Ageing Population and Immigration in Canada: An Analysis with a Regional CGE Overlapping Generations Model*

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Introduction

The population in Canada and other industrialised countries is ageing and consequently the ratio of elderly to the working-age population (ratio of 65+ to the 15-64 population) is expected to increase dramatically over the next several decades.[1] The trend in retirement decision also indicates that older Canadian workers retire earlier than in previous decades.[2] A direct consequence of ageing population is that the transition of the baby-boom generation from work to retirement is expected to lead to job opportunities in all major occupational groups. In particular, some occupations/sectors where workers are generally older or tend to retire earlier may be more affected (e.g. Social Science, Health and Primary Industries).[3] This in turn could result in a relative scarcity of workers and the trend towards early retirement could intensify the situation.

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1. This is well documented in OECD (2000).
2. It must be noted that although the female participation rate has increased over the past decade, the average retirement age of women has come down.
3. See Government of Canada (2002).

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According to the conventional view, the transition of baby-boomers from work-to-retirement could also potentially have important perverse socio-economic effects in the future, such as a decline in national savings and in real per-capita income.[4] It could also put increased pressures on the cost of public pensions and health care, and have negative intergenerational equity implications. However, the relative scarcity of workers is likely to result in increases in real wages, which would provide some compensating effects to workers.

A wide range of policies can be considered to help accommodate some of the consequences of ageing. In this respect, the Canadian government has already taken steps forward by reforming the Canada and Quebec Pension Plans (CPP/QPP) and by adopting a strategy of gradual reduction in the ratio of public debt-to-GDP. Another key policy instrument is Canada's immigration, which reflects a range of socio-economic objectives including economic growth, family reunification and humanitarian objectives. In this respect, in comparison to other industrialised countries, Canada has one of the highest inflows of immigrants relative to its population. In fact, without the contribution of immigration, both the population and the labour force would eventually decline in the future.

Since the annual flow and the skill composition of new immigrants to Canada is an important factor of labour force growth, there is no doubt that current immigration trends contribute to enhancing the balance between the working-age population and retired people. It is, however, more difficult to quantify the economic-welfare gains associated with immigration and to evaluate the additional gain that would be associated with an increase in the number of new immigrants.

Another important factor to consider when we look at migration flows is the residential location decision of new immigrants, given the potential implications on regional disparity. In fact, according to the stylised facts, recent trends in new immigrant's residential location indicate that a large proportion of them choose to live in central Canada (province of Ontario) in much greater proportions than the province's share of the Canadian population. If the vast majority of immigrants choose the richest province as their location of residence, this may potentially have consequences on regional labour markets and regional income disparity. On the one hand, the inflows of immigrants may increase regional income disparity through changes in regional labour supply, although this effect can also be partly offset by reductions in wage pressures in the richest province and increases in the other regions. The net effects on income and regional disparity can only be disentangled through general equilibrium analysis.

Given these important migration policy issues, this paper evaluates the potential socio-economic and labour market implications of increasing the number of immigrants in Canada in the context of an ageing workforce. It also evaluates the potential implications on national and regional labour markets, wages, real per-capita income and intergenerational equity. Finally, it looks at the regional demographic and socio-economic implications of residential location decision of immigrants and the consequences on regional income disparity.

4. See, for example, Auerbach and Kotlikoff (1987), Auerbach et al (1989), Group of Ten (1998) and Hviding and Mérette (1998). It must be noted however, that the conventional view has been challenged by a number of authors including Emery and Rongve (1999), Denton and Spencer (2000), Fougère and Mérette (2000) and Mérette (2002).

The methodological approach used for this analysis is based on two models. The first is a demographic projection model (MEDS)[5] for Canada and its ten provinces. This model is used to simulate the impact of migration policy shocks on the demographic structure of the population and the elderly dependency ratio. The second model is a regional overlapping generations (OLG) model calibrated to Canadian data. This model is used to evaluate the national and regional real per-capita income and wage effects of a change in migration policy as well as the intergenerational equity and regional disparity implications.

The paper is divided as follows. In the next section, an overview of the literature on ageing and immigration is provided. Then, Canada's demographic changes are discussed and some summary facts presented on Canada's immigration. In the following section, the regional demographic scenarios and the contribution of alternative migration policies to the elderly dependency ratio are presented. This is followed by a brief non-technical description of the regional OLG model and the main calibration parameters (the detailed model structure is available in the Appendix). Then, the main simulation results using the regional OLG model are presented. Finally, some policy conclusions are discussed.

Ageing and Immigration

It has long been recognised that international migration can play an important demographic and economic role in industrialised countries, particularly in the context of population ageing. Immigration is seen as a way to partially compensate for the phenomenon experienced in several countries of fertility rates being below natural replacement levels. This section provides a summary review of the literature on the demographic and economic impacts of immigration.

The demographic impacts of immigration include not only the direct increase in population size, but also the specific profile of immigrants, such as their age composition, which can induce demographic changes. For example, selecting an immigrant population with a younger mean age than the native-born population would influence the age structure of the population.

There are also indirect effects of immigration on population growth through immigrant fertility. Immigrant fertility may induce population effects by selecting a disproportional number of younger immigrant women in their reproductive years and by selecting immigrants with higher fertility rates than native-born women. According to Statistics Canada (2002), the fertility of immigrant women differs, depending on their country of origin. For the period 1996-2001, the fertility rate of immigrant women born in Europe was similar to that of Canadian-born women, while the fertility rate of immigrant women born in Asia and other regions of the

5. See Models of economic-demographic system (MEDS), Research Institute for Quantitative Studies in Economics and Population, McMaster University, Hamilton.

world was much higher. However, since immigrant women represent a relatively small portion of the total female population in Canada, the contribution of immigration adds less than one-tenth of a point to the total fertility rate (1.44 for the fertility rate of women born in Canada versus 1.52 for the total fertility rate, according to Vital Statistics estimates).

Several papers have examined the economic impact of immigration using the neoclassical framework and have come up with mixed results. Berry and Soligo (1969) argue that if natives own the economy's fixed factors, immigration would increase the natives' factor incomes through increased fixed factor returns. Simon (1989) separates the production capital used by immigrants in the job market from the demographic capital and finds positive economic effects. Clark and Ng (1991) also find positive economic effects from immigration. Hellwig et al (1992) and the Centre for International Economics (1988) use macroeconomic models to evaluate the economic impact of immigration and find that immigration raises real per-capita GDP. By contrast, Usher (1977) and Peter and Verikios (1994) using respectively UK and Australian data conclude that immigration reduces native's incomes.[6]

There is also an abundant literature that examines the labour market implications of immigration. Among these, Tu (1991) argues that the native labour force whose skills are complementary to those of immigrants experience an improvement in their relative position with respect to workers whose skills are substitutable to those of immigrants. In the same vein, Borjas (1994, 1995) and Borjas et al (1996) find that lower-skilled immigrant workers reduce the wages and employment of lower-skilled native workers in the United States. Finally, Green (1995) finds that targeted skilled immigrants to Canada are more occupationally mobile than native workers and contribute to improved economic efficiency through a more flexible labour market.

Storesletten (2000) uses a computable general equilibrium model with overlapping generations to investigate whether a reform of immigration policy can resolve the fiscal problem associated to population ageing. His results indicate that selective immigration policies that involve increasing the inflow of high and medium-skilled immigrant workers would remove the need for fiscal reform in the United States.

Some Summary Facts on Demographic Changes and Immigration

Decline in the fertility rate and a rise in life expectancy are the two principal causes of ageing population. In Canada, after reaching the unprecedented level of 3.9 children per woman on average in 1960, the total fertility rate has declined dramatically since. As shown in Figure 1, the total fertility rate has come down very significantly since the mid 1960s, reaching 1.5 on average between 1996 and

6. For a more exhaustive review of the literature, see for example, Alvarado and Creedy (1998).

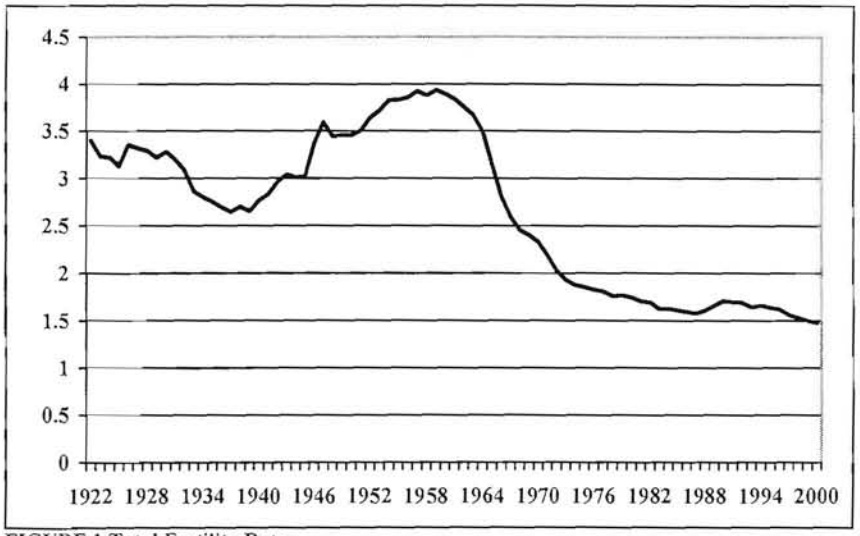

FIGURE 1 Total Fertility Rate
Sources: 1922-1982: Statistics Canada, 91-524; 1983-2000: Statistics Canada, 91-209-XPE; 2001: Statistics Canada, The Daily, August 11, 2003

TABLE 1 Life Expectancy at Birth

Years	Women	Men
1960	74	68
1970	76	69
1980	79	72
1985	80	73
1990	80	74
1995	81	75
2000	82	76

Source: Census of Canada

2000. Also, with increasing quality of life, Canadians are living longer and healthier lives. As a result, the life expectancy at birth has increased very significantly during the past 40 years from 68 years for males and 74 years for females in 1960 to 76 years and 82 years for males and females respectively in 2000 (Table 1).

As the baby-boom generation moves through the age structure, the growth of Canadian born individuals decreases and immigration becomes an important source of population growth. As shown in Figure 2, after falling below the 100,000 per year range in the mid-1980s, immigration levels have risen sharply since, averaging 220,000 per year during the 1990s or 0.75 % of the population and 232,000 between 2000 and 2003 or 0.75 % of the population. In addition, during the 1991-1996 period, net migration has provided 71 % of Canada's labour force

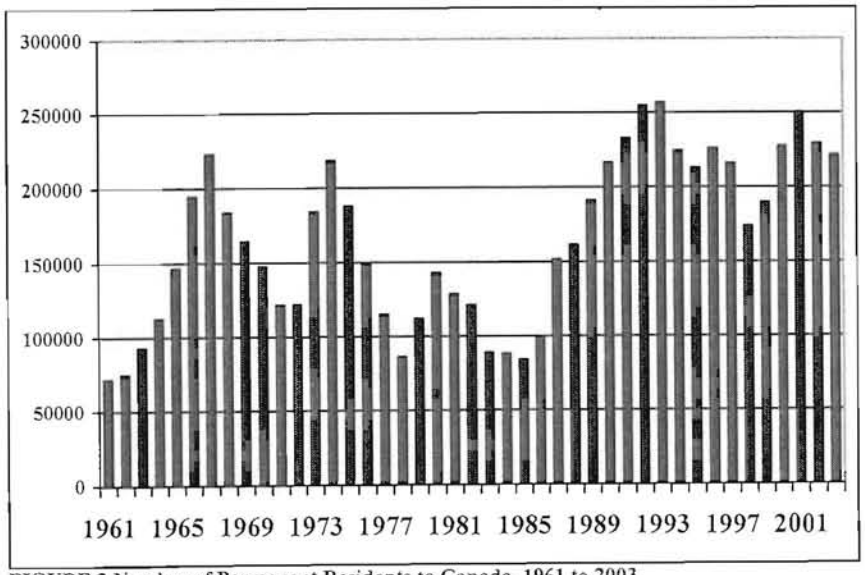

FIGURE 2 Number of Permanent Residents to Canada, 1961 to 2003
Source: Citizenship and Immigration

growth with foreign born individuals accounting for 19 % of its labour force in 1996.[7]

Despite the increasing share of immigrants in the labour force, Canada's elderly dependency ratio has increased steadily during the 1980s and 1990s. Also, according to the demographic model MEDS and based on reasonable assumptions on net migration and the fertility rate, the elderly dependency ratio is projected to increase more rapidly after 2010 and reach unprecedented levels by 2046 as it could more than double (see Figure 3).[8] These projections are consistent with those of Statistics Canada (2001), Beaujot and Matthews (2000) and Beaujot (2002).

However, despite the anticipated rise in the elderly dependency ratio, maintaining the recent trend in migration flows in the future would significantly contribute to limiting the rise in the elderly dependency ratio, assuming that the age distribution of new immigrants remains unchanged. As indicated in Table 2, new immigrants are generally younger given the higher proportion representing age groups 0-14 and 25-39 relative to the Canadian population. In order to evaluate the potential demographic implications of immigration on the elderly dependency ratio, we present a demographic scenario, which assumes that net immigration is zero after 2001. As shown in Figure 3, without immigration, the elderly dependency ratio would be 23 % higher by 2046, reaching 49 % instead of 40 % in the

7. For more information on the Canadian demographic situation, see for example, Denton et al (1999) and Statistics Canada (2002).
8. The simulation is based on the assumption that the fertility rate is 1.5 during the projection period, the number of new immigrants corresponds to 0.75 % of the population and the age distribution of immigrants remains constant at its 1996-2001 average.

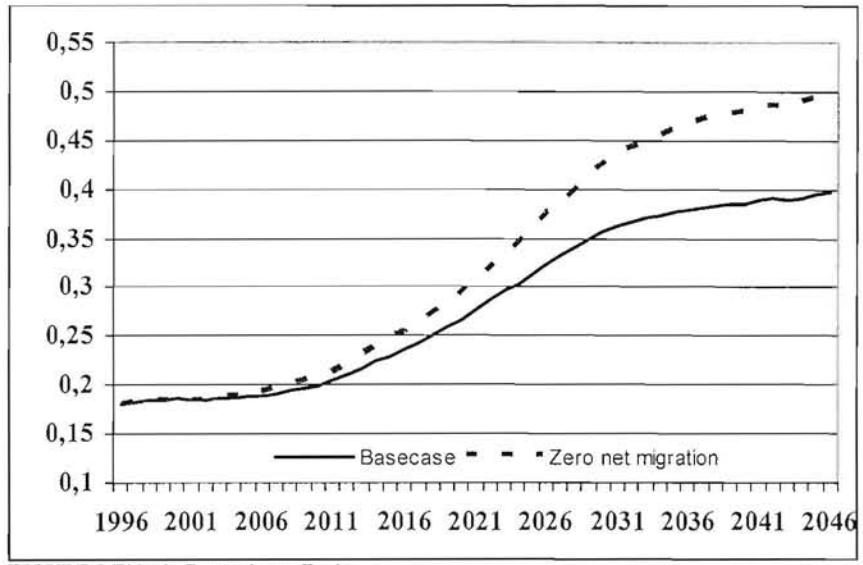

FIGURE 3 Elderly Dependency Ratio

TABLE 2 Percent Age Distribution of Canadians and Recent Immigrants, 1999

	Males		Females	
Age group	Population	Immigrant	Population	Immigrant
0-14	18.3	24.0	17.1	22.5
15-24	13.8	12.6	13.0	16.5
25-39	22.8	43.6	22.4	42.1
40-64	33.3	17.8	33.0	16.4
65+	11.8	2.0	14.5	2.5

Source: Citizenship and Immigration

scenario with immigration.

The regional distribution of immigrants is also an important problem in the context of ageing given that the regional location decision of immigrants will have longer term implications on the growth of the population by province and potentially also on regional disparity. As shown in Table 3, in recent years, more than half of new immigrants have settled in Ontario, averaging 55 % between 1997 and 2001 and 59 % in 2001. In comparison, Ontario's population represents 38 % of Canada's population. British Columbia is the other province, which benefited from a proportion of immigrants greater than its share of the Canadian population. All the other provinces have hosted a proportion of immigrants that is significantly smaller than their share of the Canadian population. If this situation persists in the future, it will likely have implications on regional labour markets and on the regional distribution of income.

Finally, according to Canada's current immigration target, Elinor Caplan,

TABLE 3 Residence of Immigrants, 1997-2001 Average

Province	Share of Canadian Population	Share of Total Recent Immigrants
Newfoundland	1.7	0.21
P.E.I.	0.45	0.07
Nova Scotia	3.03	1.04
New Brunswick	2.44	0.35
Quebec	23.8	14.3
Ontario	38.2	55.4
Manitoba	3.7	1.85
Saskatchewan	3.27	0.8
Alberta	9.86	6.26
British Columbia	13.18	19.6

Minister of Citizenship and Immigration indicated in her November 1999 statement that the federal government long-run immigration target is to achieve 1 % of the population annually.

Regional Demographic Scenarios and the Effect of Immigration

We examine the impact of immigration through four scenarios of demographic projections. The assumptions concerning fertility rate, life expectancy, the proportion of emigrants and the age distribution of immigrants are the same in each scenario and are summarized in Tables 2 and 4. The assumptions regarding the fertility rate and life expectancy are based on the most recent numbers available by province. In the demographic projections, it is assumed that immigrants and non-immigrants have similar life-expectancy levels. Also for simplicity, the assumption regarding the fertility rate is based on the adaptation hypothesis, where immigrant women in Canada are assumed to have the same fertility rate as non-immigrants. It must be noted, however, that the demographic model captures the difference in family size between immigrants when they enter Canada and non-immigrants. The assumption of similar fertility rates between immigrant and non-immigrant women has some potential implications for the results. They are likely to result in a more conservative impact of demographic changes associated with immigration than assuming a higher fertility rate for immigrant women.

The difference in each scenario can be summarized as follows. Scenario 1 (Baseline scenario) assumes that the proportion of new immigrants in Canada represents 0.75 % of the population each year, corresponding to the 1997-2001 historical average. It also supposes that Canada does not achieve its current immigration target of 1 % and that the regional location of immigrants remains the same as that observed during the 1997-2001 period (Table 4). Scenario 2 assumes a more optimistic scenario where Canada achieves its national target of immigration, which corresponds to 1 % of the population each year. Scenario 2 supposes that

TABLE 4 Main Demographic Assumptions

	NF	PEI	NS	NB	Qc	Ont	Man	Sask	Alb	BC
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)										
Scen1 and Scen2	0.21	0.07	1.04	0.35	14.3	55.4	1.85	0.80	6.26	19.6
Scen3 and Scen4	1.70	0.45	3.03	2.44	23.8	38.2	3.70	3.27	9.86	13.2

TABLE 5 Impact of Changes in Immigration Target on Elderly Dependency Ratio by 2044 Relative to the Baseline Scenario (Scen1)

Region	Atlantic	Quebec	Ontario	Prairies	Alberta	BC
Scen1						
Level	0.56	0.45	0.38	0.37	0.40	0.41
Scen2						
Level	0.54	0.42	0.34	0.35	0.37	0.37
% difference from Scen1	-4.2%	-7.7%	-9.7%	-4.6%	-5.7%	-9.9%
Scen3						
Level	0.43	0.40	0.41	0.32	0.37	0.45
% difference from Scen1	-22.5%	-10.6%	9.1%	-12.8%	-6.9%	10.5%
Scen4						
Level	0.39	0.37	0.38	0.30	0.34	0.42
% difference from Scen1	-30.0%	-19.2%	-0.2%	-19.6%	-13.6%	0.9%

the regional distribution of new immigrants is the same as in Scenario 1. As a result, the assumption regarding the regional location of recent immigrants in Scenarios 1 and 2 is more favourable to the provinces of Ontario and British Columbia that receive more than their share of the Canadian population.

Scenarios 3 and 4 have the same national immigration targets of 0.75 % and 1 %, respectively, but in contrast to the first two scenarios, it is assumed that the regional distribution of immigrants will be equal in the future to the provincial share of the Canadian population. Under this alternative assumption, immigration contributes to keeping the provincial distribution of the population constant as opposed to the first two scenarios where immigration contributes to increasing the population weight of Ontario and British Columbia.

Table 5 and Figure 4 present the impact of alternative migration target scenarios on Canada's elderly dependency ratios. As can be seen, in comparison to the baseline scenario with 0.75 % of new immigrants each year, achieving a target of 1 % would reduce the elderly dependency ratio by 9 % by 2046, which is not negligible at the national level. For illustrative purposes, we also added a more optimistic scenario of an immigration objective of 1.25 % of the population. In this

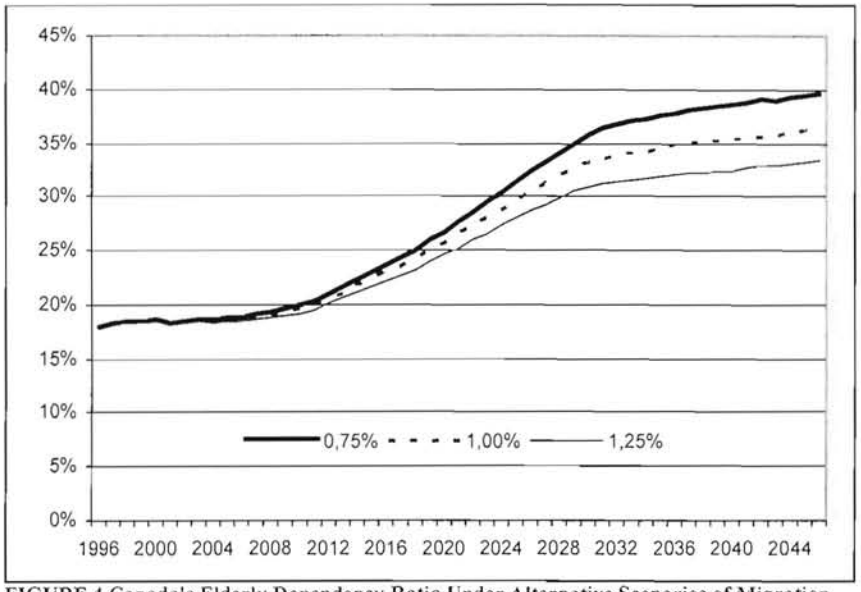

FIGURE 4 Canada's Elderly Dependency Ratio Under Alternative Scenarios of Migration Targets

case, the elderly dependency ratio would be reduced by 16 % by 2046 compared to a scenario of 0.75 %.

When we look at the impact by region, the results indicate that regional differences in fertility rates and the assumption concerning the regional location of immigrants lead to substantial regional differences in elderly dependency ratios. Figure 5 presents the demographic projection by region according to the four scenarios. As can be seen in the figure, the baseline scenario indicates that the Prairies will experience the smallest increase in the elderly dependency ratio compared to the other regions, mainly because of the relatively higher assumed fertility rate. This region is followed by Ontario and British Columbia. In this scenario, these two provinces benefit mainly from the high proportion of new immigrants who choose these provinces as their residential location. By contrast, the Atlantic region experiences the most significant increase in the elderly dependency ratio, followed by Quebec and Alberta.

When we achieve new immigration targets as in Scen2, all the regions benefit through a relatively smaller increase in the elderly dependency ratio. However, not surprisingly, Ontario and British Columbia have the greatest reduction in the elderly dependency ratio since they receive the highest proportion of immigrants relative to their population. Shock minus control, the elderly dependency ratio is 9.7 % lower in Scen2 for Ontario by 2044 and 9.9 % lower for British Columbia. When we look at the remaining regions, Quebec has the third largest reduction in the elderly dependency ratio compared to the baseline with 7.7 %, while the impact is relatively smaller in the remaining regions, ranging from 7.7 % to 4.2 %. Assuming that recent immigrants have the same degree of labour force attachment in

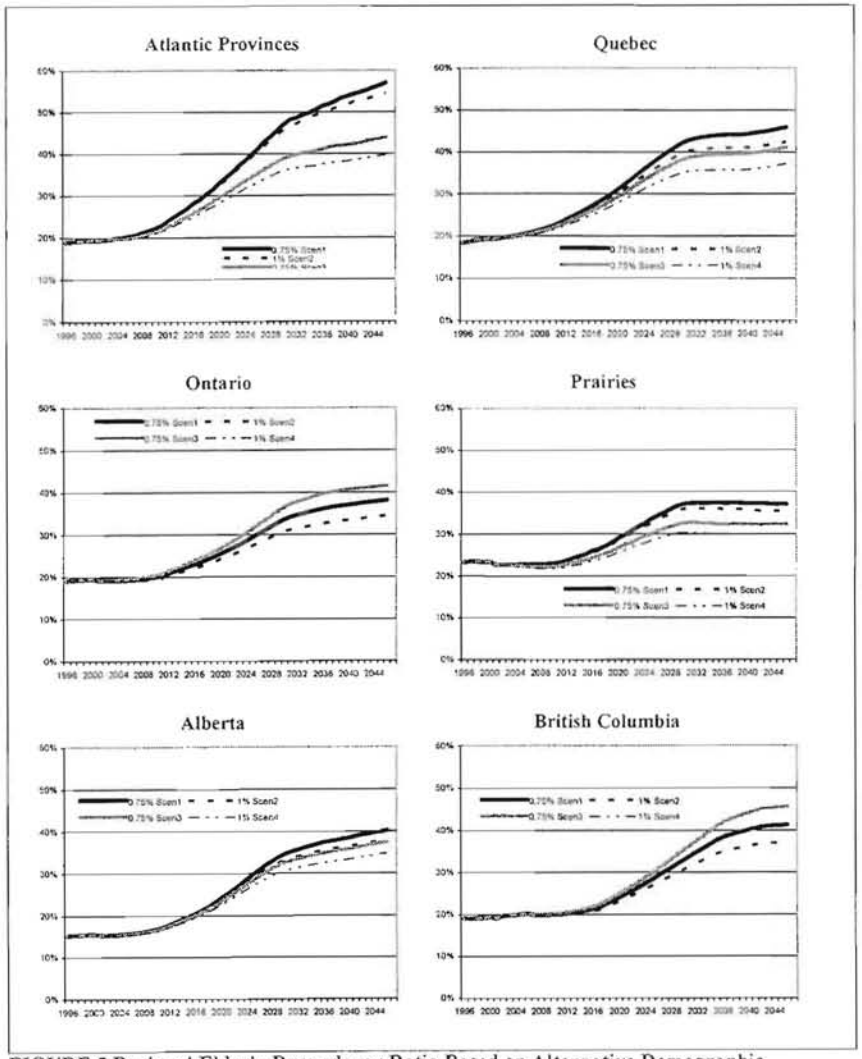

FIGURE 5 Regional Elderly Dependency Ratio Based on Alternative Demographic Scenarios

every province, this suggests that Ontario and BC would benefit the most in terms of labour supply growth.

When we assume that the regional location of immigrants is the same as the provincial share of the population in Scen3 and Scen4, the results are strikingly different. The regional difference in the elderly dependency ratio is significantly reduced. For example, in these alternative scenarios, the province of Quebec and the Atlantic region have a similar demographic profile to Ontario by 2044 in terms of the elderly dependency ratio. The Atlantic and Quebec also do better than British Columbia. Finally, the Prairies regions and Alberta have the lowest elderly dependency ratio in Scen3 and Scen4 compared to the rest of Canada.

The Regional OLG Model

In this section, we present a brief non-technical description of the regional OLG model and discuss the calibration. A description of the model's equations is available upon request. A full description of the model is also available in Mercenier and Mérette (2002).

Model Description

The model is dynamic and represents the economy of Canada. It is composed of six regions: the Atlantic region (Newfoundland, Prince-Edward Island, Nova Scotia and New Brunswick), Quebec, Ontario, the Prairies (Manitoba and Saskatchewan), Alberta and British Columbia. In the model, each region produces one differentiated good, that is, a good imperfectly substitutable with other regions' production good and is very open to trade with the other regions. In response to the demographic shock, the Canadian economy responds like a closed economy. This assumption is tolerable since the projection of demographic changes in Canada over the next 50 years is similar to that in other OECD countries.[9]

There are four types of economic agents in each region: a representative firm, one household per age group, and six regional governments plus a national government. The model has six final goods, two factors of production (physical capital and labour), and two financial assets (bonds and capital ownership titles).

The representative firm produces the unique regional good. Its production technology is represented by a Cobb-Douglas function. The regional firm hires labour and rents physical capital. Labour and physical capital are assumed to be immobile across regions, which implies that there is one market for labour and capital in each of these two factors of production in each region. The model's production technologies differ across regions. Physical capital is a composite good of the six regional final goods. This implies that although aggregate investment is pinned down by the equilibrium condition for the goods market, the allocation of investment demand across the regional goods is determined by an investment technology specific to each region. Consequently, the prices of investment may differ across regions. The investment technology is represented by a constant elasticity of substitution (CES) function.

Each region has 15 representative households, one per age group, with each period corresponding to 4 years. An overlapping generation framework also characterises the household's dynamic, with 15 generations living side by side in each period. At any new period, a new generation is born and the eldest one dies. Each native individual enters the labour market at the age of 17 and dies at the age of 77. The population growth rate is treated as exogenous. Each native generation

9. Fougère and Mérette (1998) have examined the macroeconomic impact of ageing in Canada and six other OECD countries under the closed versus small-open economy assumptions. Given that the anticipated US demographic shock is roughly similar than in Canada, their analysis shows that the simulated economic impact is roughly the same under both assumptions.

optimises a CES type inter-temporal utility function of consumption and bequest subject to lifetime income. The household's optimisation problem consists of choosing the consumption and savings pattern. Savings can be allocated between domestic physical capital ownership titles or regional bonds issued by regional governments. Similarly, consumption expenditures are allocated toward the six available final goods accordingly to households' preferences represented by a CES function.

Since immigrant households are not born in Canada, they enter the country at one point during their life and choose a regional location. The age of arrival and regional location decisions are exogenous. Once immigrant households enter the country, they adopt a similar behaviour to their Canadian native counterpart in terms of consumption, savings and labour-leisure decision. We also assume that they initially own the same value of wealth when they enter the country as their native counterpart of the same generation.

Governments issue bonds to finance their public debt and to satisfy their budget constraint. They tax labour income, capital income and consumption expenditures and spend on public expenditures, health care, education and interest payments on the public debt. The national government also manages the public pension system, which is represented by a simple pay-as-you go pension scheme and financed by contribution rates on labour income. Since the pension program is national, the contribution rate is the same in each region.

The financial market is considered perfectly integrated across regions. This means that financial capital is perfectly mobile across regions and the interest parity condition applies. Rates of returns on savings are thus perfectly identical across regions. The model assumes perfectly competitive markets and perfect foresight agents. Moreover, output prices are flexible, so combined with the assumption of regional differentiated goods, relative output prices act as if there were flexible exchange rate across regions.

Calibration

The computable general equilibrium model compares two states of the six regional economies in the context of an ageing population, according to alternative assumptions of immigration targets and immigrant regional location decisions. To accomplish the comparison we first need to generate an initial steady state equilibrium with constant demographics by calibrating the parameters of the model to replicate what is observed in the data. Since the model is dynamic, the initial equilibrium is in fact a steady state that repeats every period and where the population structure of 2000 remains forever. In other words, the age distribution and population growth rate remain unchanged from their 2000 level. A demographic shift is then introduced in the simulation experiments by replicating the projected regional elderly dependency ratios from the demographic model with alternative migration policies and regional location of immigrants. The demographic shock applied to the OLG model is of similar magnitude to the demographic projection obtained with the demographic model. The state of the regional economies will thus change

TABLE 6 Calibration Parameters

Region	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
Wage income tax rate	.318	.374	.313	.295	.304	.318
Capital income tax rate	.382	.478	.562	.407	.384	.446
Consumption tax rate	.234	.219	.200	.193	.137	.199
Public Health Care/GDP	.077	.066	.053	.066	.045	.070
Public Education/GDP	.060	.052	.032	.039	.041	.045
Government debt	.421	.431	.288	.226	.018	.110
Intertemporal elast. of substitution	1.0	1.0	1.0	1.0	1.0	1.0
Elast. of substitution for consump.	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

in comparison to the initial steady state. The impact of alternative migration policies and regional location decision of immigrants are compared with a base case scenario of population ageing.

Table 6 reports variable and 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. The value of this parameter is relatively high with respect to the literature to compensate for the fact that Canada is considered in the model as a closed economy.

A matrix of interregional flows is calculated between the six regions and serves to estimate the ownership distribution of wealth (physical capital plus government bonds) across individuals and regions. We assume that regional capital is owned first by local residents. This means that residents have a stock of wealth composed of local physical capital ownership titles plus bonds issued by local and outside regional governments. Given this interregional distribution of wealth and the above parameter values, a regional rate of time preference was calibrated to ensure equilibrium in the Canadian financial asset market. For simulation purposes, the general equilibrium of the economy is replicated over the 100 period horizons. The length of horizon is determined to ensure that, after the demographic projected shift, the economy converges to a long-run steady state. Although the model contains only 15 overlapping-generations and 6 regions, the model has more than 54,000 equations. It can thus be solved only through computations.

Simulation Results with the Regional CGE Overlapping Generations Model

We first present the simulation results at both national and regional levels for the baseline demographic scenario. This is followed by an examination of alternative scenarios with increased immigration and according to an alternative assumption regarding the residential location of recent immigrants.

TABLE 7 % Shock-minus-Control Baseline Results (National Level)

et al	Real GDP per Capita	National Savings	Real Wage Rate		Real Return to Capital
			Before Tax	After Tax	
2002	0.0%	0.0%	0.0%	0.0%	0,0%
2006	0.5%	-0.6%	0.7%	1.2%	-0,1%
2010	0.7%	-1.3%	1.4%	2.2%	-0,2%
2014	0.8%	-2.0%	2.0%	3.1%	-0,4%
2018	0.7%	-2.7%	2.7%	3.8%	-0,5%
2022	0.3%	-3.5%	3.3%	4.3%	-0,6%
2026	-0.2%	-4.3%	3.8%	4.7%	-0,7%
2030	-0.9%	-5.0%	4.3%	4.8%	-0,7%
2034	-1.9%	-5.8%	4.7%	4.7%	-0,8%
2038	-3.0%	-6.6%	5.0%	4.3%	-0,8%
2042	-4.3%	-7.2%	5.1%	3.5%	-0,7%
2046	-5.8%	-7.9%	5.0%	2.3%	-0,7%
2050	-7.4%	-8.4%	4.6%	0.9%	-0,6%

The baseline results first indicate that the declining share of the working-age population and the rising proportion of older people have negative economic implications on national savings (Table 7). The life-cycle theory of savings is a key assumption in the model and explains this result. The negative labour supply effect and the decline in savings also explain the fall in real GDP per capita relative to a scenario with no ageing. Initially, however, the demographic shock positively contributes to growth as the baby-boomers are still in the labour force, accumulating large amounts of savings and being highly productive at work. However, as they move through retirement, their savings decline as well as real per-capita GDP. Shock minus control, between 2002 and 2050, real per-capita GDP falls by 7.4 % in comparison to a situation with no demographic changes.

Also in the demographic shock, the proportion of workers becomes relatively scarce as opposed to physical capital, which is more abundant (rising capital-labour ratio). This is the result of excess demand pressures on labour, which contributes to raise real wages, while the real return to capital declines. Moreover, according to the baseline scenario, current older generations benefit from the demographic shock through economic-welfare gains via increased lifetime real after-tax income and consumption, while younger future generations suffer economic-welfare losses as a result of ageing.

When we look at the results by region, the numbers vary quite markedly after 2026. As shown in Figure 6, the Atlantic region and the province of Quebec suffer the largest real income decline compared to the rest of Canada. As illustrated with the elderly dependency ratio, these regions experience the greatest increase in the proportion of older people as a share of their population. In comparison, Alberta and British Columbia are closest to the national average and the Prairies and Ontario benefit from the smallest decline in real per-capita income. The Prairies benefit from a higher-than-average fertility rate, which partially offsets the rising

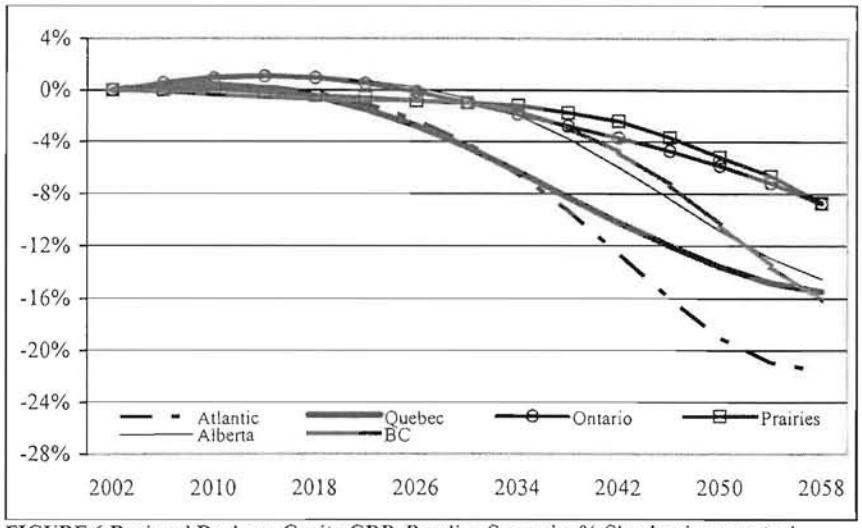

FIGURE 6 Regional Real per-Capita GDP, Baseline Scenario, % Shock-minus-control impact

number of older people, while Ontario receives the largest share of recent immigrants.

Moreover, since the province of Ontario attracts a larger proportion of immigrants, this contributes to reduce labour market pressures and potential labour shortages in the province. Conversely, the other provinces, particularly the East, do not benefit as much from immigration and regional labour market pressures are relatively greater compared to Ontario. This is reflected by smaller increases in real wage rates in Ontario relative to the rest of Canada (Figure 7 & 8). The results also indicate that the more rapid pace of ageing in the Eastern provinces provides some compensation in terms of a more rapid increase in real wages. This implies that regional differences in demographic changes could provide some incentives for regional labour mobility from Ontario to the rest of Canada, especially in favour of the Atlantic Provinces.

In addition, since each region produces one unique good, which are imperfect substitutes, the faster ageing regions benefit from an improvement in their terms of trade because of a more limited supply of their goods, as illustrated by the relative increase in regional output prices. However, these favourable terms of trade effects are insufficient to compensate for the negative effects on the provinces' real per-capita income. These results, both national and regional are consistent with other studies presented for Canada and other industrialized countries.[10]

When we look at the regional fiscal implications of ageing, there are opposing forces at play. On the one hand, the rising proportion of baby-boomers going

10. See, for example, Auerbach and Kotlikoff (1987), Auerbach et al (1989), Hviding and Mérette (1998), Fougère and Mérette (2000) and Mercenier and Mérette (2002), Borsch-Supan et al (2002) and Equipe Ingenue (2001).

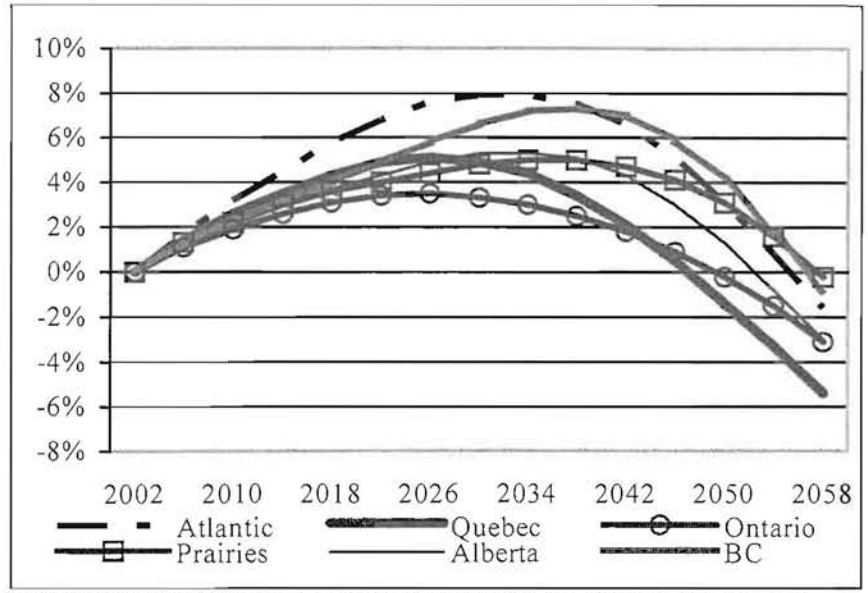

FIGURE 7 Regional Real After-Tax Wages, Baseline Scenario, % Shock-minus-control

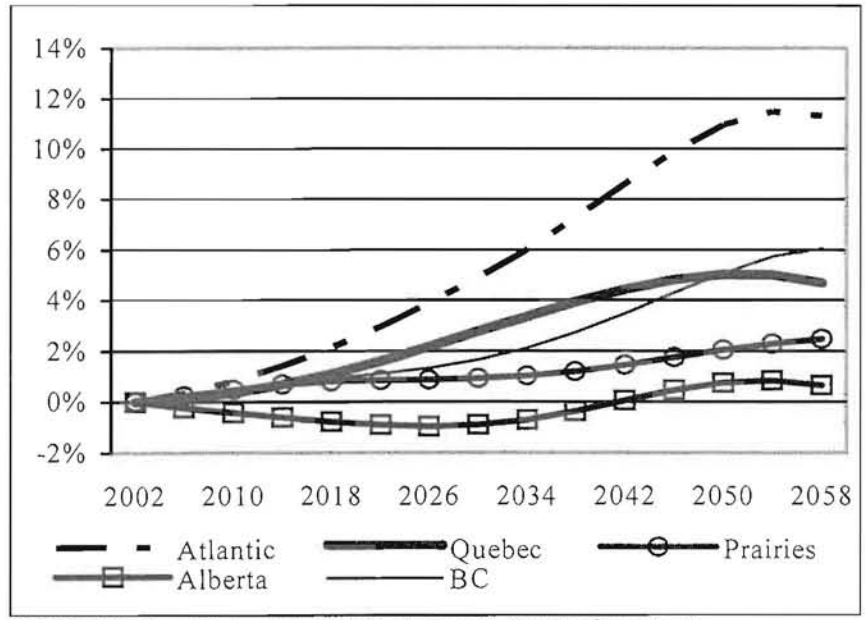

FIGURE 8 Regional Output Price Relative to Ontario, Baseline Scenario, % Shock-minus-control

through retirement contributes to reducing the wage income tax base and to raising public health expenditures. On the other hand, the relative scarcity of workers and the abundance in the stock of physical capital lead to an increase in wages and a decline in interest rates. The wage increase partially offsets the impact of the decline in the number of workers on the wage income tax base and the fall in interest rates contributes to reduce the interest payments on the public debt. Finally, the declining proportion of younger people provides downward pressures on public education spending. In the simulations, we assume that both national and regional governments maintain a constant debt per capita ratio and adjust the wage income tax rate accordingly. Initially, the net effect of ageing on the fiscal balance is positive and the wage income tax rate declines in all regions. However, the effects are reversed and the wage income tax base has to increase to maintain the debt per capita ratio constant.

In Scenario 2, the immigration target of 1 % of the total population is achieved, which contributes to reducing the negative consequences of ageing on real per-capita GDP. However, the differential impacts are more noticeable over the longer term. At the national level, the decline in real per-capita GDP is reduced by nearly 10 % by 2050, corresponding to about a 1 percentage point gain in real per-capita GDP, but with the consequence of a somewhat smaller increase in real wages and a smaller decline in the real return to capital. This also provides an indication that increasing the immigration target further to 1.25 % of the population, for example, and achieving it would roughly double the benefits on real per-capita GDP to 20 % or 2 percentage points. The improvement in real per-capita income has also significant positive intergenerational consequences through improved economic-welfare benefits to future young generations compared to existing older generations. Finally, the rise in the number of immigrants has some implications for the financing of public pensions. However, there are two factors at play. On the one hand, the rise in the number of immigrants raises labour supply, which in turn increases total wage compensation and reduces the pressure on public pension contribution rates. On the other hand, the increase in labour supply reduces real wage growth, thus reducing total wage compensation.

The result that higher immigration increases real per-capita GDP appears to be contradictory to the intuitive interpretation provided by the standard neo-classical model. One reason is that, in contrast to the model used in this paper, static neo-classical models usually assume that immigrants do not bring capital with them and do not save or accumulate capital in the host country. The other reason is that in the demographic context, higher immigration reduces the elderly dependency ratio as immigrants are on average younger than Canadians.

At the regional level, it can be noted that the increase in the number of immigrants has virtually no effect on real per-capita income for the Atlantic region, Alberta and the Prairies, since these provinces receive a very small fraction of immigrants (Figure 9). It also only has a small effect in Quebec. However, the impact is more significant in Ontario and British Columbia. The increase in the number of immigrants to these two provinces also reduces labour market pressures, which is reflected by smaller real wage growth compared to the other regions and

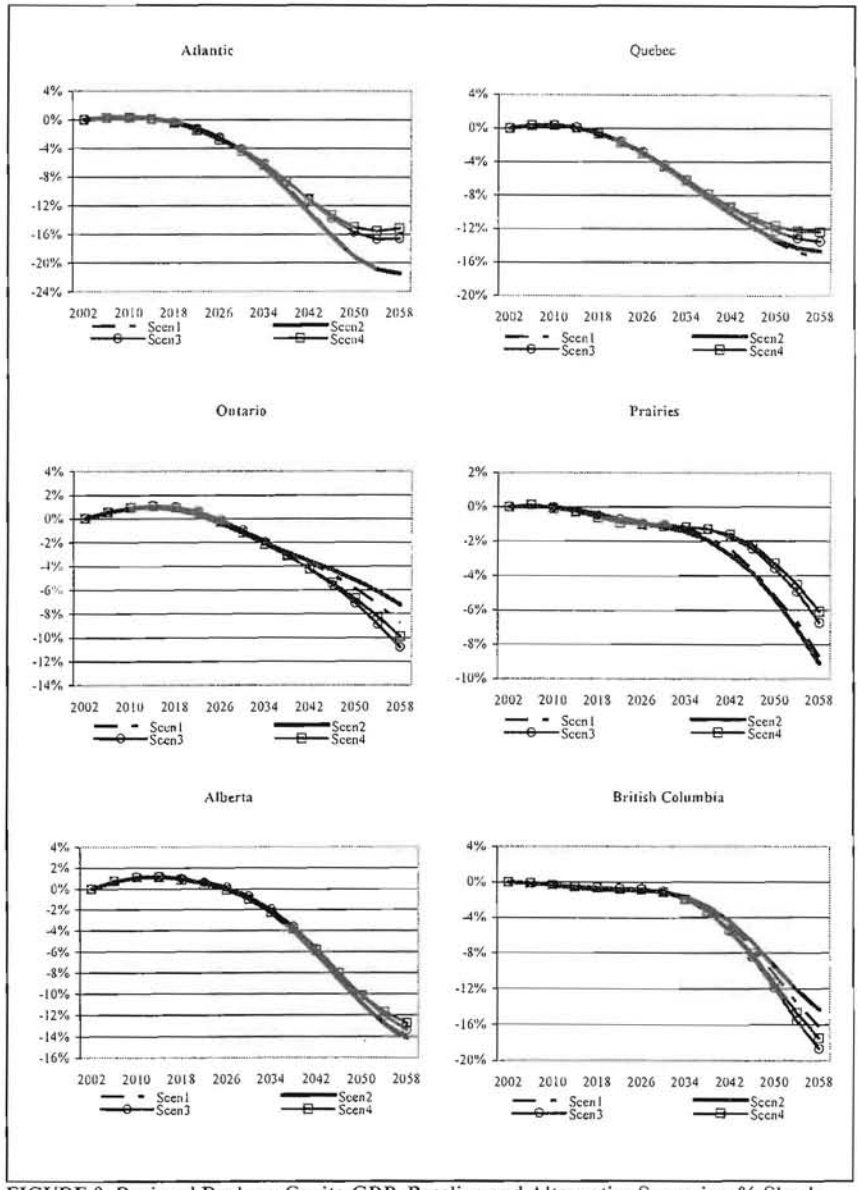

FIGURE 9 Regional Real per Capita GDP, Baseline and Alternative Scenarios, % Shock - control

relative to the baseline scenario. This suggests that increasing the number of immigrants in a scenario where Ontario and British Columbia continue to receive a proportion of immigrants greater than their share of the population would provide more incentives to labour mobility due to rising real wage differences in favour of the other provinces.

In Scenario 3, the proportion of immigrants is the same as in the baseline scenario. However, the regional location of immigrants, rather than being dominated by Ontario and BC, is equally distributed, according to the provincial share of the population in the total population. Accordingly, the negative impact on real per-capita income for the Atlantic, Quebec, the Prairies and Alberta are relatively smaller over the long run since these provinces now benefit more from immigration. Also not surprisingly, Ontario and BC have a larger decline in real per-capita income compared to the baseline scenario, since they benefit less from immigration. This scenario also reduces regional real wage growth differences, which implies a more balanced reduction in regional labour market pressures due to immigration. This implies that immigration in this scenario has no influence on incentives to regional labour mobility.

Finally, in Scenario 4, we have maintained the same assumption as in Scenario 3 concerning the regional location of immigrants, but the number of immigrants achieves 1 % of the population per year. As can be seen in Figure 9, this is the most favourable scenario for the Atlantic, the Prairies, Quebec and Alberta in terms of improvement in real per-capita income, since they can benefit from the larger proportion of immigrants in their region. Ontario and BC are almost identical as in the baseline scenario. Moreover, as shown in Figure 10, this scenario reduces the impact on regional income disparity. This scenario also reduces regional labour market pressures in a more balanced way.

Interpretation of Results, Policy Implications and Conclusion

The results first indicate that since the proportion of immigrants entering Canada is substantial and the age distribution of recent immigrants is normally younger than the age distribution of Canadian born individuals, the projected impact of immigration on the Canadian labour force is quite significant in the long run as illustrated by the elderly dependency ratio projections. According to simulation results with the regional OLG model, a simple rule-of thumb calculation would suggest that under standard demographic assumptions, expected future immigration flows would contribute to reducing the negative impact of ageing on real per capita GDP by roughly 30 %.

The results also reveal that raising the number of immigrants would provide some additional long-run benefits in terms of real GDP gains. For example, achieving an immigration target of 1 % of the population rather than 0.75 % could prevent an additional 10 % decline in real GDP per-capita in the long run. The results also imply that Canada's immigration would significantly reduce potential intergenerational inequity effects associated to ageing as future generations would be better-off compared to a scenario with no immigration.

However, the simulations suggest that the regional location decision of immigrants may potentially have large implications on regional labour markets and regional income disparity. If current immigration trends persist in the long run, Ontario and British Columbia could obtain most of the socio-economic benefits

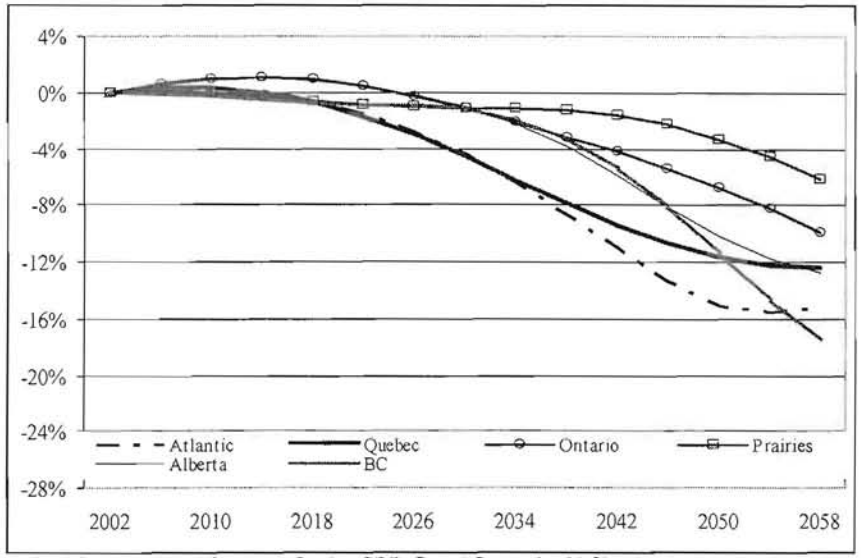

FIGURE 10 Regional Real per Capita GDP, Scen4 Scenario, % Shock-minus-control impact

of immigration, which would in turn contribute to raising regional disparity. On the other hand, regional wage growth differentials would also arise at the advantage of the other provinces. This would in turn provide incentives to regional labour mobility from Ontario to the rest of Canada.

Moreover, according to the simulations, a more equitable regional distribution of recent immigrants would generate significant economic benefits to regions like the Atlantic, the Prairies and Quebec in the long run, benefits that could be superior for these regions than raising immigration targets. It would also significantly contribute to reducing regional disparity. Finally, a combination of both increased immigration and a more equal regional distribution of immigration would be the most preferred scenario since it would generate both positive and more equitable benefits to all the regions of Canada.

Since the results found in this study are model-based simulations, a number of caveats need to be raised. For model simplification, we assumed that recent immigrants have similar labour force characteristics and owned the same value of assets as Canadian-born individuals. Relaxing these two assumptions would likely change the magnitude of the results but not their direction.

Correspondingly, the next step in our work will consist of presenting simulation scenarios where recent immigrant workers have a different level of education/skill level and a different stock of assets compared to Canadian-born workers in order to evaluate the socio-economic implications of raising the proportion of skilled immigrants. Finally, we also plan to use a regional CGE overlapping generations model disaggregated at both the sectoral and occupational level to evaluate more specifically the potential implication of attracting skilled immigrants by occupational group on the labour market in the context of an ageing population.

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Appendix: Model Structure

The Production Sector

The regional economy's production is represented by a Cobb-Douglas function where $Y_{j,t}$ represents the output of region j at time t, K is the capital stock, L the effective labour force and A the scaling variable.

$$Y_{j,t} = A_j K_{j,t}^{a_j} L_{j,t}^{1-a_j} \tag{1}$$

Firms in each region hire labour and rent physical capital to produce output and operate in a perfect competition market. Factor demand and output are determined by the following conditions for profit maximisation:

$$\frac{re_{j,t}}{P_{j,t}} = a_j A_j \left(\frac{K_{j,t}}{L_{j,t}}\right)^{a_j - 1} \tag{2}$$

$$\frac{w_{j,t}}{P_{j,t}} = (1 - a_j) A_j \left(\frac{K_{j,t}}{L_{j,t}}\right)^{a_j} \tag{3}$$

where re is the rental rate of capital, w the wage rate per unit of effective labour and P the output price. The regional capital stock (K) is determined as follows:

$$K_{j,t+1} = Inv_{j,t} + (1 - \delta_j) K_{j,t} \tag{4}$$

with Inv representing investment and δ the depreciation rate of capital.

Household Behaviour

Each native generation optimises a CES type inter-temporal utility function of consumption and bequest subject to lifetime income. The household's optimisation problem consists of choosing the consumption and savings pattern. Savings can be allocated between domestic physical capital ownership titles or regional bonds issued by regional governments. Similarly, consumption expenditures are allocated toward the six available final goods accordingly to households' preferences represented by a CES function.

$$U = \frac{1}{1-\theta} \sum_{g=1}^{15} \left(\frac{1}{1+\rho}\right)^g \left(C_{j,g,t+g-1}^{1-\theta} + \beta_g^{\theta} Beq_{j,g,t+g-1}^{1-\theta}\right) \tag{5}$$

$0 < \theta < 1$, $\beta_{g \neq 15} = 0$, $\beta_{g=15} > 0$,

where $C_{j,g,t}$ is consumption of an individual in region j of age group g at time t. Beq is bequest, ρ the pure time preference and θ the inverse of the inter-temporal elasticity of substitution. β is a constant parameter. Following Blinder (1974), the level of bequest enters in the utility function giving rise to intergenerational transfers. It should be noted that this presentation of the utility function yields very different results from the alternative of introducing the utility of future generations directly into the utility function of current generations. In this form presented here, the utility of bequest is independent of the present value of cash receipts extending beyond the death of the current generation.

The present value of household wealth W at birth is the discounted sum of lifetime labour income after deduction of taxes, deduction of public old-age pensions *pens* and inheritance *inh*.

$$W = \sum_{g=1}^{15} \left(\frac{1}{1 + ri_{t+g-1}(1 - \tau_k)}\right) \left[Y_{L,g,t+g-1}\left(1 - \tau_{w,j,t+g-1} - C_{P,t+g-1}\right) + inh_{g,t+g-1} + pens_{g,t+g-1}\right] \tag{6}$$

where Y_L is labour income, ri is the rate of interest, τ_K the tax rate on capital income τ_w the tax rate on labour income and c_P the public pension plan contribution rate. Labour income depends on the individual's productivity or earnings profile E, which is defined as a quadratic function of age. It is also assumed to be identical across region.

$$E_g = \gamma + \lambda g - \psi g^2 \qquad \gamma, \lambda, \psi \geq 0 \tag{7}$$

Labour income of an individual age group is defined as :

$$Y_{L,j,g,t} = w_{j,t} E_g \qquad g = 1,2,...,12 \tag{8}$$

So although earnings profile are similar for all individuals, labour income may differ across regions as the wage rate per unit of effective labour is region specific. Pension benefits of the retirees are a fraction of their average labour earnings. The fraction is determined by the public pension replacement rate *repl* that applies identically across Canada. Pension benefits are thus equal to:

$$Pens_{j,gm,t} = repl \frac{1}{12} \sum_{gj} w_{j,t-14+gj} E_{gj} \quad gm = 13,14,15,\ gj = 1,2,...,12 \tag{9}$$

The first-order condition for consumption and bequest can be defined as follows:

$$C_{j,g+1,t+g} = \left[\frac{(1 + ri_{t+g}(1 - \tau_k))}{(1 + \rho)} \frac{P_{C,j,t+g-1}}{P_{C,j,t+g}} \right]^{\frac{1}{\theta}} C_{j,g,t+g-1} \tag{10}$$

$$Beq_{j,g,t} = \beta_g C_{j,g,t} \tag{11}$$

Bequest is distributed at the end of each generation's lifetime. Inheritances arising from the oldest age group's (g=15) bequests are assumed to be equally distributed to all working generations.

$$Inh_{j,gj,t} Pop_{j,gj,t} = \frac{1}{12} Beq_{j,gn,t} Pop_{j,gn,t} \qquad , gn = 15, \tag{12}$$

where $Pop_{j,g,t}$ is the number of people living in region j of age group g at time t. The population growth rate is treated as exogenous.

The next step in the optimisation problem for households is to allocate their consumption expenditures across the six different final goods. A CES function is used to represent the inter-regional household preference. In the first-order conditions, a final goods produced in region i and consumed by an individual in region j ($ConI_{i,j,g}$) is determined by:

$$ConI_{i,j,g} = \mu_{C,i,j} \left(\frac{P_{C,j}}{P_i} \right)^{\sigma_{C,j}} C_{j,g} \tag{13}$$

where P_c is the price of consumption, μ_c is a preference parameter for resident of region j for goods produced in region i and determines the regional distribution of total consumption, and σ_c is the inter-regional consumption elasticity of substitution.

The price of consumption is determined by a non-linear weighted average of local prices and also depends on the preferences parameters.

$$P_{Cj}^{(1-\sigma_{c,j})} = \sum_j \mu_C P_i^{(1-\sigma_{C,j})} \tag{14}$$

A CES function describes the investment technology. The composition of regional investment is then defined as:

$$Einv_{i,j} = \mu_{Inv,i,j} \left(\frac{P_{Inv,j}}{P_i} \right)^{\sigma_{Inv,j}} Inv_j \tag{15}$$

where μ_{Inv} is a parameter in the CES investment technology and σ_{Inv} is the corresponding elasticity of substitution.

The price of investment is determined similarly as for the price of consumption, that is:

$$P_{Inv,j,t}^{(1-\sigma_{Inv,j})} = \sum \mu_{Inv,i,j} P_{i,t}^{(1-\sigma_{Inv,j})} \tag{16}$$

As bonds and capital shares are assumed to be perfect substitutes, expected returns on bonds equal expected returns on capital shares. Moreover, financial capital is perfectly mobile across the Canadian regions and an interest parity condition ensures that the interest rate is unique across regions. In equation 17, the unique rate of interest ri is expressed as being equal to the rental return on capital re minus the depreciation rate plus the capital gains, and this, for all regions j:

$$ri_{j,t} = \left(re_{j,t} + \left(1 - \delta_j\right) \right) \frac{P_{Inv,j,t}}{P_{Inv,j,t-1}}, \forall j \tag{17}$$

The Government Sector

The government budget constraint is defined as :

$$\begin{aligned} & P_{j,t} Bond_{j,t+1} + \sum_g Pop_{j,g,t} \left(\begin{array}{l} \tau_{w,t} \left(w_{j,t} E_g + Pens_{j,g} \right) + \tau_{C,t} P_{C,j,t} C_{j,g} \\ + \tau_{K,t} \sum_i ri_t Lend_{i,g,t} \end{array} \right) \\ & = P_{j,t} \left(Gov_{j,t} + GovH_{j,t} + GovE_{j,t} \right) + \left(1 + ri_t\right) P_{j,t-1} Bond_{j,t} \end{aligned} \tag{18}$$

where, τ_c is the effective tax rate on consumption, *Lend* is the stock of wealth accumulated by households, *Gov* is public expenditures, *GovH* health care spending and *GovE* education spending. Pay-as-you-go pension benefits are financed by contribution rates on labour income. The pension program is represented by the following equation:

$$\begin{aligned} & \sum_{gm} Pop_{j,gm,t} Pens_{j,gm,t} = C_{P,t} \sum Pop_{j,gj,t} E_{j,gj,t} w_{j,t} \\ & , gj = 1,2,...12 \, , \, gm = 13,14,15 \end{aligned} \tag{19}$$

where c_p is the national contribution rate for the pay-as-you-go program.

Market and Aggregation Conditions

The model assumes that all markets are perfectly competitive. There are 6 goods markets in the model. The equilibrium condition for the goods market states that each regional output must be equal to total demand:

$$Y_{j,t} = \sum_{i} \left(EC_{j,i,t} + EInv_{j,i,t} \right) + Gov_{j,t} + GovH_{j,t} + GovE_{j,t} \tag{20}$$

where

$$EC_{j,i,t} = \sum_{g} ConI_{j,i,g,t}$$

Labour and physical capital are immobile across regions, so a market exists for these two production factors in each region. The stock of effective labour is the number of individuals times their corresponding productivity level:

$$L_{j,t} = \sum_{gj} Pop_{j,gi,t} E_{gj} \tag{21}$$

Finally, the capital market must be in equilibrium for Canada that is, the sum of the stock of wealth (*Lend*) accumulated by all Canadians at any point in time must be equal to the sum of bonds issued by regional governments and the stocks of capital used in each region:

$$\sum_{j,g} Pop_{j,g,t} Lend_{j,g+1,t+1} = \sum_{j} P_{j,t+1} + P_{Inv,j,t} K_{j,t+1} \tag{22}$$