Population Ageing and Quality Immigration: A National and Regional Perspective for Canada*

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Abstract: How much more high-skill immigration would Canada need to offset the anticipated negative macroeconomic impact of population ageing? This is the issue we address using a dynamic regional applied overlapping generations model. We show that raising the proportion of high-skilled immigrant workers by half a percent of the population each year could virtually offset the long-term negative impact of population ageing on productive capacity in Canada over the next 40 years. This aggregate result masks important regional disparities, however: in some regions, the policy more than offsets the income losses due to ageing, whereas other regions gain very little from it. All regions do benefit from the policy, though.

JEL classification:

Key words: population ageing, skilled immigrants, overlapping generations model, regions

*The views expressed in this document are solely those of the authors and do not necessarily reflect the views of HRSDC

1. Introduction

As indicated in United Nations (2003), population growth is slowing in most industrialized countries as a result of lower fertility rates. This effect, combined with the rise in life expectancy will lead to a substantial increase in the proportion of the older population, over the next decades. Population ageing poses several macroeconomic challenges, such as increased labour market pressures, lower savings and slower growth in productive capacity. It also raises concerns about the sustainability of social security and health care programs.[1]

To help address the potential consequences of population ageing, Canada has adopted a strategy of gradual public debt reduction during the 1990s, reformed the Canada and Quebec Pension Plans (CPP/QPP) and the Quebec provincial government intents to implement more changes to the QPP. In addition, even though Canada's immigration has always been dominated by economic objectives, it is explicitly being committed to long-term labour market targets since the 1990s, with the selection of an increased proportion of skilled workers.

The macroeconomic impact of immigration for the host country can have mitigated effects. Ferh *et al.* (2003, 2004) for Japan, Europe and the United States, Storesletten (2000) for the U.S. and Fougère *et al.* (2005) for Canada, have found that the long-term impact is highly dependent on the skill-composition of immigrants. In particular, selecting low-skilled immigrants would generate very small or no benefit, while raising the proportion of high-skilled immigrants has more positive macroeconomic and fiscal impacts, conditional on their integration and recognition of their foreign credentials. Not all effects of a selection policy are likely to be positive, however. According to Borjas (2005), a 10% immigration-induced increase in the supply of doctorates in the U.S. would lower the wage of competing workers by about 3% hence reducing incentives for locals to invest in human capital.

[1] For a comprehensive overview of the economic consequences of population ageing, see for example, Weil (1997), Gruber and Wise (1999), Miles (2000) and Rogers *et al.* (2000).

Despite these potential adverse effects, the general conclusion that emerges from this literature is that an immigration policy more favourable to highly skilled workers would have favourable macroeconomic effects for the host country. The obvious question that immediately arises then is: how many more skilled immigrants would be needed to prevent a reduction in the growth of living standards due to population ageing? To address this question in more details, we use a dynamic regional applied general equilibrium model calibrated on Canadian data. As the paper demonstrates, good policy advice in this matter requires adopting a regional perspective, as we do.

The paper is structured as follows. Section 2 summarizes the demographic trend for Canada and its regions. Section 3 describes the model used; our main results are discussed in Section 4. Section 5 concludes.

2. Demographic Changes

This section presents our demographic projections at the national and provincial level. The projections are based on the demographic model MEDS.[2]

Table 2.1 provides the main demographic assumptions used in the baseline scenario for total fertility rate, life expectancy at birth, emigration and immigration. It is assumed that the proportion of new permanent residents represents 0.75% of the population each year, corresponding to the 2000-2003 historical average. However, the provincial distribution of recent immigrants differs quite drastically, Ontario and British Columbia receiving the largest share of immigrants relative to their population. Quebec receives the third largest share of immigrants, followed by the Western provinces.

The skill-composition of permanent residents is calibrated on the Canadian Census data for 2001. Appendix A2 presents the national and regional distribution of immigrant and non-immigrant workers by skill in the model and provides a description of the occupational composition of skills.

[2] See Denton *et al.* (2005) for more details on the demographic model.

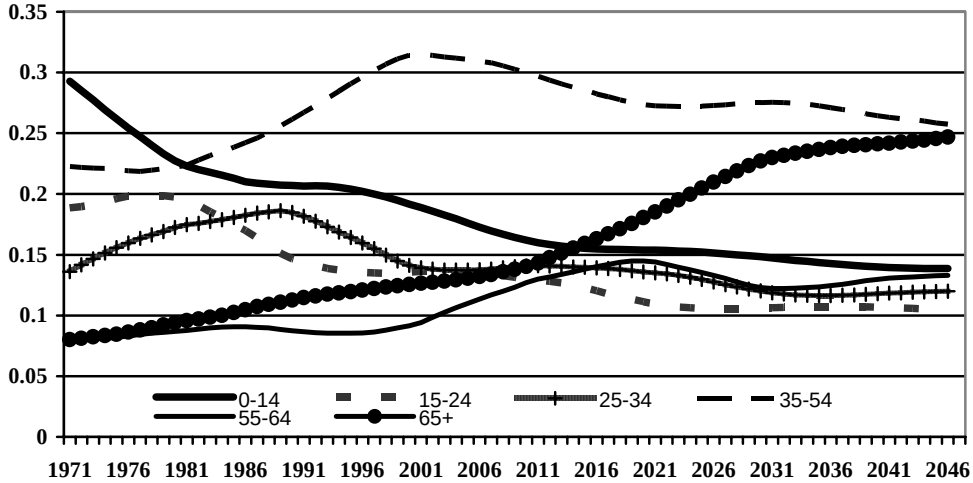
Table 2.1
Main Demographic Assumptions

Province	NF	PEI	NS	NB	Qc	Ont	Man	Sask	Alb	BC
Share of Canadian Population in 2003	.016	.004	.03	.024	.237	.388	.037	.031	.10	.131
Total Fertility rate	1.21	1.56	1.42	1.45	1.47	1.53	1.81	1.81	1.70	1.45
Life expectancy at birth(2044)										
Men	78	79	79	81	80	82	80	80	81	81
Women	82	85	85	85	85	86	84	86	84	85
Annual share of emigrants (% of Pop)	0.05	0.03	0.07	0.04	0.16	0.28	0.16	0.11	0.26	0.22
Annual share of new immigrants (% of Pop)	0.21	0.07	1.04	0.35	14.3	55.4	1.85	0.80	6.26	19.6

Chart 2.1 displays the historical and projected change in the age-composition of the population at the national level, for the period 1971 to 2046. The rapid decline in the share of the younger population (0-14) during the past 25 years, due to lower fertility rates, will continue in the future from 18.8% in 2003 to 13.8% in 2046. The proportion of age group 15-24 has also been falling since the early 1980s. Its share is expected to fall more moderately over the next decades, from 13.5% in 2003 to 10.4% in 2046. In comparison, the proportion of the prime-age population (25-34) has risen until 1991 and declined since. Its share is expected to fall at a very moderate pace in the future, from 13.8% to 12% over the period 2001 to 2046. In contrast, the proportion of the middle-age population (35-54) has increased substantially over the past two decades, which illustrates the effect of the baby boom of the early sixties on the future demographic structure. According to the demographic projection, the proportion of the middle-age population is beginning to decline. From the 31.5% peak in 2001, the proportion of this age group will fall to some 25.7% of the population in 2046.

As the baby boom cohorts move up the age pyramid, the proportion of the 55-64 age group is projected to increase from 9.4% in 2001 to 14.5% in 2020. This will be followed by a moderate decline in the longer term to 13.3% by 2046. Finally, the older age group (65+) is expected to increase at a rapid pace during the next 25 years, from 12.6% in 2001 to 22.7% in 2030, then grow more moderately between 2030 and 2046 and reach 24.7% by 2046.

Chart 2.1
Population Share by Age Group in Canada



Source: Statistics Canada, 1971-2002; MEDS, 2003-2046

Table 2.2 reports the projected change in the elderly dependency ratio[3] between 2003 and 2050 at the national and regional level. This change is imposed on the initially-in-stationary-state economy to generate our base-case simulation. At the national level, the elderly dependency ratio is expected to rise from 18.6% in 2003 to 39.7% in 2046. Also, as can be seen from the table, the Atlantic region (Newfoundland, Prince-Edward Island, Nova Scotia and New Brunswick) and Quebec will exhibit the largest increase in the elderly dependency ratio, while the Prairies (Manitoba and Saskatchewan) and Ontario will have the smallest increase. Alberta and British Columbia are in between.

Table 2.2
Projected Elderly Dependency Ratios

Region	2003	2046
Canada	18.7	39.7
Atlantic	19.7	57.0
Quebec	19.8	46.0
Ontario	19.2	38.1
Prairies	22.7	37.1
Alberta	15.4	40.2
British Columbia	19.8	41.3

[3] The elderly dependency ratio is defined as the population 65+ as a ratio of the 17-64 population.

3. The Dynamic OLG Model

3.1 Overall Model Structure

The model represents the economy of Canada and has a dynamic structure. It distinguishes between six regions: the region of the Atlantic (Newfoundland, Prince-Edward Island, Nova Scotia and New Brunswick), Quebec, Ontario, the Prairies (Manitoba and Saskatchewan), Alberta and British Columbia. A detailed technical description of the model is available upon request. A brief description of the key model parameters is presented in Appendix 1.

There is one competitive firm in each region that produces a good that is an imperfect substitute to other regions' production goods. The production technology is Cobb-Douglas, combining labour and physical capital inputs. Both production factors are immobile across regions, which implies that there is one market for labour and capital in each region. Physical capital is a composite of the six regional final goods. Indeed, the investment technology is a region-specific constant elasticity of substitution (CES) mix of these goods so that the price of investment differs across regions.

Each region has 15 representative households, one per age group, with each period corresponding to 4 years. An Allais-Samuelson overlapping generations framework characterizes household dynamics. The labour market in each region distinguishes both immigrants and non-immigrants by skill levels: high-skilled, medium-skilled and low-skilled workers. Moreover, the model includes inactive adults who receive transfer payments from governments.

The population growth rate is treated as exogenous. Each native generation optimises a constant elasticity of inter-temporal substitution utility function of consumption and bequests, subject to lifetime income. The household's problem consists of choosing optimal consumption (and hence savings) time-path. Savings can be allocated between domestic physical capital ownership titles or regional bonds issued by local governments. Similarly, consumption expenditures are allocated between the six regional goods using intra-period CES preferences.

The government sector is structured as a federation, with one national and six regional governments. The national government distributes transfers to regional governments and all governments distribute social transfers to individuals. The public pension system distinguishes between the Old Age Security (OAS) system, a national transfer program to the elderly, financed through general taxes from the national government, and a compulsory pension plan, the Canada and Quebec Pension Plans (CPP/QPP), financed through payroll taxes. Government spending is divided into health care, education, interest payments on debt and other government expenditures. All governments collect taxes on factor incomes and on consumption expenditures.

The financial market is assumed perfectly integrated across regions. Financial capital is therefore perfectly mobile across regions and rates of returns on all assets are identical across regions. All markets are perfectly competitive and agents have perfect foresight. Flexible regionally-differentiated output prices imply flexible real exchange rates across regions.

4. Simulation results

Table 4.1 compares the results of the baseline-with-ageing scenario and those generated with the alternative policy scenarios. All results reported are percent deviations with respect to a steady state with no population ageing. The policy experiments consist to increase the proportion of high-skilled immigrants in an effort to offset the negative impact of population ageing on real per-capita GDP.

We see from the baseline scenario that, the (anticipated) demographic change is projected to have virtually no negative effect on real per-capita GDP before 2025. Real GDP begins to decline relative to the initial steady state after that. The reduction in real per-capita GDP is explained by a sharp reduction in labour supply due to accelerated retirement of baby boomers, complemented by a reduction in national savings. By 2050, real per-capita GDP is 10.5% lower, compared to a steady state with no population ageing.

Several alternative policy scenarios concerning skilled immigration have been experimented with the model. In a first scenario (referred to as Alternative Scenario 1), we simulate a permanent—after year 2002—increase in the level of yearly high-skilled

immigration flows. The increase is chosen so as to maintain unchanged the average national real per-capita GDP over the period 2006-2050. This requires raising the proportion of high-skilled immigrants from the current trend by 0.5% of the population each year which corresponds to raising the total proportion of recent immigrants from 0.75% to 1.25% of the population. Unreported simulations suggest that to achieve the same GDP objective by acting on medium-skilled immigration numbers would require a 0.7% increase in the proportion of immigrants each year, corresponding to nearly doubling the current flow of recent immigrants.

Table 4.1
Macroeconomic Impact of Population Aging at the National Level
Percent deviations with respect to initial steady state

	2006	2014	2018	2026	2030	2034	2038	2042	2046	2050
Real GDP per-capita										
Baseline	0.5	0.8	0.7	-0.3	-1.2	-2.5	-4.0	-5.9	-8.1	-10.5
Alternative Scenario 1	1.2	2.8	3.2	3.3	3.0	2.6	1.9	1.0	-0.2	-1.7
Alternative Scenario 2	0.5	0.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proportion of New Immigrants in Population										
Baseline	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Alternative Scenario 1	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Alternative Scenario 2	0.75	0.75	0.75	1.00	1.18	1.45	1.79	2.06	2.33	2.52
National Savings Rate										
Baseline	-0.5	-1.6	-2.2	-3.5	-4.2	-4.9	-5.9	-7.2	-8.7	-10.4
Alternative Scenario 1	-0.3	-1.1	-1.6	-2.5	-3.0	-3.5	-4.3	-5.6	-7.3	-9.4
Effective units of labour[4]										
Baseline	1.9	2.2	0.6	-5.9	-10.6	-15.8	-21.3	-26.9	-32.2	-37.0
Alternative Scenario 1	2.2	3.4	2.4	-2.5	-6.1	-10.1	-14.2	-18.3	-22.0	-25.1
Capital-labour ratio										
Baseline	2.1	6.9	9.6	15.3	18.2	20.9	23.0	24.1	23.4	20.1
Alternative Scenario 1	2.5	8.5	11.8	18.7	22.0	25.1	27.4	28.4	27.0	22.3
Real Wages (High-skilled)										
Baseline	0.5	1.7	2.4	3.8	4.5	5.1	5.7	6.0	5.9	5.2
Alternative Scenario 1	-0.1	0.0	0.1	0.6	0.9	1.1	1.3	1.2	0.6	-0.8

We see that in the short-to-medium term, a 0.5% increase of high-skilled immigrants is enough to more than offset the negative impact of ageing on real GDP per-capita, suggesting

[4] Effective units of labour is an indicator of labour supply which combines both the number and the quality (experience and skills) of labour.

that fewer immigrants would be required. However, in the long run, the negative impact of ageing is amplified by increased retirement rates. By 2050, the 0.5% higher-to-base-case immigration flows can no longer suffice to prevent a reduction in real per-capita GDP. This suggests that additional increases in immigration would eventually be required to prevent a reduction in real GDP per-capita in about 40 years.

In Alternative Scenario 2, we simulate a more gradual increase in the proportion of high-skilled immigrants in an effort to counter the fall in real per-capita GDP. Table 4.1 reports the real GDP effect and the required increase in immigration to maintain real GDP per-capita constant. In the initial years—between 2006 and 2022—no change in the proportion of immigrants is required. The proportion of immigrants has to be raised to 1% of the population in 2026, 1.18% in 2030, 1.45% in 2034, 1.79% in 2038, 2.06% in 2042, 2.33% in 2046 and 2.5% in 2050, in order to stabilize real per-capita GDP. Such a policy would require raising the immigration target several times to what seem unrealistic levels of immigration, given that Canada is competing with other industrialized countries to attract skilled immigrants.

Returning to the Alternative Scenario 1, the results show that replacement by skilled immigrants of every effective units of retiring labour is not necessary to keep real GDP per-capita from falling. The reason is that the policy also raises national savings and the capital-labour ratio, with a positive effect of long run productive capacities.

Population ageing leads to increased labour market pressures and to a rise in real wages from the baseline scenario, we see that real wages for high-skilled workers rise by 6% by 2046, relative to a steady state with no ageing. Not surprisingly, an increase in the flow of high-skilled immigrants will offset this price change: high-skilled real wages remain almost flat in Alternative Scenario 1.

Looking at the results by region (see Table 4.2) we see that the benefits of an immigration policy more favourable towards skilled immigrants are not spread equally across regions. The relative magnitude of the demographic shock and the regional location of immigrants differ quite drastically across regions. Instead, the new immigration target contributes to raise regional income disparity.

The provinces of Ontario and British Columbia are slower ageing regions and benefit more from immigration. Consequently, they are significantly more than compensated by increased immigration. Alberta is also better off until 2038. However, by 2042, increased immigration no longer compensates for the effect of ageing and real GDP per-capita falls. At the other extreme, the Atlantic region and Quebec are faster ageing regions and their economies are more severely affected than the rest of Canada. The negative effect of population ageing is also exacerbated by early retirement behaviour. Consequently, the new national target for high-skilled immigrants cannot compensate for the reduction in real GDP per-capita. Finally, the Prairies also do not receive enough skilled immigrants and real GDP per-capita continues to fall significantly.

Table 4.2
Impact of Population Ageing on Regional Real GDP per-Capita
Percent shock minus control relative to a scenario with no population ageing

Real GDP per Capita	**2006**	**2014**	**2018**	**2026**	**2034**	**2038**	**2042**	**2046**	**2050**
Atlantic									
Baseline	0.1	-0.5	-1.4	-4.8	-11.2	-15.4	-19.9	-24.5	-28.5
Alternative Scenario 1	0.2	-0.1	-0.8	-4.0	-9.7	-13.7	-18.1	-22.5	-26.3
Quebec									
Baseline	-0.3	-1.9	-3.1	-6.9	-12.3	-15.2	-18.0	-20.6	-22.8
Alternative Scenario 1	0.0	-1.0	-1.9	-5.2	-9.9	-13.7	-14.5	-16.4	-18.0
Ontario									
Baseline	0.6	1.2	1.0	-0.1	-1.5	-2.1	-2.8	-3.9	-5.5
Alternative Scenario 1	1.6	4.0	4.8	4.8	5.3	6.0	6.7	7.2	6.9
Prairies									
Baseline	-0.3	-1.1	-1.7	-2.3	-2.4	-2.7	-3.7	-5.4	-8.0
Alternative Scenario 1	-0.1	-0.7	-1.2	-1.5	-1.1	-1.2	-1.8	-3.2	-5.7
Alberta									
Baseline	1.3	2.5	2.7	2.8	0.8	-1.4	-4.5	-8.3	-12.0
Alternative Scenario 1	1.6	3.5	4.0	4.5	3.1	1.2	-1.7	-5.3	-9.1
British Columbia									
Baseline	-0.4	-0.8	0.1	0.1	-0.5	-2.2	-5.0	-9.0	-13.6
Alternative Scenario 1	1.0	3.1	4.5	7.9	10.1	9.8	8.2	5.2	1.3

5. Conclusion

In this paper, we have explored the following question: how many more skilled immigrants would Canada need to offset the anticipated negative macroeconomic impact of

population ageing? The analysis is conducted with a dynamic regional applied overlapping generations model.

At the national level, the analysis suggests that raising the number of high-skilled immigrants by 0.5% of the population each year could offset the negative impact of population on real GDP per-capita. However, this policy would eventually need to be revisited for 2050. A more gradual increase in immigration would be less effective and would eventually require an astronomical rise in the number of immigrants.

From a regional perspective, things are more complicated. Our results clearly indicate that using immigration as a policy to compensate for the negative effects of population ageing will induce strong disparities in regional welfare. Increased immigration would need to be accompanied by strong incentives for regional mobility of skills from slower ageing to faster ageing regions of Canada. Finally, these findings support the view that ignoring the regional perspective of immigration in Canada could lead to a sharp increase in regional income disparity.

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Appendix 1 - Calibration

The computable general equilibrium model compares two states of the six regional economies, a steady state scenario and one with population ageing. Table A1 reports some key parameter values that are imposed in the calibration procedure. The inter-temporal elasticity of substitution is assumed to be the same across regions and consistent with values found in the literature. The intra-temporal elasticity of substitution is also assumed identical across the different types of consumption and investment demands and across regions.

Table A1
Calibration and Government Program Parameters

National/Regional	National	Atlantic	Quebec	Ontario	Prairies	Alberta	BC
Regional Share of GDP	-	.062	.217	.387	.070	.137	.128
Share of capital in production	-	.278	.280	.280	.324	.324	.270
Intertemporal elast. of substitution	-	1.0	1.0	1.0	1.0	1.0	1.0
Elast. of substitution for consumption	-	9.0	9.0	9.0	9.0	9.0	9.0
Elast. of substitution for investment	-	9.0	9.0	9.0	9.0	9.0	9.0
Wage income tax rate	.14	.18	.23	.17	.16	.16	.18
Capital income tax rate	.22	.16	.26	.34	.19	.16	.23
Consumption tax rate	.10	.13	.12	.10	.093	.037	.099
Public Education/GDP	0	.060	.052	.032	.039	.041	.045
Government debt	.11	.42	.43	.29	.23	.02	.11
Public Health Care/GDP	0	.077	.066	.053	.066	.045	.070

Appendix 2 - Distribution of workers by skill

Table A2 reports the distribution of immigrant and non-immigrant workers by skill levels, for each region as calibrated in the baseline simulation. We use skill-share information based on Canada's 2001 Census. The occupational composition of high-skilled workers used in the paper is the same as the definition of highly qualified workers used in OECD (2000). Using the National Occupation Classification (NOC) Matrix, high-skilled workers include managers, skill level A occupations (usually requiring university education) and part of occupations in skill level B (usually require college education). We also separate the remaining workforce between medium and low-skilled workers. Low-skilled workers include all workers in skill levels C and D (requiring secondary school or occupation-specific training or on-the-job training). Finally, medium-skilled workers are the remaining workers in skill level B, whose occupation usually require apprenticeship training. The model also includes a group of unattached individuals. These individuals of working-age are defined as people with a low attachment to the labour market.

Table A2
Skill Share of Immigrant and Non-Immigrant Workforce by Region
(Baseline Scenario)

Skill level	National	Atlantic	Quebec	Ontario	Prairies	Alberta	B.C.
Non-Immigrants							
High skill	0.267	0.182	0.237	0.315	0.220	0.264	0.303
Medium Skill	0.222	0.180	0.206	0.217	0.256	0.263	0.253
Low skill	0.293	0.282	0.284	0.290	0.306	0.288	0.329
Unattached	0.219	0.356	0.273	0.177	0.218	0.185	0.116
Immigrants							
High skill	0.156	0.303	0.168	0.148	0.148	0.147	0.164
Medium Skill	0.136	0.146	0.123	0.136	0.148	0.154	0.139
Low skill	0.302	0.186	0.285	0.318	0.378	0.348	0.256
Unattached	0.406	0.365	0.423	0.399	0.326	0.351	0.441