14,15.

for the Profession 2 and 5, we need Skill levels of 2 and 3. For the Profession 3 Skill levels of 2,3, and 4 are required. For the Profession 6 necessary Skill levels are 3,4, 5. And Occupations of Type 3 refer to Professions 7,8,9. The Occupations of the latter 3 Professions can be distinguished by Skill level 3, 4, and 5.

Table 6. Professions and Skill Levels

Professions
1. Business, finance and administration occupations
2. Natural and applied sciences and related occupations
3. Health occupation
4. Occupations in social science, education, government services and religion
5. Occupation in arts, culture, recreation and sport
6. sales and services occupations
7. Trades, transport and equipment operators and relate d occupations
8. Occupations specific to primary industry
9. Occupations specific to processing, manufacturing and utilities
10. Management
Skill Levels
1. Management occupations
2. Skill Level A (Occupations that usually require university education)
3. Skill Level B (Occupations that usually require college education or apprenticeship training)
4. Skill Level C (Occupations that usually require secondary school and/or occupation specific training)
5. Skill Level D (On-the-job training is usually provided for these occupations)

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.17.

Table 7. Occupations by Type

TYPE 1						
Profession 1				Profession 4		Profession 10
Qual 2	Qual 3	Qual 4	Qual 5	Qual 2	Qual 3	Qual 1

TYPE 2									
Profession 2		Profession 3			Profession 5		Profession 6		
Qual 2	Qual 3	Qual 2	Qual 3	Qual 4	Qual 2	Qual 3	Qual 3	Qual 4	Qual 5

TYPE 3								
Profession 7			Profession 8			Profession 9		
Qual 3	Qual 4	Qual 5	Qual 3	Qual 4	Qual 5	Qual 3	Qual 4	Qual 5

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.41.

The next table reports some calibrated values for parameters and variables of the different regions. We normalize Canadian GDP to one, so the regional GDPs are presented as shares of economic activity generated in each region. The table also reports public debt and public expenditures with respect to regional GDP. Notice that public health care with respect to GDP is larger than education expediture in all parts of Canada. Moreover, it could be seen from the table that capital tax rate is higher that other two tax rates everywhere in Canada ; and is at its highest rate in Ontario.

Table 8. Parameters and Exogenous Variables

	ATL	QUE	ONT	PRA	ALB	BCO
GDP	.057	.213	.414	.069	.120	.127
Gov't Debt/GDP	.422	.433	.288	.226	.018	.110
Public Health Care/GDP	.077	.066	.053	.066	.045	.070
Public Education/GDP	.060	.052	.032	.039	.041	.045
Wage tax rate	.318	.374	.313	.295	.304	.318
Capital tax rate	.382	.478	.562	.407	.384	.446
Consumption tax rate	.234	.219	.200	.193	.137	.199

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.18.

Many other parameters are assumed identical across Canada due to the lack of statistical evidence on regional differences. Among them we have households' inter-temporal and inter-regional elasticities of substitution and bequest rates. It is assumed that the value of the inter-temporal elasticity of substitution equal to 0.175, the inter-regional elasticities of substitution equal to 2.5. We set the pension replacement rate ($PenR$) to 0.30, the bequest parameter ($BeqR$) to 0.40, the inheritance rate ($InhR$) to 0.20 (whereas private bequests assumed to be equal distributed among the working age groups. Labour demand substitution elasticities ($\sigma^{Ldem}_{j,s}, \sigma^{Ltype}_{j,s,itype}, \sigma^{Lqual}_{j,s,iqual}$) were taken from Mercenier and Mérette (2002).We assume that elasticity of substitution for intermediate goods ($\sigma^{X}_{j,s}$) at 2.0. The calibrated interest rate (Rint) is 3.8 percent and it is applied in all regions as financial assets are perfectly substitutable and mobile across regions. The calibrated deprecation rate equals 5.1 percent, the export price elasticities (η_s) to the RoW are assumed to be 5.0 in all sectors.

Table 9. Parameters common to all regions

$1/\theta$	.175	$\sigma^{Ldem}_{j,s}$	0.5
$\sigma^{Con}_{j,s}$	2.5	$\sigma^{Ltype}_{j,s,itype}$, $itype$=1	2.0
$\sigma^{Inv}_{j,s}$	2.5	$\sigma^{Ltype}_{j,s,itype}$, $itype$ =2	1.3
$\sigma^{Gov}_{j,s}$	2.5	$\sigma^{Ltype}_{j,s,itype}$, $itype$ =3	2.5
$\sigma^{c}_{j,s}$	3.0	$\sigma^{Prof}_{j,s,iprof}$	3.0
$BeqR$	.40	$\sigma^{X}_{j,s}$	2.0
$InhR$	.25	$R\text{int}$	.038
$PensR$	.3	$DepR$	.051
η_s	5		

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.19.

Moreover, we assume that preferences are perfectly identical across Canada. As a result, spending shares with respect to sectoral goods and services are assumed identical across the country as well. From the

Spending Survey data of Statistics Canada, 1999, we include 14 types of goods in our model. From the table presented below we may observe that SEP and ICS sectors refer to services to enterprises, consumer's spending shares equal zero for all age groups. The intermediate demands result from the production activity and the input-output table because firms use goods as inputs. As could be seen from the tables below, the old aged group spends more money on the health care (HRD), while the young group spends more on education (EDP) and construction (CST). Middle aged group spends relatively more on real estate services, insurance and finance (FAI). Moreover, because the survey shows spending shares and not consumption expenditures, spending share allocation to public administration (ADM) is relatively high. The spending share to the Public administration in fact represents tax payments to the governments. From the table below it could be seen that government expenditure is allocated into four different types, such as Health (HRD), education (EDP), construction (CST), and administration (ADM) as a residual.

Table 10. Spending Shares by age group(%)

Age group	**15-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65-84**
PRI	2.9	3.2	3.3	3.5	3.9	3.8
MAN	22.8	18.4	19.2	19.0	19.1	20.8
CST	16.8	16.5	14.8	12.2	11.5	12.7
TRA	4.6	3.2	3.0	3.1	3.1	2.9
COM	2.5	1.9	1.7	1.6	1.8	2.1
CGD	14.0	11.3	11.8	11.6	11.7	12.7
FAI	6.9	8.4	8.6	9.4	8.6	6.2
ADM	13.0	24.2	24.5	26.0	24.4	19.4
SEP	0	0	0	0	0	0
ICS	0	0	0	0	0	0
EDP	3.1	1.0	0.7	1.3	0.8	0.1
SAN	1.1	0.8	1.1	1.3	1.6	2.6
HRD	9.1	7.2	6.8	6.8	7.5	8.0
AUT	3.0	3.7	4.4	4.1	5.9	8.7

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.20.

And the following table demonstrates public expenditure per age group.

Table 11. Public Expenditure per Age Group (Dollar share per capita, %)

Age group	15-24	25-34	35-44	45-54	55-64	65-84
Health	6.0	8.0	10.0	15.0	25.0	36.0
Education	26.0	40.0	20.0	7.0	5.0	2.0

Source: Mercenier and Mérette, " The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canada", 2002, p.21.

As it was mentioned before, Canadian population is ageing slowly but surely. But, as could be expected, different regions will age with different speed. In this paper we investigate the microeconomic impact for the year 2030. The old age dependency ratio will then reach around 45 percent in the Atlantic region and 42.8 percent in Quebec. The speed of the population ageing will be slower in Ontario -34 percent, 35.5 in Prairies and Alberta-37.1, and finally 37.1 percent in British Columbia.

6. SIMULATION RESULTS

BASELINE SCENARIO

The simulation experiments that take place change the composition of the population in order to match the projections of demographers for the year 2030. And then we analyze changes in relative wage rates and projections on the future labour imbalances for the year 2030. In the model, labour markets are in equilibrium and labour supplies are exogenous. Relative scarcity of labour is captured by the changes in relative wage rates. We simulate a number of different scenarios in this model. The first one is the base case scenario, where we assume that labour markets are in equilibrium and labour supplies change for all occupational types and skills according to the demographic projections for each regions. We normalize wage rates to unity in the benchmark year. (See table below). Next, we experiment with different scenarios regarding labour supply. For instance, the second scenario is a 15 percent increase of the health professions. The third one, is a 15 percent increase of supply of high-skilled labour.

Table 12. Scenario 1: Base Case. Wage indices by occupations, year 2030

Iprof	IQual	ATL	QUE	ONT	PRA	ALB	BCO
business, finance, admininstr'n	QUAL2	1.019	1.0073	0.9938	0.9864	1.0604	0.9971
business, finance, admininstr'n	QUAL3	1.0194	1.0081	0.9927	0.9856	1.0644	0.9961
business, finance, admininstr'n	QUAL4	1.0201	1.0086	0.994	0.9874	1.0674	0.998
soc.science, educ'n, gov.,religion	QUAL2	1.0206	1.0091	0.9952	0.987	1.0684	0.9987
soc.science, educ'n, gov.,religion	QUAL3	1.0249	1.0163	1.0008	0.9904	1.071	1.0052
management	QUAL1	1.0161	1.0059	0.9896	0.9822	1.0619	0.9925
natural & applied science	QUAL2	1.0315	1.0195	1.009	0.9974	1.0655	1.0141
natural & applied science	QUAL3	1.0329	1.019	1.0077	0.9969	1.0677	1.0134
health occupations	QUAL2	1.0957	1.0758	1.0425	1.0245	1.1698	1.0666
health occupations	QUAL3	1.109	1.0779	1.0449	1.024	1.1654	1.062
health occupationS	QUAL4	1.1078	1.0685	1.0461	1.0349	1.1832	1.0685
arts, culture, recreation & sport	QUAL2	1.0486	1.0292	1.0118	0.998	1.1062	1.0207
arts, culture, recreation & sport	QUAL3	1.0432	1.0267	1.0112	0.9979	1.0932	1.0197
sales & services	QUAL3	1.0439	1.026	1.006	0.9952	1.113	1.0161
sales & services	QUAL4	1.0458	1.0289	1.0088	0.9966	1.1178	1.0211
sales & services	QUAL5	1.0424	1.0268	1.0071	0.9958	1.1176	1.0184
trades,transport & equip't oper'r	QUAL3	0.9875	0.9936	0.9704	0.9623	1.0178	0.9714
trades,transport & equip't oper'r	QUAL4	0.9973	0.9991	0.9798	0.9754	1.0261	0.9815
trades,transport & equip't oper'r	QUAL5	0.9857	0.9931	0.9647	0.9593	1.0182	0.9671
primary industry occupations	QUAL3	1.0116	1.0255	1.0014	0.9979	1.0281	0.9952
primary industry occupations	QUAL4	1.0105	1.0283	1.0098	1.0008	1.025	0.9991
primary industry occupations	QUAL5	1.0012	1.0079	0.9833	0.9743	1.0353	0.9863
processing, manufact'g, utilities	QUAL3	1.0041	1.0061	1.0019	0.9975	1.0221	0.9998
processing, manufact'g, utilities	QUAL4	1.004	1.0059	1.0013	0.9971	1.0232	0.9998
processing, manufact'g, utilities	QUAL5	1.0055	1.0062	1.0016	1.0005	1.0218	1.0012

From the table above it is possible to observe that, first of all, the increase of wages is higher in two regions for most occupations in Alberta and the Atlantic region. In the Prairies region wages decrease, as well as in Ontario, British Columbia, and Quebec regions . Second of all, the simulation results demonstrate that for all skill levels (Qual 2, Qual 3, and Qual 4) in health occupations (Prof 3) there will be a large increase in the relative wages. The opposite refers to the occupations related to trades, transport, and equipment operators and related occupations (Prof 7), particularly for the lowest skill level (Qual 5), where the wage rate declines as Canadian population gets older. In our simulation procedure we control the supply side effects. As a result, relative wage changes from our table abstract from the expected decrease in the growth rate of aggregate labour supply. Hence, even in the absence of the supply shock, changes in relative wages are very meaningful and show that labour markets might have to go through some significant adjustments in the years to come as population ages.

Now it would be interesting to see what changes could occur for the relative wages in different regions if we exercise different scenarios regarding labour supply. Before we introduce certain shocks to the model, it should be said that we consider Qualification 1 as the one that requires the highest skills level and education (university education); Qualifications 2-4 -as the ones that do not require as high level of skills and education (college education or apprenticeship training, secondary school and/or occupation specific training) ; and, finally, Qualification 5-as the one with the lowest level of required skills and education (On-the-job training is usually provided for these occupations).

Scenario 2: Increase supply of high-skilled labour. 15 percent increase in the supply of health care professions (Prof 3, Type 2) in all regions.

The following results could be obtained from Appendix 2, Table 13. (Wage indices by occupations, year 2030, with 15% increase supply for health care professions).

If we compare the results with the Base Scenario, we could observe that obtained results are consistent with the economic prediction. As could be expected, due to the 15 percent increase in the supply of high-skilled labour health care professions in 2030, wages decrease for all health care professions with different levels of qualification (Qual 2, Qual 3, and Qual 4) in all our regions, while for the rest of the professions relative wages stay approximately the same with an exception of British Columbia region, where relative wages for business, finance, and administration (Qual 3 and 4) and for social science, education, government, and religion occupations (Qual 2) decrease as well. Even though, with the 15 %

increase supply of the health care professions, we observe that relative wages go down a little bit, the net effect of the relative wage increase is still greater for the health care professions then for the other professions. We also can see that the elasticity of substitution for Prof 3, Type 2 is low for all three qualifications (Qual 2, Qual 3, Qual 4). Hence, we expect the impact of the same attitude.

Scenario 3: Increase supply of high-skilled labour. If we impose shock of 15 percent on qualification1 for all regions, the following results occur. (Appendix 3, Table 14. Wage indices by occupations, year 2030, with 15% increase for qualification 1.)

Qualification 1 is present in this table in Occupation Type 1 Profession 10 (Management). In Atlantic region and Quebec such increase in high-skilled labour supply for qualification 1 does not bring any changes in wage. And for Ontario, Prairies, Alberta, and British Columbia there is an insignificant decrease in wages. Moreover, with the introduction of such a shock, it could be seen that in Atlantic, Ontario, Prairies, and Alberta regions there is a slight decrease in relative wages for business, finance, and administration professions (Qual 2,3,4), as well as for social science, education, government, and religion occupations (Qual 2 and 3). Another interesting fact is that for all our regions relative wages for sales and services occupations (Qual 3,4,5) increase by a little bit along with the health professions (Qual 2,3,4). However, the most increase for the health care professions occurs in Alberta region. But at the same time in Alberta we can see that relative wages for primary industry occupations and processing, manufacturing, utilities occupations go down. We observe from the table that trades, transport and equipment operator professions show low relative wage in all six regions. Business, finance, and administration occupations demonstrate low relative wage level in Ontario , Prairies and British Columbia

In the simulation experiments presented above we controlled the effects of the supply side. Changes in the relative wages presented in Tables 13 and 14,abstract from the decrease in the growth rate of aggregate labour supply. After introducing the above shocks into our model, we may see that the health professions will get the most benefits in relative wage increase in all regions. The situation for trades, transport and equipment operator occupation is quite different though. The results show that relative wage will decrease for these professions in most of the regions with an exception of Alberta. As could be expected changes in the relative wages are important because they demonstrate what adjustment challenges might appear in the labour market. Note that we did not observe drastic changes in numbers with the introduction of the 15 % increase in supply of health care professions and Qual 1 due to the possibility of such increase being distributed across all sectors. Hence, the effect on wages is relatively small.

PROJECTING FUTURE LABOUR IMBALANCES

In our model we make an assumption that labour markets are balanced. Hence, we may expect cost of labour relative to capital to be influenced by the ageing of the population and changes in the aggregate demand. As a result, firms should adjust their production technologies by substituting capital to labour. As we could assume the demographic changes will affect all labour categories in different says. There will be a scarcity among professional qualifications, and certain labour qualifications will require substitution by others. If we compare the old equilibrium with the new one, we may observe changes in relative scarcity of labour qualifications through changes in relative wage rates. In order to do so we have to modify the model and substitute to the labour market equilibrium conditions, which will freeze the relative price of all primary factors at their pre-shock equilibrium level. So we will get the results of the excess labour demands or supplies that might occur from the demographic changes. It should be taken in consideration that for the reasons of households' budget constraints not being satisfied, the numbers that are reported in the table are not fully meaningful. To be precise, in our experiment, given the relative prices faced by firms, firms hire as much labour as it is profitable to them. Then firms produce goods using this labour, even though this labour might be unavailable. As a result, we should keep in mind that our experiment might overestimate the excess labour demand.

If we take a look at the following table, we may observe that the demographic shock will affect excess labour demands differently all Canadian regions. First of all, excess labour demands are quite significant for Atlantic Provinces, Alberta and slightly less in Quebec and British Columbia regions, as opposed to Ontario and the Prairies. It could be seen that labour excess demands will be larger in the health procession (Prof 3) in all regions of Canada. In the contrary, excess labour demands will be very small for low skilled trades, transport and equipment operators and related occupations (Prof 7, qual 5). These results are consistent with the relative wages effects. Note, that the results presented in this model are derived from the partial equilibrium results, that is why one should be very careful over interpreting them.
To be consistent with the relative wages simulations, we use the year 2030 for excess labour demands.

Table 15. Excess Labour Demands, year 2030 (as % of initial employment)

Iprof	IQual	ATL	QUE	ONT	PRA	ALB	BCO
business,finance,adm'n	QUAL2	5.9366	5.6061	3.5927	3.4636	9.53	5.2017
business,finance,adm'n	QUAL3	5.5855	5.0054	3.321	2.9797	9.4064	4.4151
business,finance,adm'n	QUAL4	5.9016	5.2994	3.5811	3.3849	10.5231	4.8501
soc.science,educ.,gov.,relig'n	QUAL2	5.795	4.9101	3.4345	3.3457	11.3044	4.7503
soc.science,educ.,gov.,relig'n	QUAL3	7.4052	7.4314	5.578	4.5355	13.1802	7.3666
management	QUAL1	5.8606	5.3777	3.1202	2.903	9.2583	4.4272
natural & applied science	QUAL2	5.4052	5.3322	3.9509	3.3368	9.3611	5.2953
natural & applied science	QUAL3	5.3243	5.0899	3.3548	3.0205	8.0086	4.3396
health occupations	QUAL2	11.399	12.0737	7.5943	6.1828	17.8309	10.3706
health occupations	QUAL3	15.0758	13.9668	8.4913	6.0438	16.4149	10.0794
health occupations	QUAL4	16.0848	10.9774	9.3336	9.2114	20.7025	11.3737
arts,culture,recreation & sports	QUAL2	10.0146	7.904	5.2296	4.7568	15.6452	7.2048
arts,culture,recreation & sports	QUAL3	7.4665	6.2673	4.8225	4.0283	12.0802	6.9991
sales & services	QUAL3	8.4945	6.7629	4.29	3.8226	13.0372	5.4266
sales & services	QUAL4	10.6452	8.962	6.0242	4.995	16.5925	8.2262
sales & services	QUAL5	9.2167	8.1359	5.4992	5.2797	16.661	7.5416
trades,transp.& equip't oper'r	QUAL3	2.9984	4.1672	0.9544	0.947	3.4585	1.7939
trades,transp.& equip't oper'r	QUAL4	6.537	5.9493	3.2708	3.8351	9.3997	4.7133
trades,transp.& equip't oper'r	QUAL5	1.8146	3.0728	-0.0603	0.1079	2.7527	0.6937
primary industry	QUAL3	8.945	10.3149	6.232	5.3114	10.9815	7.0128
primary industry	QUAL4	7.7975	10.2711	7.2194	5.4644	10.4205	7.3166
primary industry	QUAL5	6.1602	6.8933	3.7963	2.6953	11.9972	4.7795
processing,manufact,utilities	QUAL3	6.6542	6.242	4.2622	5.0163	9.0126	6.3918
processing,manufact,utilities	QUAL4	6.7734	6.3708	4.2405	5.0082	9.6403	6.4656
processing,manufact,utilities	QUAL5	7.0613	6.3284	4.3194	5.3925	9.7473	6.5634

Now we will introduce the same shocks as we did for relative wages: 15 percent increase in supply of health care professions. (Appendix 4. Table 16. Excess Labour Demands, year 2030 (as % of initial employment),shock of 15 percent increase of supply health care professions)

After the simulation is done, we observe that with 15 percent increase for health care, the excess labour demands will decrease in Atlantic , Quebec, Ontario and British Columbia regions for all professions and qualifications. In particular, decline of excess labour demands will be noticeable for the health care professions (Prof 3) in the Atlantic, Quebec, the Praries, and British Columbia regions. In all regions the excess labour demands are large for the health care professions. Excess labour demands are quite substantial in Alberta for social sciences, education, government, and religion occupations (Qual2 and 3), as well as for business, finance, administration occupations (Qual 3), sales and services occupations(Qual 3,4,5), and for primary industry occupations (Qual 3,4,5).

The above simulations showed different behaviour of excess labour demands due to the changes in shocks applied to the model. The most noticeable results are for the high excess demands for all health care occupations in all six regions. Moreover, the excess labour demands are very large in health care occupations compare to trades, transports, and equipment operators occupations, where in some regions it becomes negative. We observe that through all the experiments Alberta had the highest excess labour demands for most of the occupations. Than there is an Atlantic region, Quebec and British Columbia. However, the same did not apply to Ontario and, especially, Prairies.

7. CONCLUSION

In this paper, it has been shown that the ageing of the Canadian population is going to bring some major microeconomic and macroeconomic changes to the economy. A computable general equilibrium model developed by Mercenier and Mérette (2002) helped to demonstrate the structure and calibration procedure. The results of this report imply that public and private consumption demands will change due to the ageing of Canadian population. Moreover, after performing different experiments, it could be seen that population ageing affects the labour market, various regions, occupations, and production to varying degrees. The results of this research show how changes in the aggregate consumption demand due to ageing could alter output and occupations. Presented experiments demonstrate that public and private consumption demand changes will have important inter-regional, inter-sectoral and occupational effects. These effects result from the combination of various factors, such as demographic projections, changes within consumption basket of good during the lifetime of the households, shifts in the government's spending due to the population ageing, changes in the technology, and others.

We cannot avoid the ageing of the active population. Nevertheless, certain measures could be taken in order to prevent negative effects on the labour market. These measures could consist of attempts to keep older workers in the labour market, transfer of knowledge between older and younger generations, changes in the pension plans, training and retraining workers, and many more. Even though demographic changes occur slowly, employers and government should start making changes to workplace and changes to policies today in order to deal with the impact of the ageing population to be less drastic on the labour shortage and the economy as a whole.

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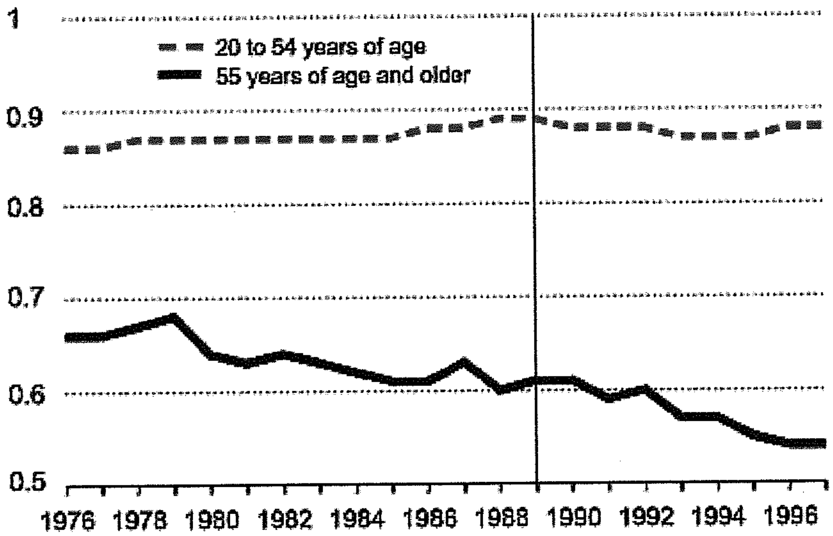
Appendix 1. Graph 1,2 and 3.

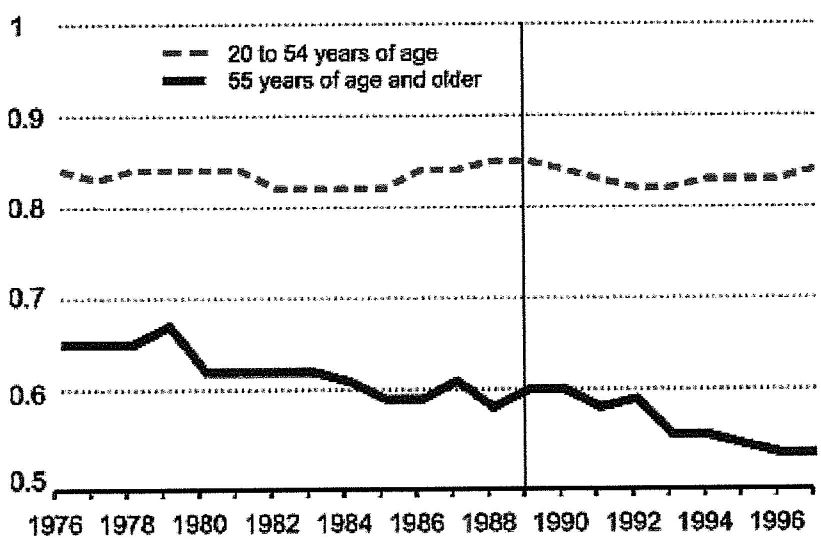
Participation Rate Ratio

Low-Skilled to High-Skilled Individuals



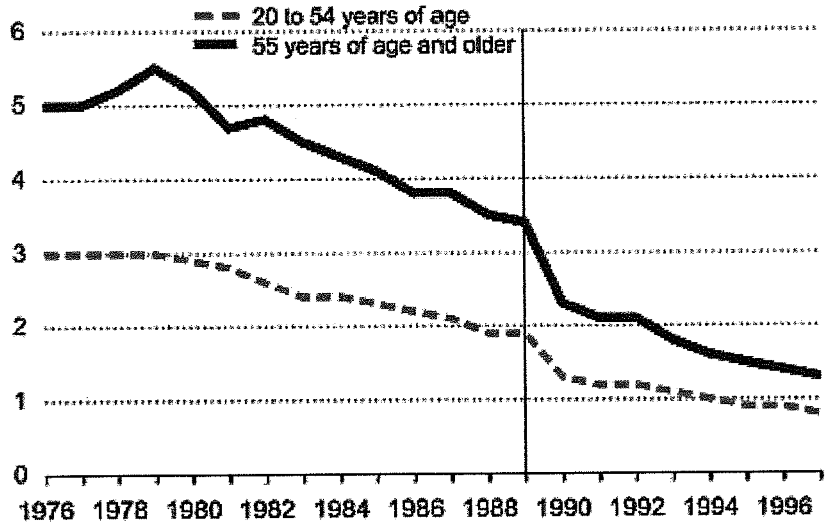
Employment Rate Ratio

Low-Skilled to High-Skilled Individuals



Relative Size of Low-Skilled Labour Force

Ratio of Low-Skilled to High-Skilled Individuals



Note: *The vertical line at 1989 indicates the last year before changes in the data collection methodology.*

Source: *Computation from unpublished Labour Force Survey data*

Appendix 2. Table 13 Wages indices by occupations, year 2030, with 15% increase in health care professions.

Iprof	IQual	ATL	QUE	ONT	PRA	ALB	BCO
business,finance,admininstr'n	QUAL2	1.0187	1.0072	0.9936	0.9864	1.0601	0.9968
business,finance,admininstr'n	QUAL3	1.0191	1.0079	0.9926	0.9855	1.064	0.9958
business,finance,admininstr'n	QUAL4	1.0198	1.0084	0.9938	0.9873	1.067	0.9977
soc.science,educ'n,gov.,religion	QUAL2	1.0202	1.0089	0.995	0.9869	1.0678	0.9983
soc.science,educ'n,gov.,religion	QUAL3	1.0244	1.0157	1.0004	0.9901	1.0702	1.0046
management	QUAL1	1.0159	1.0057	0.9895	0.9821	1.0616	0.9922
natural & applied science	QUAL2	1.0317	1.0196	1.0092	0.9975	1.0657	1.0142
natural & applied science	QUAL3	1.0331	1.0191	1.0078	0.997	1.0679	1.0135
health occupations	QUAL2	1.0934	1.0738	1.0413	1.0234	1.1674	1.065
health occupations	QUAL3	1.1066	1.076	1.0437	1.0229	1.1629	1.0606
health occupations	QUAL4	1.1053	1.0667	1.0449	1.0336	1.1807	1.067
arts,culture,recreation & sport	QUAL2	1.0487	1.0293	1.0119	0.9981	1.1063	1.0208
arts,culture,recreation & sport	QUAL3	1.0433	1.0268	1.0113	0.9979	1.0934	1.0198
sales & services	QUAL3	1.0439	1.0261	1.006	0.9953	1.113	1.0161
sales & services	QUAL4	1.0458	1.0288	1.0088	0.9966	1.1177	1.021
sales & services	QUAL5	1.0423	1.0268	1.0071	0.9958	1.1175	1.0183
trades,transp.& equip't oper'r	QUAL3	0.9875	0.9936	0.9704	0.9623	1.0178	0.9714
trades,transp.& equip't oper'r	QUAL4	0.9973	0.9991	0.9798	0.9754	1.0261	0.9815
trades,transp.& equip't oper'r	QUAL5	0.9858	0.9931	0.9647	0.9593	1.0182	0.9671
primary industry occup'ns	QUAL3	1.0116	1.0255	1.0013	0.9979	1.028	0.9952
primary industry occup'ns	QUAL4	1.0105	1.0283	1.0097	1.0008	1.025	0.9991
primary industry occup'ns	QUAL5	1.0012	1.0079	0.9833	0.9742	1.0352	0.9863
processing,manufac'g,utilities	QUAL3	1.0041	1.0061	1.0019	0.9976	1.022	0.9998
processing,manufac'g,utilities	QUAL4	1.004	1.0059	1.0013	0.9971	1.0232	0.9998
processing,manufac'g,utilities	QUAL5	1.0056	1.0062	1.0016	1.0005	1.0218	1.0012

Appendix 3

Table 14. Wage indices by occupations, year 2030, with 15% increase for qualification 1

Iprof	IQual	ATL	QUE	ONT	PRA	ALB	BCO
business,finance,admin'n	QUAL2	1.0189	1.0073	0.9937	0.9863	1.0603	0.997
business,finance,admin'n	QUAL3	1.0193	1.0081	0.9927	0.9855	1.0643	0.996
business,finance,admin'n	QUAL4	1.02	1.0085	0.9939	0.9873	1.0672	0.9979
soc.science,educ.,gov.,relig'n	QUAL2	1.0205	1.0091	0.9951	0.9869	1.0683	0.9986
soc.science,educ.,gov.,relig'n	QUAL2	1.0205	1.0091	0.9951	0.9869	1.0683	0.9986
soc.science,educ.,gov.,relig'n	QUAL3	1.0248	1.0162	1.0007	0.9903	1.0709	1.0051
management	QUAL1	1.016	1.0059	0.9895	0.9821	1.0617	0.9923
natural & applied science	QUAL2	1.0317	1.0196	1.0093	0.9976	1.0657	1.0143
natural & applied science	QUAL3	1.0331	1.0191	1.008	0.9971	1.0679	1.0136
health occupations	QUAL2	1.0963	1.0763	1.0429	1.0248	1.1704	1.0671
health occupations	QUAL3	1.1096	1.0782	1.0453	1.0244	1.1659	1.0625
health occupations	QUAL4	1.1084	1.0689	1.0466	1.0352	1.1838	1.0691
arts,culture,recreation & sport	QUAL2	1.0488	1.0294	1.0121	0.9982	1.1064	1.0209
arts,culture,recreation & sport	QUAL3	1.0434	1.0269	1.0115	0.998	1.0934	1.02
sales & services	QUAL3	1.0442	1.0263	1.0063	0.9954	1.1133	1.0164
sales & services	QUAL4	1.0462	1.0292	1.0091	0.9968	1.1182	1.0215
sales & services	QUAL5	1.0427	1.0271	1.0074	0.996	1.118	1.0187
trades,transp.& equip't oper'r	QUAL3	0.9875	0.9937	0.9705	0.9624	1.0176	0.9714
trades,transp.& equip't oper'r	QUAL4	0.9973	0.9992	0.9799	0.9755	1.0259	0.9816
trades,transp.& equip'toper'r	QUAL5	0.9857	0.9932	0.9647	0.9594	1.018	0.9671
primary industry occup'ns	QUAL3	1.0116	1.0256	1.0016	0.9982	1.0279	0.9954
primary industry occup'ns	QUAL4	1.0105	1.0284	1.01	1.001	1.0248	0.9993
primary industry occup'ns	QUAL5	1.0012	1.0081	0.9835	0.9744	1.0351	0.9865
processing,manufac'g,utilities	QUAL3	1.0041	1.0061	1.0019	0.9977	1.0219	0.9999
processing,manufac'g,utilities	QAUL4	1.004	1.006	1.0014	0.9972	1.023	0.9999
processing,manufac'g,utilities	QUAL5	1.0055	1.0063	1.0017	1.0006	1.0216	1.0013

Appendix 4 Table 16. Excess Labour Demands, year 2030 (as % of initial employment),shock of 15 percent increase for health care.

Iprof	IQual	ATL	QUE	ONT	PRA	ALB	BCO
business,finance,adm'n	QUAL2	5.9364	5.6037	3.591	3.4649	9.525	5.2014
business,finance,adm'n	QUAL3	5.5724	4.9941	3.3104	2.9759	9.3925	4.4039
business,finance,adm'n	QUAL4	5.8921	5.2938	3.5756	3.3813	10.5113	4.8397
soc.science,educ.,gov.,relig'n	QUAL2	5.771	4.8869	3.4165	3.3361	11.2734	4.7196
soc.science,educ.,gov.,relig'n	QUAL3	7.3515	7.3513	5.5194	4.4949	13.0916	7.2786
management	QUAL1	5.8522	5.3696	3.1146	2.8978	9.2474	4.4194
natural & applied science	QUAL2	5.4051	5.3293	3.9499	3.338	9.3605	5.294
natural & applied science	QUAL3	5.3252	5.0893	3.3545	3.0215	8.007	4.3354
health occupations	QUAL2	11.1282	11.8304	7.4368	6.0316	17.5796	10.1642
health occupations	QUAL3	14.7686	13.7944	8.3478	5.9049	16.1414	9.9245
health occupations	QUAL4	15.8189	10.8051	9.1868	9.0422	20.4423	11.1801
arts,culture,recreation & sports	QUAL2	10.013	7.8981	5.2271	4.7587	15.6461	7.204
arts,culture,recreation & sports	QUAL3	7.4648	6.2604	4.8232	4.0245	12.0818	6.9962
sales & services	QUAL3	8.4935	6.7568	4.2888	3.8234	13.0379	5.4266
sales & services	QUAL4	10.6342	8.9455	6.0122	4.9871	16.5794	8.2087
sales & services	QUAL5	9.1982	8.1228	5.4903	5.2696	16.6489	7.527
trades,transp.& equip't oper'r	QUAL3	2.9953	4.1645	0.9527	0.945	3.4538	1.7912
trades,transp.& equip't oper'r	QUAL4	6.5374	5.9477	3.269	3.8342	9.3971	4.711
trades,transp.& equip't oper'r	QUAL5	1.8123	3.072	-0.0621	0.1058	2.7467	0.6915
primary industry	QUAL3	8.9445	10.3131	6.228	5.3122	10.9811	7.0112
primary industry	QUAL4	7.7977	10.2708	7.2188	5.465	10.4182	7.3148
primary industry	QUAL5	6.1605	6.8877	3.7949	2.6948	11.9947	4.777
processing,manufact,utilities	QUAL3	6.6541	6.2414	4.262	5.0172	9.0112	6.3913
processing,manufact,utilities	QUAL4	6.7731	6.3693	4.24	5.0076	9.6394	6.4652
processing,manufact,utilities	QUAL5	7.0611	6.3271	4.3179	5.3896	9.7471	6.5633