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# Will Population Aging Increase Inequality across Regions in Canada?

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**by**
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# Abstract

A three-region, three-good, fifteen overlapping generations model is built for the first time to analyze the interregional consequences of population aging in Canada. Each region of the model produces one differentiated good. Households work the first twelve periods of their life and retire in the last three. Households' behaviour is characterized by the life-cycle theory and their savings can be invested in any region since the financial capital market is considered perfectly integrated in Canada. The model includes an across Canada pay-as-you-go pension scheme. Regions differ from each other by the size of their economy, their specific local taxation and their demographic projections. Although the upcoming demographic change is inevitable across all Canadian regions, the intensity and speed of the change differ significantly across them. This paper investigates to what extent differences in the aging process will have asymmetric regional economic consequences. Two opposing forces are at work in the simulation experiments. On one hand, the economic integration of Canadian regions helps to harmonize the economic consequences of aging populations across regions. On the other hand, faster aging regions have to support more rapidly growing spending on public health care that increases differences among Canadian regions, especially on the fiscal balance.

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# 1. Introduction

The heading of the baby boom generations towards retirement will rapidly increase the proportion of elderly in the population of many industrialized countries. Canada is not escaping this demographic phenomenon as the population of seniors is projected to increase from 3.8 million in 1999 to 11.2 million in 2046, accounting for half of the projected growth in the total population (from 30 million to 44.4 million). As a result, population aging will proceed at an unprecedented pace in Canada. The largest part of this increase will take place in the 2011-2031 period as the baby-boomers move into the 65 and plus age group.

The upcoming dramatic demographic change has attracted a lot of attention worldwide and within Canada. However, most of the available analyses on the economic consequences of an aging population have been at the national level.[1] National studies may hide important discrepancies in large country like Canada. Indeed, population aging would be more extensive in the poorest provinces in Canada if inter-provincial migration flows follow the average pattern observed during the 1976-1996 period. As shown in Table 1, the old-age dependency ratio is projected to rise between 1996 and 2040 from 16.2 to 56.0 percent in Newfoundland, whereas in Alberta this ratio will rise from 15.5 to only 36.8 percent. No factor in sight seems able to reverse these trends. There is no evidence of any significant increase in the birth rate, nor in the age composition of immigration flows. In Canada, life expectancy is expected to continue to increase over the next several decades, with an additional gain of 4 years for women (to 86 years) and a gain of 6 years for men (to 82 years).

In this paper we present a computable three-good three-region overlapping generations model to investigate the inter-regional impact of population aging in Canada. According to data in Table 1, although Canadian regions share the same projected old-age dependency trend, the level and rate of change differ across them. The main issue in this paper is to what extent the economic effects of the aging shock will be or not be shared across regions. In the next section we present the model in intuitive terms. Section 3 presents the demographic trends of the three regions of the model. Section 4 describes the calibration procedure of the computable model. In Section 5, we discuss the results of the

[1] See for instances Auerbach *et al.* (1989), Hviding and Mérette (1998) and Miles (1999) for international studies and Fougère and Mérette (2000a, 2000b) for analyses on Canada.

simulation of the aging population shock for the baseline scenario whereas in Section 6 we discuss the sensitivity of these results to some specific parameter values. Section 7 concludes.

Table 1: **Old-Age Dependency Ratio in Canada: 1996, 2040**

| | **1996** | **2040** |
|---|---|---|
| Newfoundland | 16.2 | 56.0 |
| Prince Edward Island | 21.8 | 46.9 |
| Nova Scotia | 20.6 | 49.4 |
| New Brunswick | 19.8 | 50.8 |
| Québec | 18.7 | 39.8 |
| Ontario | 19.3 | 36.1 |
| Manitoba | 22.5 | 39.3 |
| Saskatchewan | 25.6 | 43.4 |
| Alberta | 15.5 | 36.8 |
| British Columbia | 20.6 | 40.0 |
| Yukon | 6.8 | 25.7 |
| Northwest Territories | 5.7 | 22.9 |
| **Canada** | **19.2** | **38.5** |

Source: Population Projections Section at Statistics Canada

## 2. Brief Description of the Model

In this section, we confine the description of the mechanics of the model at the intuitive level.[2]

The economy is Canada and is composed of three regions. As in Fougère and Mérette (2000), Canada as a whole is considered to be a closed economy. This assumption is tolerable since the projection of seniors in Canada over the next 50 years is similar to that in other OECD countries. In contrast, the individual regions are very open to trade with other regions. Each region produces one differentiated good, that is a good imperfectly substitutable with other regions' production good. Four types of economic agents are found in each region: A representative firm produces the unique regional good; fifteen different age groups represent households; a regional government supplies public goods and taxes consequently; and a national body represents the pay-as-you-go pension program. The model has three final goods, two factors of production (physical capital and labour), and two financial assets (bonds and capital ownership titles).

To produce, the regional representative firm hires labour and rents physical capital. Production technology is represented by a Cobb-Douglas function. To increase the stock of physical capital for future production, firms invest. Physical capital is a composite good of the three regional final goods. A CES function described the investment technology. Therefore, in addition to the presence of a price for each final goods in the economy, there is a price for the investment good in each region, which is in fact a composite of the three final goods' prices. The investment demand of a particular good augments when the ratio of the investment good price over the output price increases. The degree of substitution depends on the assumed elasticity of substitution in the CES function. In the model production and investment technologies may differ across regions.

An overlapping generations framework characterizes households. At each period, 15 generations live side by side. At any new period, a new generation is born and an old one dies. This implies that each generation lives 15 periods, with each period corresponding to 4 years of life. The model concentrates on adult life and hence individuals are born at the age of 18 and die at 78 years of age. The population growth rate is treated as exogenous. In each region, there is a representative agent for each of the

2 Full description of the equations of the model can be obtained upon request.

fifteen generations. Each agent optimizes an intertemporal felicity function. Households' felicity is assumed of the CES type. Households' optimization problem consists of choosing in a first step between consumption and savings. Savings can be allocated on domestic physical capital ownership titles or regional bonds issued by regional governments. Similarly, consumption expenditures are allocated toward the three available final goods accordingly to households' preferences represented by a CES function. This specification is equivalent to the Armington assumption currently used in trade models to explain intra-industry flow of goods across countries.

Government taxes labour and capital income, and consumption expenditures. In addition to public expenditures, health care and education expenditures, the government bear public debt payments. To satisfy its budget constraint when tax revenues come short of public expenditures and interest debt payments, the government issues new bonds. Pay-as-you go pension benefits are financed by contribution rates on wage earnings. With population aging, the contribution rate is expected to rise. But as the program is considered nation-wide, no inter-regional consequences are expected.

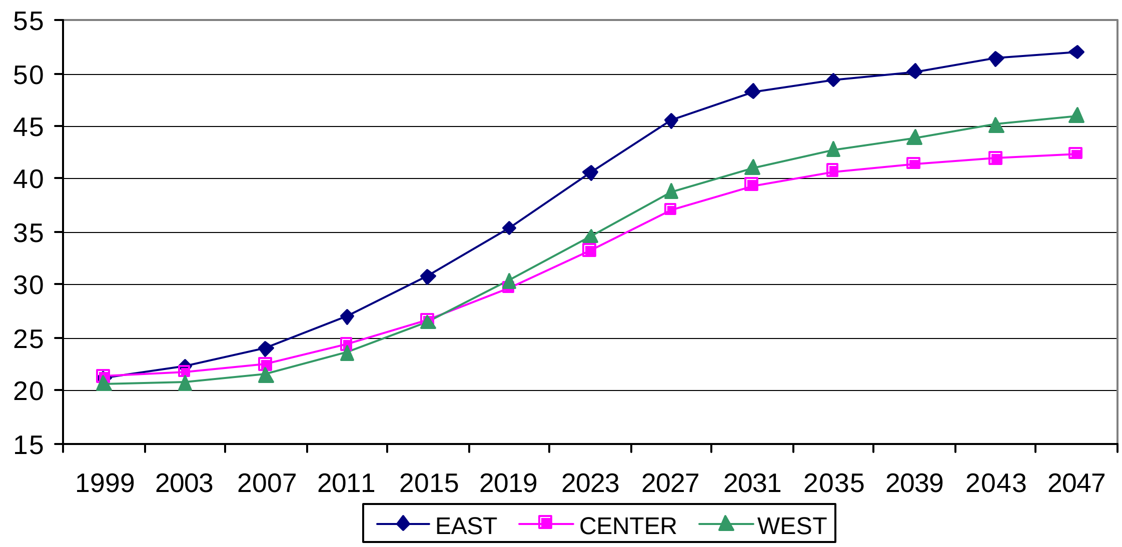
There are three good markets in the model. As labour and physical capital are immobile across regions, there is a market for each of these two factors of production in each region. The financial market is considered perfectly integrated across regions. This means that financial capital is very mobile 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 good, relative output prices act as if there were flexible exchange rate across regions.

# 3. The Demographic Trends in the Model

The three regions of the model are East, the Center and the West. East is composed of the four Atlantic regions plus Quebec. The Center is in fact Ontario whereas the West is composed of all the other Canadian provinces.

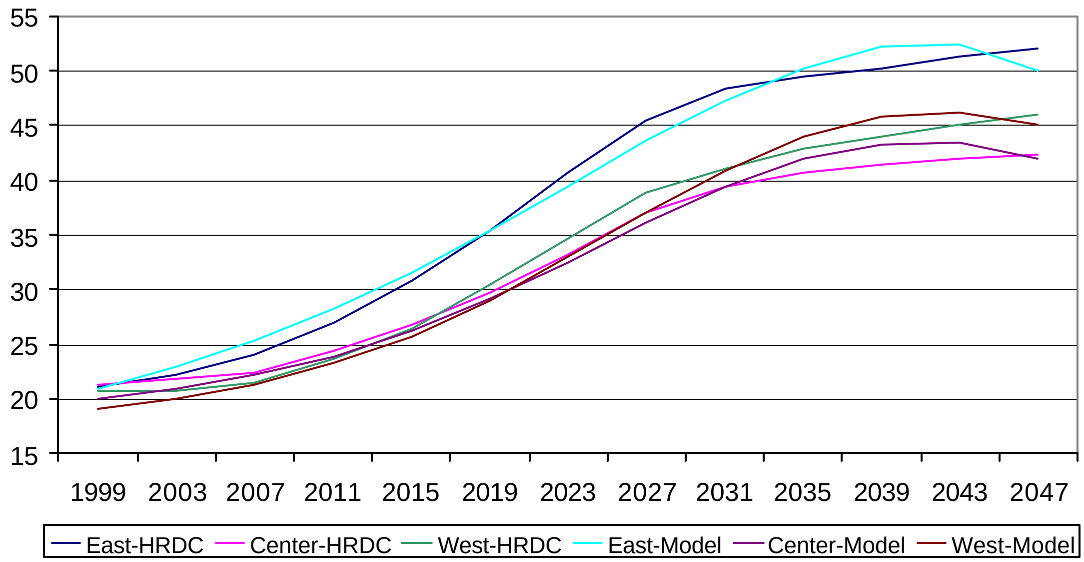
The age-group composition of the population is rather similar in 1999 as the old-age dependency ratio is around 21 percent in all three regions. As reported in Figure 1, the old-age dependency ratio, defined as the number of individuals 65+ divided by those aged between 15-64, is expected to rise dramatically in the three regions. However, the population aging will be more severe in the East than in the other two regions. The old-age dependency ratio takes a upward trend with respect to the other two regions as early as 2007. In 2047, the ratio is above 50 percent in the East region whereas its level is around 45 percent in the Center and West regions. Notice that the aging process is faster in the West region than in the Center region as the the two old-age dependency ratio curves intersect around the year 2015 in Figure 1.

Figure 1 **Old-Age Depedency Ratio**




Although increased longevity, emigration, and persistent low birth rates are contributing factors, it is recognized that the main reason behind the rise in the old-age dependency ratio is the baby-boom baby-bust event. The model does neither contain migration nor increased life expectancy. The regional rise in the old-age dependency ratio is thus captured by the change in the birth rate (of the 18 years-old age-group) only. Figure 2 shows the old-age dependency ratio curves of the three regions as projected by Human Resources and Development Canada (HRDC) and by the model. One can see that for each of the three regions, the old-age dependency ratios generated by the model fits relatively well the HRDC projections.

Figure 2 **Old-Age Dependency Ratio HRDC vs Model**



# 4. Calibration

The object of a computable general equilibrium model is to compare two states of the economy. In our case, we compare the state of the three region economies when population is aging as predicted by the demographic projections of the old-age dependency ratio to the state of the economy in the absence of such an aging shift. To accomplish the comparison we need to generate an initial equilibrium. This is what is called the calibration procedure. It consists mainly to calibrate certain parameters of the model in order to replicate what is observed in the data, given the known values of other variables or parameters. As our model is dynamic, the initial equilibrium is in fact a steady state that is, a general equilibrium that repeats every period. In our simulation experiments, we will introduce a demographic shift. The state of the economy will thus change and we will compare this new state with the original steady state, which is a state where the population structure of year 1999 remains forever.

Table 2 reports variable and parameter values that were imposed in the calibration procedure. Most values were supplied by Human Resources Development Canada as is the case for the demographic projections. We have imposed an identical intertemporal elasticity of substitution across regions that are consistent with values found in the literature. The intratemporal elasticity of substitution for is also assumed identical across the different types of demands (consumption and investment) and across regions. The value of this parameter is relative 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 was calculated between the three regions and serve to estimate the ownership distribution of wealth (physical capital plus government bonds) across individuals and regions. It was assumed that regional physical capital was owned by regional residents first. This means that residents have a stock of wealth composed of local physical capital ownership titles plus bonds issued by local and outside regional governements. Given this interregional date and the above parameter values, regional rate of time preference was calibrated as 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 3 regions, the model has more than 27,000 equations. It can thus be solved only through computations.

Table 2

| | **EAST** | **CENTER** | **WEST** |
|---|---|---|---|
| GDP (when Canada GDP = 1) | .278 | .420 | .302 |
| Share of capital in the production | .280 | .280 | .302 |
| Wage income tax rate | .362 | .313 | .308 |
| Capital income tax rate | .458 | .562 | .412 |
| Consumption tax rate | .216 | .200 | .177 |
| Government debt | .264 | .339 | .187 |
| Intertemp. elasticity of substitution | .275 | .275 | .275 |
| Elast. of subst. for consumption | 7.5 | 7.5 | 7.5 |
| Elast. of subst. for investment | 7.5 | 7.5 | 7.5 |

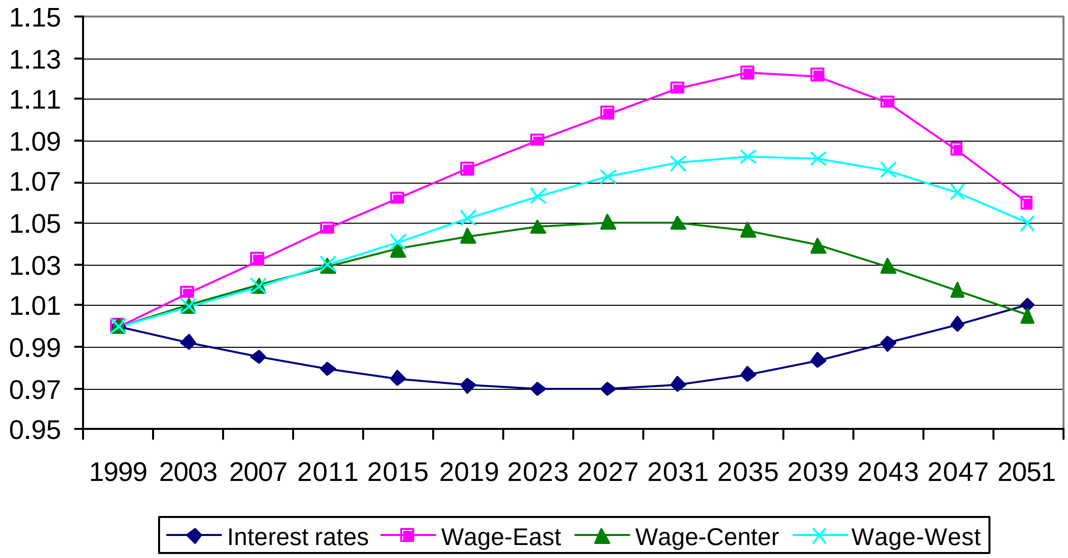
# 5. Baseline Scenario Results

Intuitively, the more common is the aging shock, the more homogeneous would be the economic effects across regions. Figure 1 illustrates that although population ages everywhere, the intensity and speed of the aging process differ significantly across regions. In the model, two opposing forces are determining to what extent regional aging shocks are exportable to other regions. On one hand, health care cost tends to regionalize aging effects. Health care spending is many times greater for seniors than for other age groups. As the health care is publicly funded at the regional level, fiscal pressures will be higher in regions with more rapidly aging populations. On the other hand, output prices adjustment offset and spread the aging shift to other regions through terms of trade effects. Output price tend to increase in the region more affected by population aging and this positive term of trade effect tends to harmonize the economic consequences across regions.

The simulations run up to around year 2300. This horizon is necessary from a technical and numerical point of view in order for the model to reach long-run steady state. As demographic projections go only up to 2047, a slow return to a stable population structure has been assumed for the rest of the horizon. In the following figures, we only report the dynamic transition of the economy from year 1999 to year 2051. The reader must assume that after 2051 the economy and its different components converge towards the long-run steady state. Unless notified, the values of the variables reported in the following figures are in indice terms. If there were no aging shock imposed, these indices will all be equal to one.

Figure 3 illustrates the effect of aging on the production factor prices. Recall that financial markets are considered perfectly integrated across Canada, so the interest parity condition applies. Labour is assumed immobile across regions. As population aging implies a reduction in the labour force growth, factor prices adjust in favour of labour wage rates and hurt the return to capital and consequently the interest rates. As it can be seen from the Figure 3, population aging puts indeed downward pressure on interest rates. In contrast, real wages in the three regions increase with population aging in a somewhat harmonized way. The dynamic paths obtained for the interest rate and real wages are similar to those obtained in national studies. However, the rises in the wage rates are closely linked to the change in the old-age dependency ratio reported in Figure 1. That is, the rise is greater in regions (the East followed by the West) that face more important demographic transition and hence compensate somewhat for the more negative effects discussed below.

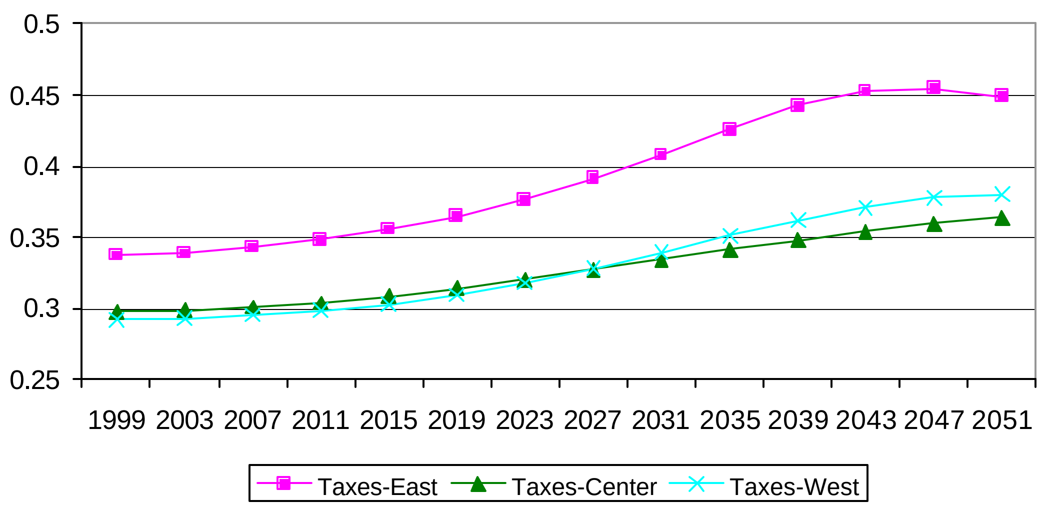
Figure 3 **Interest Rates and Wage Rates**




Aging population put obvious pressure on the pay-as-you-go pension program but the program imposes a common contribution rate to all regions contributing to harmonize the economic effects of aging across regions. The contribution rate imposes on wage earnings increases steadily from a level of 6 percent in 1999 to reach a maximum of 12.75 percent in 2047. The contribution rates would be higher in the East and West regions, but lower in the Center region if the pay-as-you go program was designed at the regional level.

Pay-as-you-go pension programs do not completely evacuate regional fiscal burden arising from population aging. Fiscal burden results from the reduction of the tax base and the rising spending pressure on health care. The tax base shrinks despite the raise in the wage rates as the decline in the labour force is more substantial. With the changing composition of the population average health care cost per person increases by as much as 27 percent in the East region, by 20 percent in the Center region and by 25 percent in the West region. The rise in health care expenditure is partially compensated by the reduction in education spending. Average education spending declines by 22 percent in the East, by 19 percent in the Center, and by 23 percent in the West. The net effect of all these offsetting factors results in a clear rise of the fiscal burden in each of the three regions. In the simulation exercise, we assume that government bonds and public expenditures change in proportion with the growth rate of population. We also assume that capital income and consumption tax rates are maintained constants. Hence it is the wage income tax rates that adjust to ensure that regional government budgets are satisfied. As debt per capita is maintained constant in the simulation, the fiscal burden is best represented by the change in the tax rate that is necessary to balance the budget. Figure 4 shows that the tax rate increases steadily in all regions. The increase in taxes is relatively modest until 2015 as the high tax payer age group (that is those between 40 and 50 years of age) rise also substantially until that time. Nevertheless, the wage income tax rate starts at 33.7 percent in 1999 in the East region to reach as much as 45.5 percent in 2047. The tax rates also rise substantially in the Center and West regions, but to a lesser extent. Thus, population aging will inflict unequal fiscal burden across regions.

Figure 4 **Tax Rates**




As population aging implies a reduction in the labour force growth rate, aging is also a negative supply shock. A more important aging shock can thus be interpreted as a more important negative supply shock. Consequently, we should expect a relative rise in the domestic output price in the most affected region (East) by population aging as the good produced becomes scarcer. The change in output relative prices is equivalent to an improvement of the terms of trade for the more affected region. Hence, with the presence of free trade among regions, the shock is dampened in the East region and propagated somewhat to the other two regions. Figure 5 reports the evolvement of relative output prices across the three regions. The output price of the Center region is considered the numéraire in the model. So the evolution of the two other output prices is relative to the Center region of which output price remains constant at one. The Figure indicates a rise in the output price of the East and West relative to the price in the Center region. The aging process hits these two regions harder, which reduce further their potential output. Consequently, the goods produced by them become scarcer and the associated price increases. Notice that the increase in the relative prices of their output is equivalent to a rise in their terms of trade they have with Center region. This fortunately helps them to dampen somewhat the negative effects of their relatively more important aging shock. Indeed, Figure 6 reports current account balances where the vertical axis refers this time to units used in the model. The decline in the balance for the East and West regions would have been much greater without the positive terms of trade effects. The opposite movement across regions reflects the fact that the sum of the three current balances is zero. The offsetting role played by the terms of trade effects can also be illustrated in the following two figures. Figure 7 shows that output per capita declines by about 5 percent more in the East region compared to the other two regions. However, as shown in Figure 8, terms of trade effects reduce the differences in value terms by half.

Figure 5 **Regional Ouput Prices**

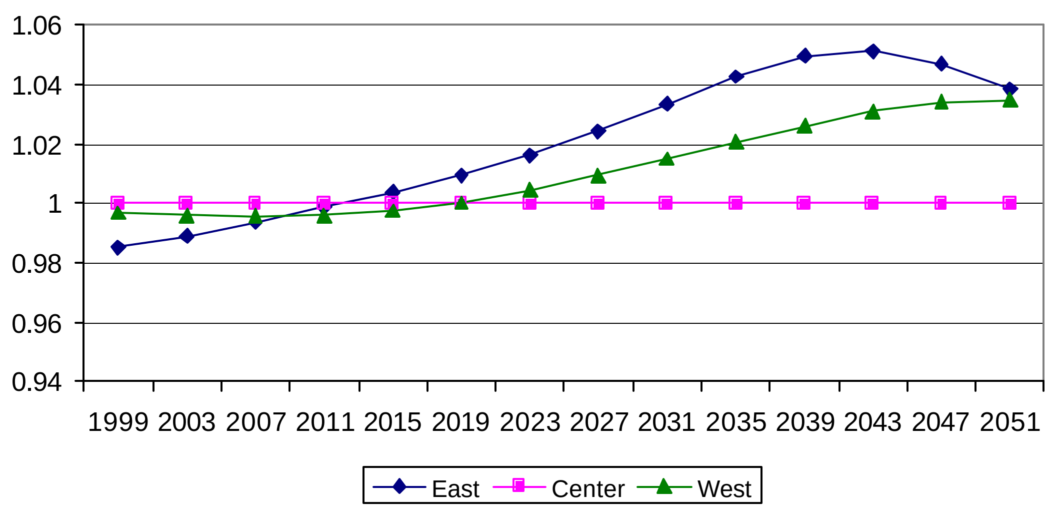


Figure 6 **Current Account Balances**

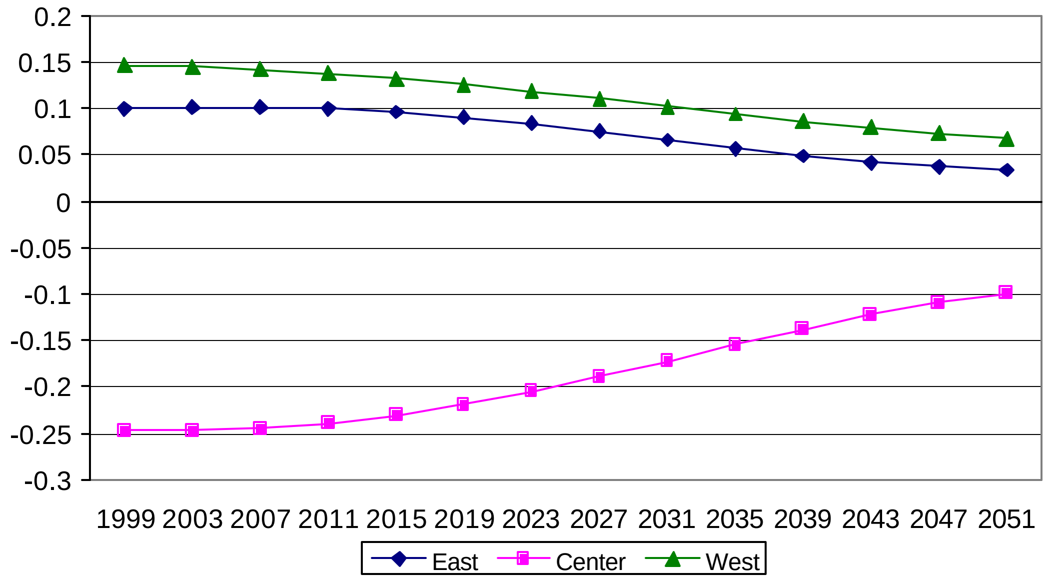



Figure 7 **Output Per Capita**

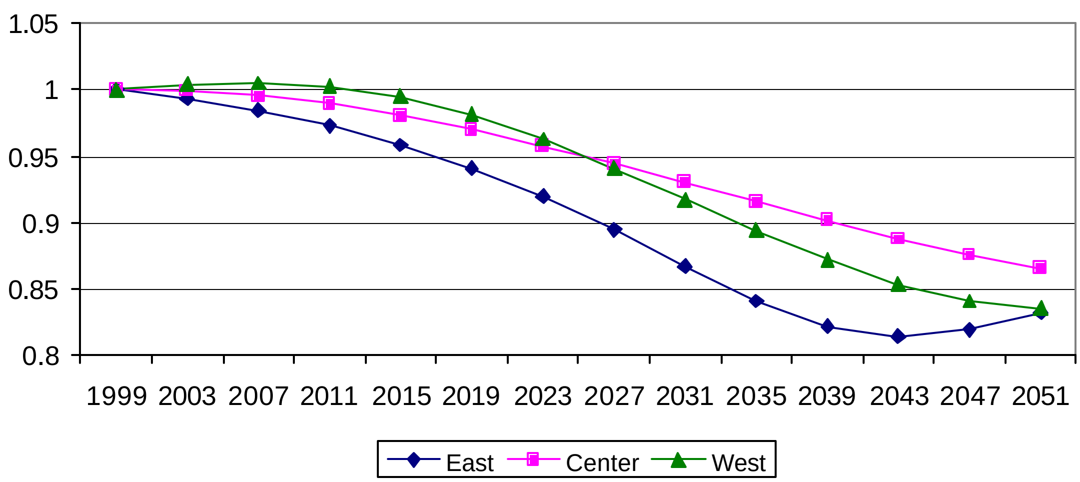


Figure 8 **Output Value Per Capita**

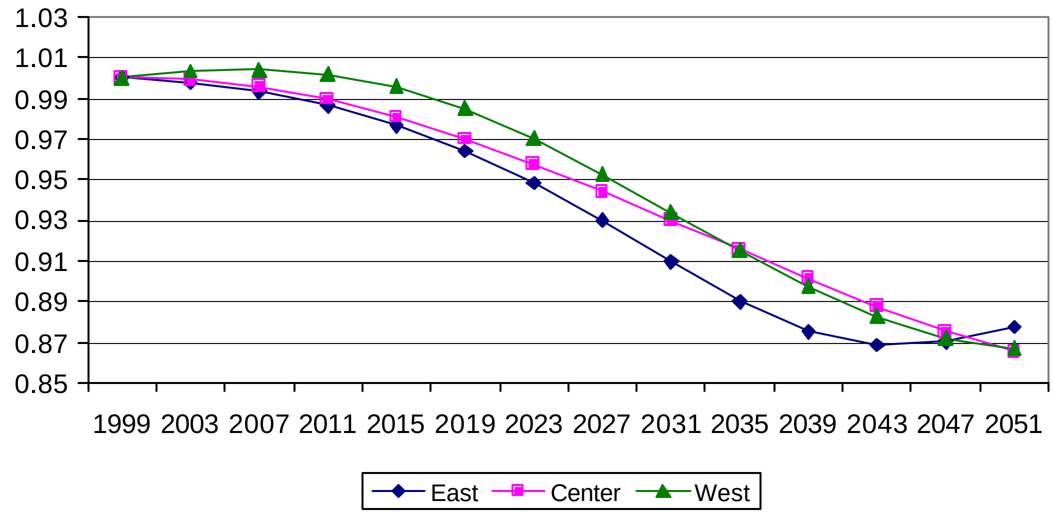
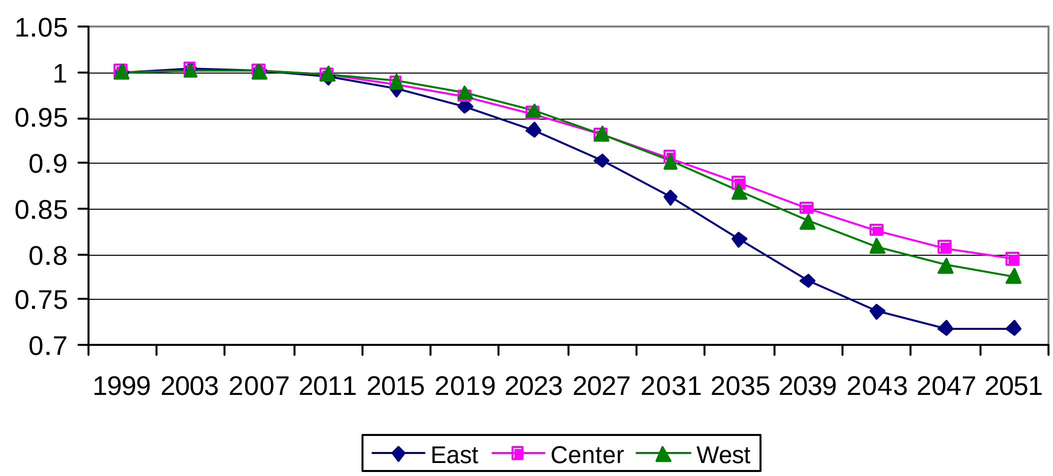


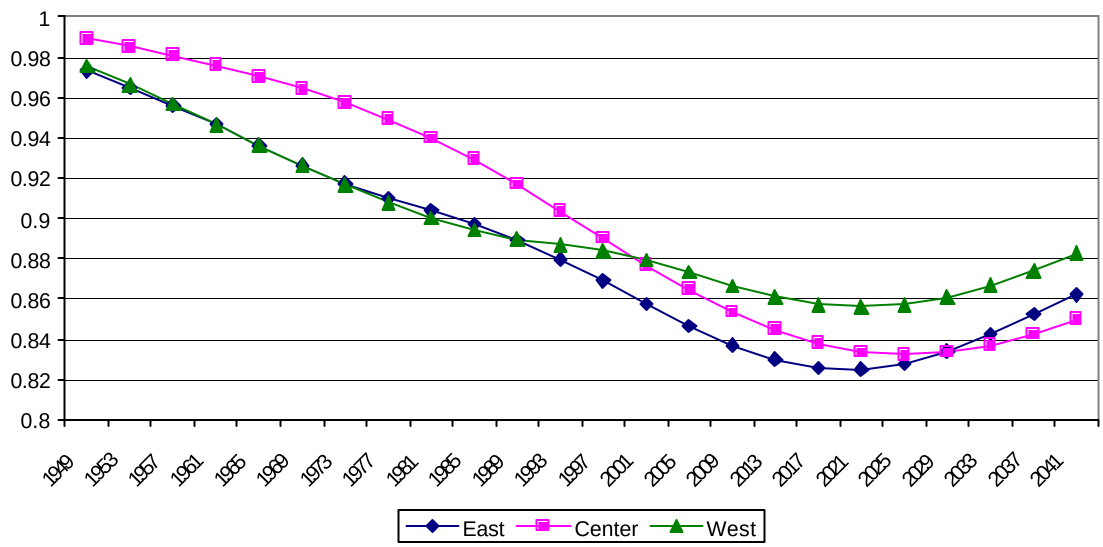

Figure 9 shows that despite greater increase of the wage rate in the East region, the real wage rate net of taxes and contributions will decline more substantially. In other words, wage income inequality will increase across regions. It is noteworthy to observe that the decline will more significant in the already poorest region of Canada (East). Real disposable income (not reported here) does not show as much increase in inequality as net of taxes wage income. This suggests that wealth effects from the ownerships of physical capital and government bonds play an important role in the simulation results. However, we do not have good data on the interregional ownership matrix. In the model, that matrix has been calibrated to accommodate the observed data on interregional trade flow and the assumption that the three regions form a closed economy.

Figure 9 **Real Wage Earnings Net of Taxes**



Aging poses important intergenerational issues. No doubt that the pressure on the regional fiscal balances will be will have to be bear by young and future generations. It is relevant to measure how these generations will fare in welfare terms. In this paper we calculate the effect in permanent consumption units terms of the process of aging. To be more precise, we compare the welfare under the scenario of aging relative to a scenario in which the composition of the population observed in 1999 would have remained constant forever. Figure 10 reports the welfare results for generations born between 1949 and 2041. Population aging after 1999 hurt all cohorts. However, those born recently and the future cohorts are much more affected than their ancestors. Moreover, welfare decline more significantly in the East region probably because future cohorts face a heavier fiscal burden.

Figure 10 **Welfare Across Cohorts**



# 6. Sensitivity Analysis

As mentioned above, the results reported depend on the relative strength of inner and outer forces. Health care expenditures tend to localize aging shift since they are funded by regional governments. In contrast adjustment of regional output prices tend to harmonize aging shifts across regions as they absorb regional specific shocks. In this section we investigate to what extent the results of the baseline scenario are sensitive to these two factors.

In the first sensitivity experiment we replace the across age-group distribution of health expenditure of the baseline scenario by the one reported by King and Jackson (2000). The new distribution increases the health care cost pressure arising from aging. In the new distribution, those aged 65 and over absorb seven times the per capita health care dollars devoted to middle aged individuals. In the baseline scenario this ratio was about four. The effect of this new distribution is to increase the tax rate by a further half percentage point the the Center and West region, but by a further full percentatage point for the East region. This means for the latter region that between 1999 and 2047, tax rates rise from 33.7 to 46.8 percent. Welfare also declines by an additional two percents in the East region and by about one percent in the other two regions.

In the second sensitivity test, we further increase the fiscal pressure arising from health care by introducing as in Robson (2001) an aged-adjusted servicing intensity. Aged-adjusted consumption of health care goods and services per person rose by 0.8 of a percentage point annually faster than the output per person of working age during the 1980s in Canada. This number has been reduced substantially in the 1990s as governments in Canada went through fiscal restrictions measure. Here, as in Robson (2001) we assume for the period 1999-2047 a rise of 0.5 of a percentage point for health care faster than output per person. The effect on tax rates is dramatic. As showed in Figure 11, tax rates reach a level over 50 percent in the East region. Compare to the baseline scenario (see Figure 4), the additional increase in the tax rate average about 5 percentage points. Not surprisingly, this increases differences of welfare levels across cohorts as reported in Figure 12. Relative to their ancestors, welfare levels attained by young and future cohorts achieve much lower levels in comparison to the baseline scenario (Figure 10). Moreover welfare differences across regions increase.

Figure 11 **Tax Rates**

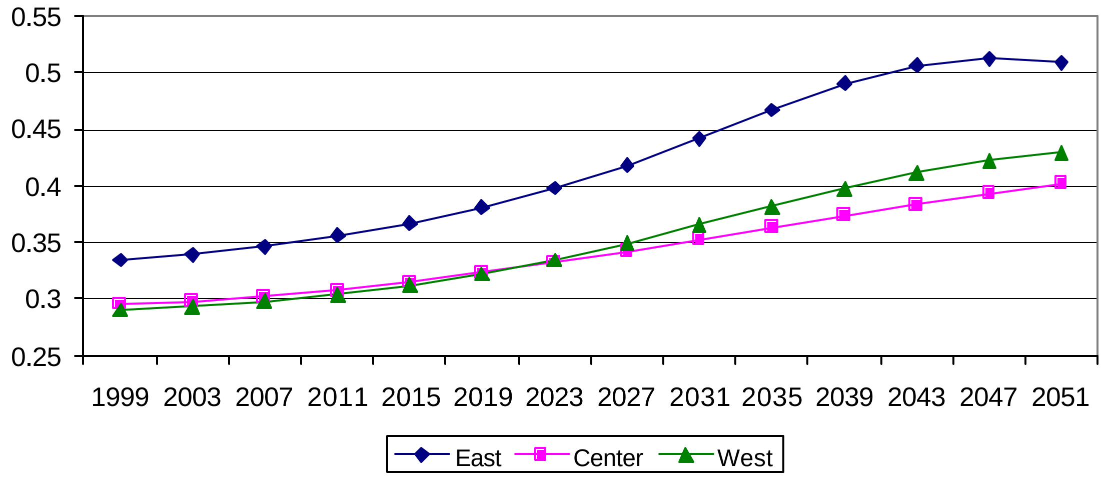
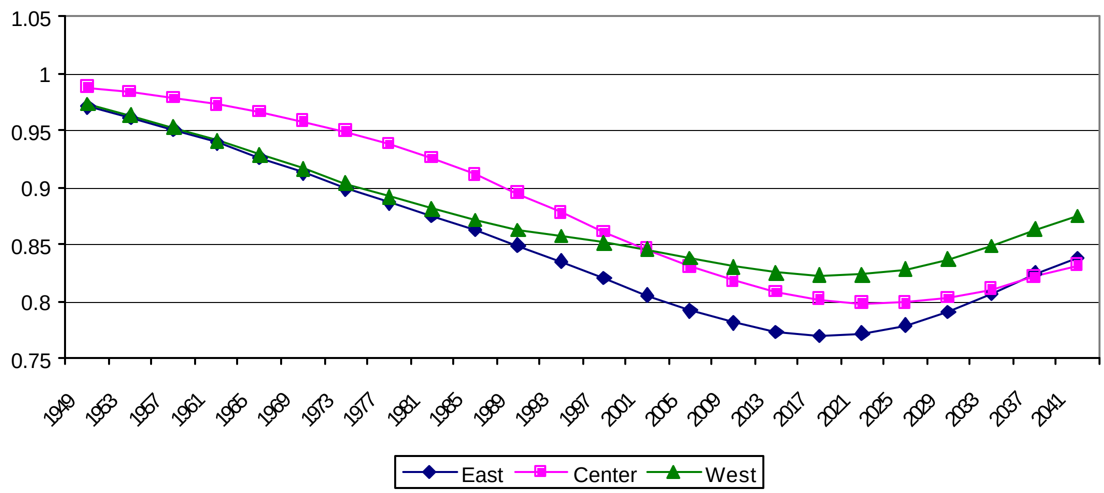



Figure 12 **Welfare Across Cohorts**




Next, we investigate the sensitivity of the results to the inter-regional elasticity of substitution for goods and investment. A lower value of elasticity increase the degree of differentiation of the goods produced by each region. Hence it does strenghtened the positive terms of trade effect that occurs in the region most affected by population aging (East). Figure 13 showes that with elasticity for consumption and investment of 4.5 rather than the baseline value of 7.5, the dynamic path of the output value per capita in the East region remains above the one for the Center region over the entire horizon covered in the figure. This is an example where terms of trade effects dominate other factors (like health care) that tend to localize population aging consequences. In contrast, a higher value of elasticity implies greater inter-regional substition in the demand for goods. Regional goods are thus less differentiated. In such a case, local population aging process is less exportable to other regions and the economic effects would differ more among regions. The differences in output value across regions shown in Figure 14 are greater than those obtained in the baseline scenario as illustrated in Figure 8.

Figure 13 **Output Value Per Capita, Low Inter-Regional Substitution Elasticity**

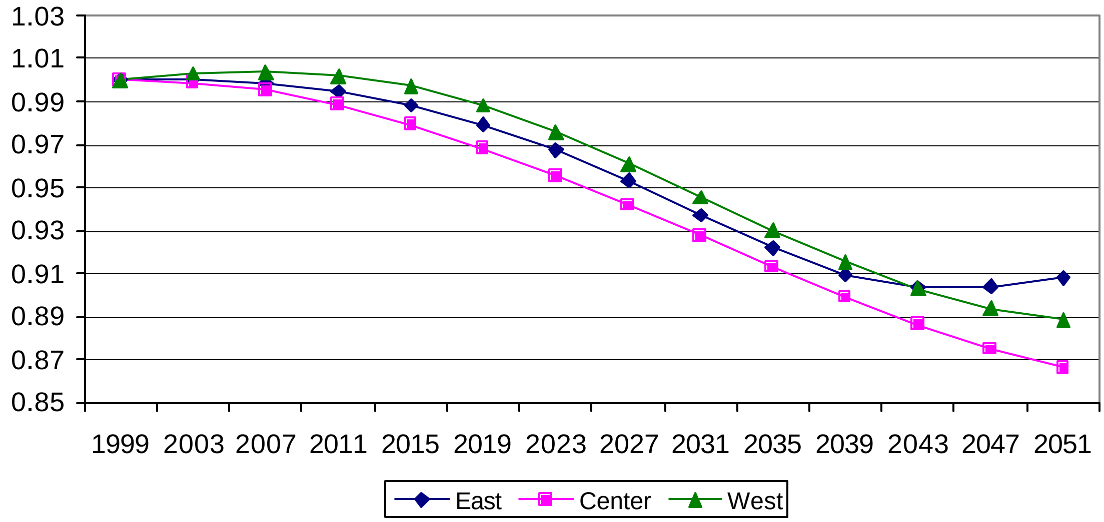
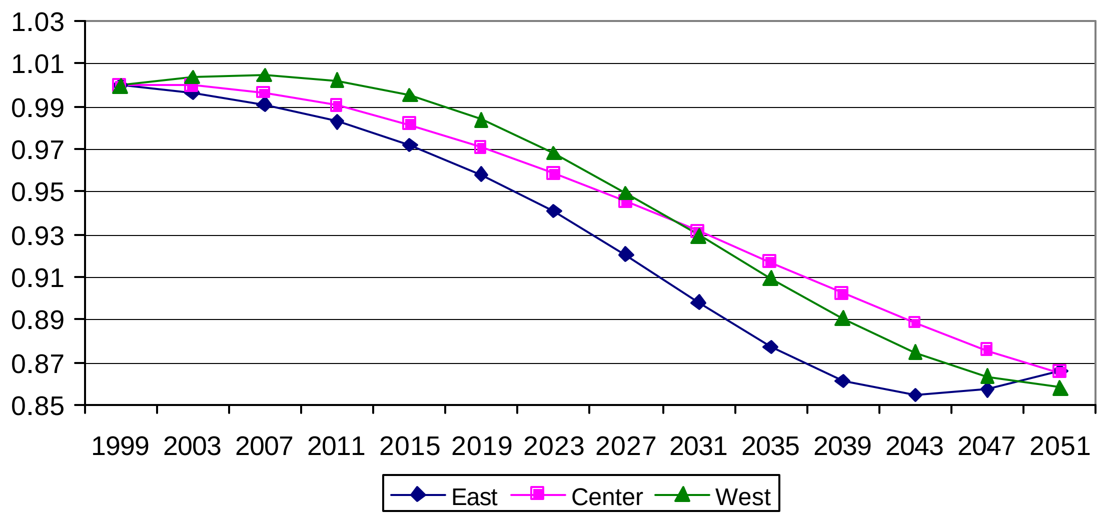



Figure 14 **Output Value Per Capita, High Inter-Regional Substitution Elasticity**



# 7. Conclusion

This paper has made a technological breakthrough by succeeding in modelling a multi-good multi-region overlapping generations model. Moreover, the model built is flexible enough to introduce other regions, more economic sectors, consumption patterns sensitive to age, and more sophisticated labour market features.

In its first application to the case of population aging in Canada, the simulation experiment demonstrates that flexible output prices, plus free trade and integrated financial market compensate somewhat for factors that localize population aging economic effects (like health care cost). The next step will be to extend the model by introducing more Canadian regions and the United States or the Rest of the World. With the presence of a region representing outside Canada, relative regional output prices may be dictated by outside rather than inside population aging development. If this is the case, economic effects of population aging have to be expected be more local than those obtained in this paper and will thus increase inequality across Canadian regions.

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