

Effects of Population Ageing on Immigration

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ABSTRACT

It is projected that most developed countries will experience population ageing in the next several decades. How will population ageing affect the economy? Immigration is also a recurrent phenomenon in the world. In fact, millions of workers in developing countries migrate to industrial countries every year. How does immigration affect the economies, especially those of ageing countries? What kind of relationship exists between population ageing and immigration? We intend to investigate these questions in this paper, using a dynamic overlapping generations general equilibrium framework. Two hypothetical regions are assumed identical in every respect except for the demographic composition. Our simulation result provides us some evidence that immigration may generate benefits to the ageing regions, and population ageing is likely to stimulate immigration.

¹ I would like to thank professor Marcel Mérette for giving me the support and guidance.

1. Introduction

In this paper, we intend to investigate the potential relationship between population ageing and immigration. Demographic projections indicate that most industrial countries will face population ageing. As the upcoming demographic change is substantial, the economic impact may be important. We discuss it in Section 2.

Many countries may be tempted to turn to immigration to offset somewhat ageing. Already immigrants represent in many developed countries the main source of population growth. Canada is no exception as it has increasingly turned to immigration as a source of skills and knowledge. Census data show that immigrants who landed in Canada during the 1990s, and who were in the labor force in 2001, represented almost 70 percent of the total growth of the labor force over the decade. If current immigration rates continue, it is possible that immigration could account for virtually all labor force growth by 2011. In section 3, we review briefly the literature on the economic implications of immigration.

In the Section 4, we discuss the potential relationship between population ageing and immigration. In section 5, we describe a stylized computable general equilibrium model that comprises two regions, Canada (CAN) and the rest-of-the-world (RoW). We intend to use this model to analyze the economic implication of ageing and the potential role of immigration in this context.

Section 6 describes the data and calibration procedures of the model, and reports the simulation results. There are three scenarios in our simulation experiment according to three different demographic shocks. In the first scenario, we impose a symmetric demographic shock with identical population growth rates across regions. An asymmetric shock is imposed in the second scenario. Canada still experiences ageing, while the RoW has a constant population. In the third scenario, we impose the asymmetric shock with immigration. To analyze the effect of immigration on the ageing economy, we compare the second and third scenario. A conclusion is given in Section 7.

The results of this paper suggest some negative effects of population ageing on the economy, such as scarce labor supply, heavier fiscal burden, higher tax rate, and slower growth on output per capita. The paper also demonstrates the positive effects of immigration on welfare of natives, and on the whole economy. So the ageing countries may be willing to attract more immigrants in the context of ageing. Moreover, the higher wage rate in ageing country may stimulate the workers to migrate, which provide us another evidence that ageing may spur immigration.

2. Economic Impact of Ageing

Demographic Trends

It is well known that the composition of the population of the world will undertake a far-reaching transformation, especially in industrial countries. The demographic projections indicate that the population of the OECD countries will

experience ageing. The major reason is that the “baby boom ” generation (those born in the two decades after 2nd World War) is moving through the age structure, and heading for retirement in the coming several decades. Another reason is the better living condition, which makes people living longer. In addition, rates of fertility have remained at low levels for the past 30 years. As a result, fewer young people are entering the working-age population to replace individuals in the age group nearing retirement. In 2001, there is a ratio of 3.447 of individuals aged 20 to 34 in the labor force for every participant aged 55 and over for OECD countries, down from a ratio of 6.197 in 1981.² Consequently, the old age dependency ratio is expected to rise dramatically. The population ageing, as a worldwide phenomenon, does not only concern developed countries, but is also projected in the developing countries. However, the difference between the proportion of elderly in the developed and developing countries will widen. So the annual labor –force have began to decline, and the decline trend will continue. As estimated and projected by the OECD, the average annual labor-force growth rate was 6.29 percent in the 1960s’, and 3.59, 3.05, 2.66 percent in 1970s’, 1980s’ and 1990s’ respectively.³

The consequence of population ageing in the industrial countries

With a decline in the growth rate of population, and higher elderly dependency

²The data from website of OECD, Labour Market Statistics-DATA
http://www1.oecd.org/scripts/cde/queryScreen.asp?DSET=CDELFS_C1T02_3D&SETNAME=LFS+by+sex+and+age&DBASE=LFS_DATA&EMAIL=&DBNAME=Labour+Market+Statistics+%2D+DATA

³ Data from the website of OECD, Labour-Market-Statistics Data
<http://www1.oecd.org/scripts/cde/members/lfsdataauthenticate.asp>

ratio, the labor force has and will become smaller and smaller. Even if nations succeed in encouraging female and old workers (65-75 years old) to participate in the labor market, it would not prevent labor force from declining. The average age of the labor force rose from 37.1 years in 1991 to 39.0 years in 2001 in Canada. By the end of the last decade, 15 percent of the labor force was within 10 years of retirement age. By 2011, when almost one fifth of the baby-boom generation will be at least 61 years of age, the potential exists for shortages in certain occupations.⁴ Most individuals follow this typical life-cycle pattern: young people prefer to invest time and money in human capital, such as formal education and training; the individual who is in the middle age prefers to work a lot, and accumulate for the future; the elderly has a stronger preference for leisure and consumption of health-care services. So an increasing private saving rate is expected while the baby born generation is of working age, and a decrease one when these individuals retire. Population aging is thus expected to lead to a lower private savings rate. Since population ageing will affect most industrialized countries, reduction in supply of saving may lead the interest rate to rise in some large economies like the United States and the European Union. Subsequently, this may push the world interest rate up.

As the baby boom generation enters retirement age and the proportion of elderly increases, the government will spend more on health-care services and public pension benefits. The ratio of the number of pension and health care beneficiaries to the

⁴ Data from the report in Canada Census 2001

contributors is pushed up. Fougère and Mérette (2000) estimate that the health care spending in Canada will increase by 2.4 percent of GDP between 1994 and 2050. Moreover, the decreasing proportion of working age population is expected to erode the overall tax base of the government. To solve the financial problem, the government may be forced to raise distorting tax and/or issue more public debt, which may pull the real potential output growth rate down.

Moreover, the rate of industrial innovation and creation may decline as older workers become less willing to take risk as they are less entrepreneurial, which may draw the output per worker and output per capita down. On the other hand, it may also be believed that labor scarcity might stimulate the innovation and technical development to replace labor. Or population ageing may urge people to invest more in human capital. Both possibilities would increase economic growth in the long run.⁵

3. Economic Impact of Immigration.

From a positive theory approach, the main goal of immigration policy should be to increase the national income accruing to natives. The OECD countries prefer to attract some working age people to their countries, especially young skilled workers, for it is widely believed that by increasing the labor force, they create wealth, and alleviate the fiscal burden of these countries. In what follows, we analyze the

⁵ See Mérette (2002)

impact of immigration on host countries' economy.

3.1 Impact on social welfare

To judge whether the immigration policy works, one important criterion may be the behavior of immigrants with respect to welfare programs. If a country has a high immigrant participation rate in welfare programs, the cost of integrating immigrants may be larger than the benefit. In other words, unsuccessful immigration may push an upward pressure on nation's fiscal burden. Borjas (1994) used the 1970, 1980, 1990 Public Use Samples of the U.S. Census to trace the evolution of immigrant participation in welfare programs. He found that there is a rising trend of immigrant participation in welfare programs. By 1990, immigrant households received a disproportionately high share of the cash benefits distributed in the United States. Even though only 8.4 percent of the households are foreign-born, these households accounted for 10.1 percent of all households that received public assistance, and for 13.1 percent of the total cash assistance distributed. He argues that the rising participation in welfare program results from a decline in immigrant skills and using the data illustrate the huge differences in the education attainment and earnings across nation origin groups in 1990 (e.g. Mexico immigrants, with a low average skill level, have a high participation in welfare programs.) Since the low and unskilled workers tend to participate in public assistance programs, the deteriorating skill composition of the immigrant flow has increased the fiscal costs of immigration substantially in U.S. In general, natives benefit from immigration

mainly because of production complementarities between immigrant workers and other factors of production, and these benefits are larger when immigrants are sufficiently different from the stock of native productive inputs. So the supply of visas is determined by the political and economic gains from the immigration. There will be differential benefits from admitting high or low skilled immigrant flows, which depends on the skill composition of the native labor force and generosity of social insurance programs.

3.2 Impact on labor market

Michalowski (1993) argues that immigration has a substantial influence on the size and growth of the population and the labor force in Canada. Over the period 1991-2001, immigrants amounted to 38 percent of the total additions to the population, almost 70 percent of the total growth of the labor force. Although it is impossible to use immigration to prevent an increase in the population aged 65 and over, it is possible to lower the old age dependency ratio through attracting working-aged immigrants. Crompton and Vickers (2000) show that the periods of most rapid labor force growth were the periods of high immigration. The growth of labor force in Canada has been 1.2 percent per year in 1991-2001 (Statistics Canada, 2001b), the average age of the labor force starts to increase from 1986 when the baby boom begin to move out from working ages. Denton, Feaver and Spencer (2001), in their "what if" scenario with no immigration since 1951, show that the labor force would have been almost 30 percent smaller in 2001 if there had been no migration. On the other

hand, the median age of the labor force would only have been 0.4 years older than its actual 2001 average age of 38.9 years.

As host countries attract immigrants to increase the labor force, it is interesting to learn whether immigration has an adverse impact or not on native earnings and employment opportunities. If the arrival in the labor market of one immigrant with given character to a host country leads to one native with same character to exit, immigration has no real positive effect on the economy of the host country. Wright, Ellis, Reibel (1997) and Butcher and Card (1991) find only very modest harm effect on job opportunities of natives. The estimates from these studies suggest that a 10 percent increase in the fraction of immigrants lowers native wages by no more than 1 percent.

Altonji and Card (1991) test a hypothesis that the employment opportunities of U.S.-born workers are strongly and adversely affected by immigration, which cannot be supported by the test result. Moreover, Velling (1994) and Hunt (1992) get similar evidences for German and French labor market respectively. There is thus little evidence to suggest that immigration has adverse effect on native employment.

3.3 Impact on fiscal balances

The inflow of immigrants is important in many host countries, e.g. 250,000 per year in Canada and about 1.1 million per year in U.S. Also immigrants are now younger than natives and have a wider distribution of skills. If workers start to work and pay taxes immediately after migration, the net fiscal effects are likely to be large

and positive, even when the gains are traded off with the subsequent costs of retirement. For instance, Gustman and Steinmeier (1998) show, using data from a survey, that immigrants have, on average, provided a positive net contribution to social security in U.S.

Storesletten (2000) stimulates a situation without fiscal reform, under which he computes the net government gain, in present value terms, of admitting one additional immigrant, conditional on skills and age at the time of immigration. The finding of the analysis illustrates that high- and medium-skilled working-age immigrants are preferable for the case of U.S.

4. Impact of Ageing on immigration

As I mentioned in part 2, many industrial countries will face the economic challenge of population ageing, which may inflict huge pressure on nation's fiscal policy. Governments of those countries hope they could solve in part the fiscal and economic challenges by making an appropriate immigration policy via increasing national income of natives. It is relevant to discuss how immigration policy and economic conditions stimulate migration.

4.1 Why people migrate?

Distribution of income between poor and rich countries

The fact that people in the relatively poor country migrate to the rich country is a worldwide phenomenon. That flow is just like the heat energy always flowing from the high-temperature part to the low-temperature part of an iron pole. No flow

occurs if the temperature is the same. Before discussing the issue of “why people have incentive to migrate”, we should investigate the distribution of income between poor and rich countries, so that we could understand better the motivations to migrate.

Jones (1997) uses a standard growth model to forecast the near-term income distribution. The results indicate that the distribution of GDP per worker has changed during 30 years after the Second World War, and that the near-term income distribution looks broadly like the current distribution. We replicate a figure (See appendix) that plots the density of GDP per worker relative to the United States in 1960 and 1988 for 121 countries. Some features deserve comment. The 1960 distribution looks like a normal distribution, but with a big right tail. But the 1980 distribution becomes a “twin-peaks” distribution, with a large right peak and a smaller one on the left. This change reflects a shift in the mass of the distribution away from the middle and toward the ends. From that, we could see income growth is a common feature around the world. Most countries made a progress on the value of “GDP per worker”. The author divides the sample into 2 groups by author. One consists of the countries with GDP per worker greater than about 15 percent of U.S. income in 1960. Other countries with very low GDP per worker (less than 15 percent of U.S.) build up the second group. The relative incomes of the countries in the first group generally increase, but with different growth rates. For example, the relative incomes of Hong Kong and Japan increased from 20 percent of U.S. GDP per worker in 1960 to about 60 percent in 1988. Botswana’s relative income grew from

5 percent to 20 percent. But the relative incomes of the countries in second group generally decreased.

Three factors work together to determine the countries' future positions in the distribution: investment rates, population growth rates, and relative technology level. Even if their average growth rate may be faster in some periods and slower in others, all countries are likely to share the same growth rate in the long run. But it does not mean poorest countries will catch up with the rich ones in the short term. Instead, countries that have grown faster than the United States over the 28-year period are predicted to continue to increase relative to the United States; countries that have grown more slowly are predicted to continue to fall. The clear implication is that once countries make it out of the lowest income categories, significant upward movements in the income distribution are much more common than large downward movements. For those poorest countries, it is more difficult to break away from their bad situations. If there is no policy change, no growth miracles will happen in these poorest countries. Indeed, growth miracles and disasters existed in history. They might happen in the future, but the probability is low. The above findings are also supported by Lucas (2000). He argues that growth in income per person has taken place very unevenly: An economy that begins to grow at any date after 1800 grows at a rate, which is the same as the growth rate of the leader, plus a term that is proportional to the percentage income gap between itself and the leader. It seems that it takes a long period of time to eliminate or even reduce any gap of income

across countries. This implies that the actual observable gap across countries will persist in the coming several decades.

4.2 Is population ageing in industrial countries going to increase the incentives of individuals in poor countries to migrate?

Since most industrial countries will experience population-ageing, demand of immigration, to some extent, may increase. For workers in poor countries, is it a rational choice to migrate to those industrial countries? Is population ageing in industrial countries going to increase the incentive for individuals in poor countries to migrate? These two questions are key points to be discussed.

Skill differential, cost differential and living standard differentials are among the factors that determine the incentive to migrate. Differences exist between the wages of high skilled and low skilled workers within each country. All else the same, the skill difference reflects the return to human capital and the degree of inequality in the wage structure. Another indicator may be the ratio of the wages of workers in the same occupation but across the countries measured in a common currency through exchange rates. All else the same, this cost differential reflects the different cost of producing goods with these workers. The different wage levels, however, is not the only thing to be considered. An important factor is the difference in the living standards, the utility and happiness that workers perceive as achievable in industrial and poor countries.

In order to examine the pattern of pay across occupations and countries, Freeman and Oostendorp (2000), transform a survey of wages conducted by the International Labor Organization into a consistent data file on Pay for 161 occupations in over 150 countries from 1983 to 1998. From the analysis on the new files, they find that the skill differential vary inversely with gross domestic product per capita. During the 1980s to 1990s, the differential fell modestly in advanced countries; fell more sharply in upper middle income countries while rising markedly in countries moving from communism to free markets and in lower middle-income countries. Moreover, wages in the same occupation vary greatly across countries when measured by common currency exchange rates using purchasing power parity. Cross-country differences in pay for comparable work have increased over time, despite the rapid expansion of world trade. The principal forces that affect the occupational wage structure around the world are the level of gross domestic product per capita and wage-setting institutions, which is obviously different between industrial and poor countries. Population ageing will result in a reduced growth of labor supply, which may lead to lower unemployment rates and an upward trend in real wage in a competitive and efficient labor market. If so, the wage differential and living standard differential may last for at least several decades. If a group of workers have low payment and low life standard in their home country, and identical productive workers in an industrial country earn more and have a better living standard, the first group might have an incentive to migrate. To a certain extent, population ageing in industrial countries may strengthen the incentive of the workers

in poor countries to migrate.

Competition between the immigrant and native workers

Since workers in poor countries may have an incentive to migrate to industrial countries, would a competition exist between the immigrant and native workers? Current wisdom says "yes". A precondition for the absence of labor-market competition between immigrants and natives is that they differ in their willingness to accept work that offers different amenities. The implications of a model embodying this assumption are that immigrants will be observed experiencing inferior workplace amenities than natives, and that the presence of immigrants will affect the amenities that natives enjoy. Hamermesh (1997) examine the possibilities of the absence of competition, then he states that observationally similar immigrants and native whites enjoy very similar packages of amenities: the precondition for non-competition between immigrants and natives does not exist. Competition exists in two forms. The direct competition is in labor market, which occurs when an immigrant takes the job of a native. The indirect competition is in the product market. The substitution between immigrants and native workers comes through product market competition between firms using native labor and those using immigrants. In a particular case, immigrants take jobs that natives do not accept, there will be no competition.

Wage disadvantage

The immigrants who are just arriving to the new country (e.g. Canada) may

lack some of the less observable skills that the native-born have—language, knowledge of the local labor market. A common result in the literature is that immigrants usually have a relative wage disadvantage at the time of entry. Ben-Porath (1967) and Chiswick (1978) develop a human capital model and they get the similar conclusion that initial human capital investments (such as becoming proficient in English) depress entry wages for immigrants, immigrants would reduce their human capital acquisitions over time, and collect the returns on earlier investments, they experience faster wage growth than natives. So the wage gap between immigrants and natives narrows over time as immigrants assimilate the host country. Borjas (1998) find that there is a positive correlation between the log entry wage of immigrants and the subsequent rate of wage growth, which suggest that immigrants with a sizable human capital endowment are also the immigrants who find it easier to adapt and acquire additional skills in their new surroundings.

The literature above suggests that it is projected that it will take long time to reduce the gap of income between poor and industrial countries. Moreover, immigrants, especially those with a sizable human capital endowment, are expected to experience faster wage growth than natives. So the individuals in poor countries have a strong incentive to migrate. Even though wage disadvantage and competition between the immigrant and native workers exist.

5. Technical Description of the Model

In this section, we describe the computable overlapping generations model. After some preliminaries, we describe the problem of the producer, of the consumer, of the investor, and the equilibrium conditions.

Preliminaries on sets and indices

There are two fully endogenous regions in the model and a reduced form residual rest-of-world indexed row in a subset denoted RoW . The set of all the regions is denoted \mathcal{I} and indexed by ii or jj ($ii = 1, \dots, \mathcal{I}$). We have $\mathcal{I} = I \cup RoW$, where I represents some OECD country say Canada.

Each region produces two goods, called good 1 and good 2. Each good is produced by a unique sector and the sector producing good s ($s = 1, 2$) is called sector s . At each period in time (time is indexed by t), there are δ generations (indexed by g , $g = 1, \dots, \delta$) that coexist. We indexed the working generations by gj ($gj = 1, \dots, 5$), the first generation by gi ($gi = 1$).

Producers s of region j at time t

In each region, there are 2 competitive sectors. Producers are assumed to be profit maximizing and each producer produces one product. The technology of production requires that the representative firm employs capital, labor and intermediate input goods from sectors across regions.

Labor and capital are homogeneous and mobile among sectors within the region. There is no inter-regional/international labor or capital mobility unless we permit migration. Therefore, the wage and rental rate, denoted by $w_{j,t}$ and $r_{j,t}^k$ respectively, are the same across sectors within a given region, but different across regions. Producers behave as price takers on products and primary inputs. When producers make the production decision, they minimize the total costs of producing good s in amount $Z_{j,s,t}$. Therefore they solve the following problem:

$$(1) \quad \underset{XS_{ss,j,s,t}, K_{j,s,t}^{dem}, L_{j,s,t}^{dem}}{\text{Minimize}} \sum_{ss} P_{j,ss,t}^c XS_{ss,j,s,t} + r_{j,t}^k K_{j,s,t}^{dem} + w_{j,t} L_{j,s,t}^{dem}$$

subject to the following set of embedded constraints that characterize the firm's technology:

$$(2) \quad Z_{j,s,t} = CD(X_{j,s,t}, Q_{j,s,t}; Sc_{j,s,t}^Z, \alpha_{j,s}^Q) \quad (P_{j,s,t})$$

$$(3) \quad X_{j,s,t} = CES(XS_{ss,j,s,t}; \alpha_{ss,j,s}^{XS}, \sigma_{j,s}^X) \quad (P_{j,s,t}^X)$$

$$(4) \quad Q_{j,s,t} = CD(K_{j,s,t}^{dem}, L_{j,s,t}^{dem}; Sc_{j,s,t}^Q, \alpha_{j,s}^K) \quad (P_{j,s,t}^Q)$$

We use $CD(., Sc, \alpha)$, as for the Cobb-Douglas form, parameterized by the scaling parameter Sc and the expenditure shares α , and $CES(., \alpha, \sigma)$, as for a constant-elasticity-of-substitution form with share parameters α and substitution elasticity σ . $Z_{j,s,t}$ denotes the amount of good s produced by sector s in region j at time t ; $X_{j,s,t}$ requires combining, in fixed expenditure shares, aggregate intermediate input and value added in amount $X_{j,s,t}$ and $Q_{j,s,t}$; $XS_{ss,j,s,t}$ denotes the amount of intermediate inputs purchased by sector s (to produce good s) of region j from sector ss at time t ; $K_{j,s,t}^{dem}$ denotes capital demanded by sector s in region j at time t ; $L_{j,s,t}^{dem}$ denotes quantity of labor demanded by sector s in region j at time t ;

$P_{j,ss,t}^c$ denotes average price for goods ss produced in region j at time t .

Household of region j at time t

An Allais-Samuelson overlapping generations framework characterizes households, so that the model is based on the life-cycle theory of saving behavior. Each individual lives for six periods of ten years, retiring after five periods. In each period the oldest generation dies and a new generation enters the labor force, which implies that at any point in time six generations are alive. The working life starts at the age of 15; younger children are assumed to be fully dependent on their parents to which they constitute no extra burden nor provide any felicity. Perfect foresight individuals retire from the labor market at the age of 64 and die at age 74. Production, exchange and payments are assumed made at the end of each period. A newborn individual's problem consists of, in a first step, choosing consumption levels and bequest that maximize its inter-temporal utility subject to a lifetime budget constraint. The utility function is time-separable and of the constant elasticity of substitution type:

$$(5) U_{j,t} = \frac{1}{1-\theta} \sum_{g=1}^6 [1+\rho]^g (C_{j,g,t+g-1}^{1-\theta} + \beta_g^\theta Beq_{j,g,t+g-1}^{1-\theta})$$

$$\theta > 0, \quad \beta_{g \neq 6} = 0, \quad \beta_{g=6} > 0,$$

Where $C_{j,g,t}$ denotes consumption of an individual living in region j of age group g at time t ; ρ denotes pure rate of time preference; θ denotes inverse of inter-temporal elasticity of substitution; β_g denotes constant parameter; $Beq_{j,g,t}$ denotes bequests (in real terms) of an individual living in region j of age group g at time t .

This equation states that the welfare of an individual is a weighted sum of 6 periods of consumption from age group $g=1$ at period t to age group $g=6$ at $t+5$, plus the (positive) utility of bequest for $g=6$ in period $t+5$. Leisure does not enter into the utility function since individual's labor supply is assumed to be exogenous. The bequest specification follows Blinder (1974) and gives rise to inter-generational transfers in addition to public old-age pension benefits. This specification of the utility function implies that the felicity from bequest is independent of the present value of cash receipts extending beyond the death of the current generation.

Assuming no-borrowing constraints and perfect capital markets, the present value of household wealth, is the discounted sum of lifetime labor income $LInc_{j,g,t}$, public old-age pensions $Pens_{j,g,t}$ and inheritance $Inh_{j,g,t}$:

$$(6) \quad W_{j,t} = \sum_{g=1}^6 \left[1 + r_{t+g-1} (1 - \tau^K) \right]^{-g} \left(LInc_{j,g,t+g-1} (1 - \tau_{j,t+g-1}^w - \tau_{t+g-1}^p) \right. \\ \left. + (1 - \tau_{j,t+g-1}^w) (Inh_{j,g,t+g-1} + Pens_{j,g,t+g-1}) \right)$$

Where r_t is the rate of interest at time t , τ^K and τ^w are the tax rates on capital and labor income respectively, and τ^p is the contribution rate on the pay-as-you-go public pension program.

Labor income depends on the individual's age-dependent productivity (earnings) profile. In this model the earnings profile is assumed to be identical across region. To be more precise, the earnings profile (EP_g) is a quadratic function of age (g) with parametric values chosen to ensure that the maximum is reached between

mid-life and retirement:

$$(7) \quad EP_g = \gamma + \lambda g - \varphi g^2, \quad \gamma, \lambda, \varphi \geq 0,$$

Pension benefits of the retirees (generation 6) are proportional to their lifetime labor earnings. The fraction is determined by the pension replacement rate $PensR_j$ that applies identically everywhere within the country. Pension benefits are thus equal to:

$$(8) \quad Pens_{j,6,t} = PensR_j \frac{1}{5} \sum_{gj} LInc_{j,gj,t-6+gj}$$

Bequests are distributed at the end of each generation's lifetime (generation 6), equally across working generations gj as inheritances:

$$(9) \quad Inh_{j,gj,t} Pop_{j,gj,t} = \frac{1}{5} P_{j,6,t}^{Con} Beq_{j,6,t} Pop_{j,6,t}$$

where $Pop_{j,g,t}$ denotes the number of people living in region j of age group g at period t . Note that $Inh_{j,gj,t}$ is defined in current prices.

Differentiating the household utility function with respect to individual's lifetime budget constraint yields the following first-order-conditions for consumption and bequests:

$$(10) \quad C_{j,g+1,t+g} = \left[\frac{1+r_{t+g}(1-\tau^K)}{1+\rho_j} \quad \frac{P_{j,g,t+g-1}^{Con}}{P_{j,g+1,t+g}^{Con}} \right]^{(1/\theta)} C_{j,g,t+g-1}$$

$$(11) \quad Beq_{j,g,t} = \beta_g C_{j,g,t}$$

In a second optimization step, households must allocate their consumption expenditures between the available final goods s ; the preferences of the households in region j with respect to good s are represented by a constant elasticity of substitution function (CES). The optimal composition of its consumption basket in terms of different goods is given by the solution of the following optimization problem:

$$(12) \quad \underset{ConS_{j,s,g,t}}{\text{Maximize}} C_{j,g,t} = \left[\sum_s \epsilon_{j,s,g}^{ConS} ConS_{j,s,g,t} \frac{\sigma_{j,g}^{Con-1}}{\sigma_{j,g}^{Con}} \right]^{\frac{\sigma_{j,g}^{Con}}{\sigma_{j,g}^{Con}-1}}$$

subject to:

$$(13) \quad P_{j,g,t}^{Con} C_{j,g,t} = \sum_s P_{j,s,t}^c ConS_{j,s,g,t}$$

The first order conditions impose that:

$$(14) \quad \left\{ \begin{array}{l} P_{j,g,t}^{Con} {}^{1-\sigma_{j,g}^{Con}} = \sum_s \alpha_{j,s,g}^{ConS} P_{j,s,t}^c {}^{1-\sigma_{j,g}^{Con}} \\ ConS_{j,s,g,t} = \alpha_{j,s,g}^{ConS} \left[\frac{P_{j,s,t}^{Con}}{P_{j,s,t}^c} \right]^{\sigma_{j,g}^{Con}} C_{j,g,t} \end{array} \right.$$

The parameter $\alpha_{j,s,g}^{ConS}$ represents the preference of residents of region j for good s ,

and $\sigma_{j,g}^{Con}$ is the consumption elasticity of substitution. Note that, because the composition of consumption baskets varies across generations - for instance, older generations consume more health services than young ones, but the young consume more education - the aggregate consumer price index is generation dependent.

Households in region j invest in physical capital $Kij_{i,j,g,t}$ and in bonds

$Bij_{i,j,g,t}$ issued by firms and regional governments. Because we assume that all assets are perfect substitutes and traded on fully integrated international markets, the composition of household's wealth is however without consequence, except on impact after an unexpected shock.

Investors of region j at time t

Capital goods are built using an investment technology that also allows for substitution between different market goods and investors have to solve the following problem to choose the optimal constituting mix:

$$(16) \quad \underset{InvS_{j,s,t}}{\text{Maximize}} P_{j,t}^{Inv} Inv_{j,t} = \sum_s P_{j,s,t}^c InvS_{j,s,t}$$

subject to:

$$(17) \quad Inv_{j,t} = \left[\sum_s \epsilon_{j,s}^{InvS} InvS_{j,s,t} \frac{\sigma_j^{Inv-1}}{\sigma_j^{Inv}} \right]$$

The problem above leads to following first-order conditions:

$$(18) \quad P_{j,t}^{Inv} {}^{1-\sigma_j^{Inv}} = \sum_s \alpha_{j,s}^{InvS} P_{j,s,t}^c {}^{1-\sigma_j^{Inv}}$$

$$(19) \quad InvS_{j,s,t} = \alpha_{j,s}^{InvS} \left[\frac{P_{j,t}^{Inv}}{P_{j,s,t}^c} \right]^{\sigma_j^{Inv}} Inv_{j,t}$$

where $\alpha_{j,s}^{InvS}$ is a parameter of the CES investment technology and α_j^{Inv} is the corresponding elasticity of substitution.

The regional stock of physical capital broadens with investment $Inv_{j,t}$ but narrows with depreciation at a constant rate $DepR_j$:

$$(20) \quad Kstock_{j,t+1} = Inv_{j,t} + (1 - DepR_j) Kstock_{j,t}$$

The one period expected rate of return on a unit of physical capital bought at time $t-1$, denoted $r_{j,t}^e$, is then defined by the following expression:

$$(21) \quad RRet_{j,t} = \frac{Rent_{j,t} + (1 - DepR_j) P_{j,t}^{Inv}}{P_{j,t-1}^{Inv}}$$

The government of region j at time t

Regional government taxes labor income, capital income and consumption expenditure. Its spending includes government consumption $Gov_{j,t}$, and debt interest payments. Government consumption spending is allocated across sectors using a CES aggregator.

$$(22) \quad P_{j,t}^{Gov^{1-\sigma_j^{Gov}}} = \sum_s \alpha_{j,s}^{GovS} P_{j,s,t}^c{}^{1-\sigma_j^{Gov}}$$

$$(23) \quad GovS_{j,s,t} = \alpha_{j,s}^{GovS} \left[\frac{P_{j,t}^{Gov}}{P_{j,s,t}^c} \right]^{\sigma_j^{Gov}} Gov_{j,t} ,$$

The share parameter α denotes the proportion of regional government spending on good s to total government spending in region j at time t . When the price of good s in region j at time t increases, government spending for good s in region j at time t declines.

To satisfy its budget constraint when tax revenues come short of expenditures, the government issues new bonds. Accordingly, the budget constraint of the government is:

$$(24) \quad P_{j,t}^{Gov} Bond_{j,t+1} + \sum_g Pop_{j,g,t} \left\{ \tau_{j,t}^w (LInc_{j,g,t} + Pens_{j,g,t}) + \tau_{j,t}^{Con} P_{j,t}^{Con} C_{j,g,t} + \right. \\ \left. \tau_{j,t}^K \sum_i \left[\frac{r_{i,t-1}^J P_{i,t}^{Gov}}{P_{i,t-1}^{Gov}} - 1 \right] P_{i,t-1}^{Gov} Bij_{i,j,g,t} + \tau_{j,t}^K \sum_i (r_{i,t-1}^e - 1) P_{i,t-1}^{inv} Kij_{i,j,g,t} \right\} \\ = P_{j,t}^{Gov} Gov_{j,t} + \left[\frac{r_{i,t-1}^J P_{j,t}^{Gov}}{P_{j,t-1}^{Gov}} \right] P_{j,t-1}^{Gov} Bond_{j,t}$$

We can see the total value of new bonds issued at time $t+1$ and all the tax revenues at time t , which is on the left side of this equation. On the right side of the equation, that is the value of government consumption plus debt interest payments.

Pay-as-you-go pension benefits are financed by contribution rates on wage earnings. With population ageing, the contribution rate is expected to rise. The program is nation-wide:

$$(25) \quad \sum_j Pop_{j,g,m,t} Pens_{j,g,m,t} = \tau_t^p \sum_j \sum_{g'} Pop_{j,g',t} LInc_{j,g',t}$$

Region J's foreign trade in goods at time t

All agents with region j make use of a composite good indexed s , which is

priced at $P_{j,s,t}^c$. The aggregate demand for a specific good is the sum of all individual demands, including the intermediate good input demand, the consumption of the population, the investment and the government spending:

$$(26) \sum_{ss} XS_{s,j,ss,t} + \sum_g Pop_{j,t,g} Cons_{j,s,g,t} + InvS_{j,s,t} + GovS_{j,s,t}$$

Where j here represents the region of Canada. The traditional Armington assumption is used to allocate this demand between regions. That is, even though individual producers are microscopic price takers, goods of sector s are assumed differentiated in demand by their geographic origin. A fictitious importer accordingly chooses the optimal basket of domestic and interregional / international goods in each sector, assuming a CES ($E_{ii,j,s,t}$; $\alpha_{ii,j,s}^E, \sigma_{j,s}^E$) aggregator. The price $P_{j,s,t}^c$ can then be expressed as a function of each supplying region's producer price $P_{j,s,t}$

$$(27) P_{j,s,t}^c \quad {}^{1-\sigma_{j,s}^E} = \sum_{ii} \alpha_{ii,j,s}^E P_{ii,s,t} \quad {}^{1-\sigma_{j,s}^E}, \quad \alpha_{ii,j,s}^E = \epsilon_{i,j,s}^E \sigma_{j,s}^E$$

and the associated demand system is :

$$(28) E_{ii,j,s,t} = \alpha_{ii,j,s}^E \left(\frac{P_{j,s,t}^c}{P_{ii,s,t}} \right)^{\sigma_{j,s}^E}$$

$$\left\{ \sum_{ss} XS_{s,j,ss,t} + \sum_g Pop_{j,t,g} Cons_{j,s,g,t} + InvS_{j,s,t} + GovS_{j,s,t} \right\} .$$

Where $E_{ii,j,s,t}$ denotes demand of region j for good s produced in ii at time t ;

$D_{j,s,t}$ denotes total demand in region j for good s at time t ; $P_{j,s,t}^c$ denotes aggregate

consumer price index of good s in region j at time t ; $P_{j,s,t}$ denotes price of good s

produced in region j at time t .

Equilibrium conditions

Market clearing for goods:

$$(29) \quad Z_{j,s,t} = \sum_{ii} E_{j,ii,s,t}$$

Full employment of capital:

$$(30) \quad Kstock_{j,t} = \sum_s K_{j,s,t}^{dem}$$

Fully integrated asset markets:

$$(31) \quad \frac{r_{j,t}^J P_{j,t+1}^{Gov}}{P_{j,t}^{Gov}} = r_{j,t+1}^e$$

$$(32) \quad r_t = \frac{r_{j,t}^J P_{j,t+1}^{Gov}}{P_{j,t}^{Gov}}$$

This completes the model description. It is easy to check that the model implies asset market clearing at each t :

$$(33) \quad \sum_j \sum_g Pop_{j,g,t} Lend_{j,g+1,t+1} = \sum_j P_{j,t}^{Gov} Bond_{j,t+1} + P_{j,t}^{Inv} Kstock_{j,t+1}$$

Prices of the rest of the world are chosen as numeraire. A static version of the model is easily found by setting $t-1 = t = t+1$ in all equations.

6. Simulation Results

Values of parameters and Calibration

This model comprises two regions: “Canada” (CAN) and the Rest-of-the-World (RoW). There are two production sectors and six generations in each region. Here we report some important parameter values in Table R1. The value of the inter-temporal elasticity of substitution $1/\theta$ is 1.50. Inter-regional elasticities of substitution for consumption, investment and government are all assumed equal to 2.5. The pension replacement rate ($PensR_j$) was set to 0.50, the bequest parameter (β_g) to 0.50 whereas the inheritance rate ($InhR$) equals 0.20 as private bequests are assumed equally distributed among the five working age generations. The elasticity of substitution for intermediate goods ($\sigma_{j,s}^X$) is set equal to 3.00, also in all regions and for all sectors. The labor demand substitution elasticity equals 1.50. The calibrated annual interest rate (r_t) equals 1.4 percent. Finally, the calibrated depreciation rate ($DepR_j$) equals 0.3 percent⁶.

Table R1

$\frac{1}{\theta}$	1.50	σ_j^{Gov}	2.50
$\sigma_{j,g}^{Con}$	2.50	σ_j^{Inv}	2.50
$PensR_j$	0.50	β_g	0.50
$InhR$	0.20	$\sigma_{j,s}^X$	3.00
r_t	0.014	$\sigma_{j,s}^E$	1.50
$DepR_j$	0.003		

⁶ The values of parameters are the same than those taken by Mercenier, Jean and Mérette, Marcel 2002: “*The Microeconomic Impact of Ageing on Industrial Sectors and Occupations in Canad,*”

Simulation Analysis

Our aim is to analyze the economic impacts of ageing and immigration, and find the relationship between those two phenomena, either of which can lead to a change in labor supply. As labor is a factor of production, producers will change their production plan by finding optimal labor and capital demand, as well as amount and price of productions. When the age structure changes, households are more likely to change their economic behaviors, such as consumption, saving and investment, which is based on life-cycle theory. Population ageing impose important implications on government behavior. We solve the model under equilibrium conditions, and try to find some answers for our issues.

In this section, we experiment three different shocks to the world's economy, and then estimate and analyze the effects of population ageing and immigration on the economy. As we have mentioned, many countries will experience population ageing not only because the baby boom generation is moving through the age structure, and heading for retirement in the coming several decades, but also because the rates of fertility have remained at low levels for the past 30 years. It is assumed in the simulation experiment that "Canada" faces the same demographic trend in all three scenarios as described in Table R2. In the first two periods, the population growth rate of Canada is very high, which illustrates the "baby boom" after the 2nd World War. Then the growth rate slows down, but remains larger than 1 until 1995. Then we impose a negative population growth trend for the following several periods to

generate an ageing process. The population after 2045 is assumed to be constant. In the table R1 below, we report the old age dependency ratios (OADR) in the thirteen periods of the model. The model contains six overlapping generations representing the age groups: 15-24, 25-34, 35-44, 45-54, 55-64, and 65-74. The OADR consists of the number of individuals who are members of the last age group over the number of individuals belonging to the first five age groups.

Table R2 Old age dependency ratio and Percent Changes of population growth rate with respect to initial population

Time	1955	1965	1975	1985	1995	2005	2015	2025	2035	2045	2055	2065	2075
G.rate	2.00%	4.04%	6.12%	4.00%	1.92%	-0.12%	-2.12%	-2.12%	-2.12%	0.00%	0.00%	0.00%	0.00%
OD-Ratio	19.53%	18.63%	17.37%	16.59%	16.23%	18.56%	21.67%	25.43%	23.36%	20.36%	17.34%	16.87%	19.59%

Scenario 1

In scenario 1, we introduce a symmetric demographic shock to the whole world: both Canada and the Rest-of-the-World (RoW). In other words, we assume that the rest of the world has the same demographic trend than Canada. The result of this simulation experiment is reported in Table R3. The definitions of the different acronyms are reported below.

Table R3. Old age dependence ratio and Percentage changes with respect to the initial values

Time	1955	1965	1975	1985	1995	2005	2015	2025	2035	2045	2055	2065	2075
G.rate	2.00%	4.04%	6.12%	4.00%	1.92%	-0.12%	-2.12%	-2.12%	-2.12%	0.00%	0.00%	0.00%	0.00%
Int.	0.00%	0.15%	0.38%	0.92%	1.46%	1.85%	1.85%	1.46%	1.00%	0.62%	0.38%	0.38%	0.54%
T.wage	0.00%	-1.50%	-3.50%	-5.50%	-4.00%	-0.50%	3.50%	7.00%	8.50%	10.00%	9.50%	9.50%	9.50%
Wage	0.00%	0.00%	-0.20%	-0.90%	-2.10%	-3.50%	-5.00%	-6.00%	-6.30%	-6.00%	-5.40%	-4.80%	-4.40%
InvS	-0.29%	-0.09%	1.07%	3.91%	8.40%	13.91%	17.71%	17.34%	14.29%	10.73%	7.66%	6.00%	6.00%
GovS	0.00%	0.00%	0.33%	1.35%	3.46%	6.31%	9.54%	12.74%	15.19%	16.54%	16.41%	15.52%	14.26%
Kdem	0.00%	-0.05%	-0.12%	-0.11%	0.24%	1.34%	3.46%	6.56%	9.80%	12.17%	12.81%	12.18%	10.83%
Ldem	0.00%	0.00%	0.34%	1.43%	3.74%	7.05%	10.96%	14.59%	16.96%	17.47%	16.50%	14.95%	13.37%
Output	0.00%	-0.02%	0.15%	0.79%	2.27%	4.62%	7.71%	11.03%	13.69%	14.94%	14.64%	13.49%	12.04%
Output per K	0.00%	0.03%	0.27%	0.90%	2.02%	3.23%	4.11%	4.19%	3.54%	2.47%	1.62%	1.16%	1.09%
KperW	0.00%	-0.05%	-0.46%	-1.52%	-3.37%	-5.33%	-6.76%	-7.00%	-6.12%	-4.51%	-3.17%	-2.41%	-2.25%
Dependence Ratio	19.53%	18.63%	17.37%	16.59%	16.23%	18.56%	21.67%	25.43%	23.36%	20.36%	17.34%	16.87%	19.59%

Legend

Time	Time period	T. Wage	Tax Wage
InvS	Investment	Ldem	Labor demand
G .rate	Population growth rate	Wage	Wage rate
GovS	Public expenditure	Output	Gross output (and not GDP)
Int	Rate of return	KperW	Capital per Worker
Kdem	Capital demand	Output per K	Output per capita

Since the shock is symmetric in this scenario, the values for both regions are identical as expected. The experiment proves that the model is running well. To simplify the discussion, we report the result on “Canada”. Figure R1 presents the changes of wage rate and labor demand at each time period. We split the horizon into two parts, “before experiencing Ageing” and “experiencing Ageing”, based on the changes of OADR. OADR has a relatively high value at the beginning that declines, as the whole baby boom generation (BBG) moves into the working age. Canada gets its lowest Old age dependence ratio before BBG reaches their retirement age. The lowest value of 16.23 percent occurs in period 1995. Since the exogenous variable Labor Supply increases from 1975 to 1995, two events may occur: unchanged wage rate with a rising unemployment, or low wage rate without unemployment increase. As in the model, prices are flexible, we can see that wage rate has a decreasing trend after 1975, and reaches the minimum point in the period 2015. As expected, labor demand increases when the wage level declines.

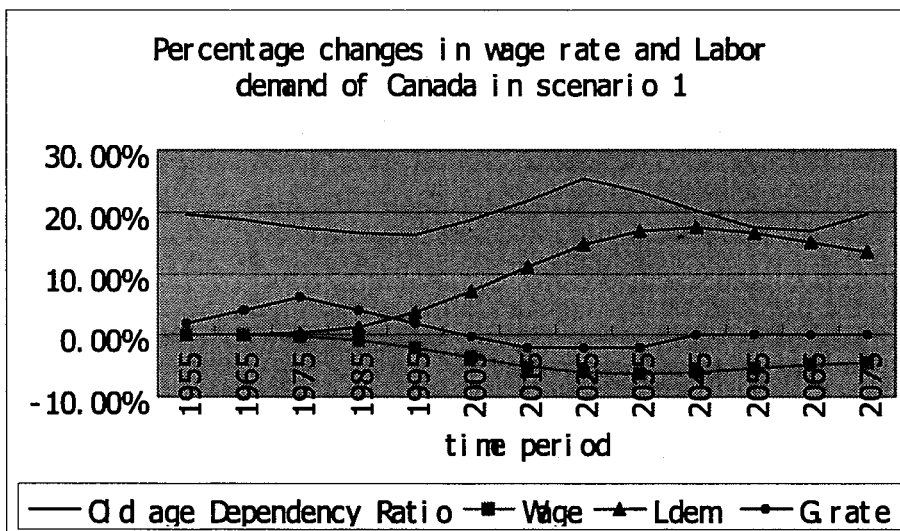


Figure R1

When the baby boom generation begins to enter into the retirement age, OADR starts to increase and the region begins to experience “Ageing”. The exogenous variable Labor Supply decreases as the population growth rate is slowing down, and exhibits a negative growth rate from period 2005 to 2035. The wage rates we got from simulation are consistent with the common economic theory. When the labor supply decreases, the wage rate increases by 1 percent in the three periods 2035, 2045 and 2055.

Figure R2 reports the percentage changes of public expenditure and tax wage. In the literature section, we have mentioned that population ageing might inflict an upward pressure on government expenditure, to finance the increased demand for health-care services and public pension benefits. Since current pension payments are financed by current contributions usually levied as payroll taxes, we can imagine that there is likely to be a heavy burden on working age population when the region experiences ageing. As expected, Figure R3 describes a generally increasing trend of public expenditure (GovS) and tax wage (T. wage) until the OADR walks out of its peak after period 2045.

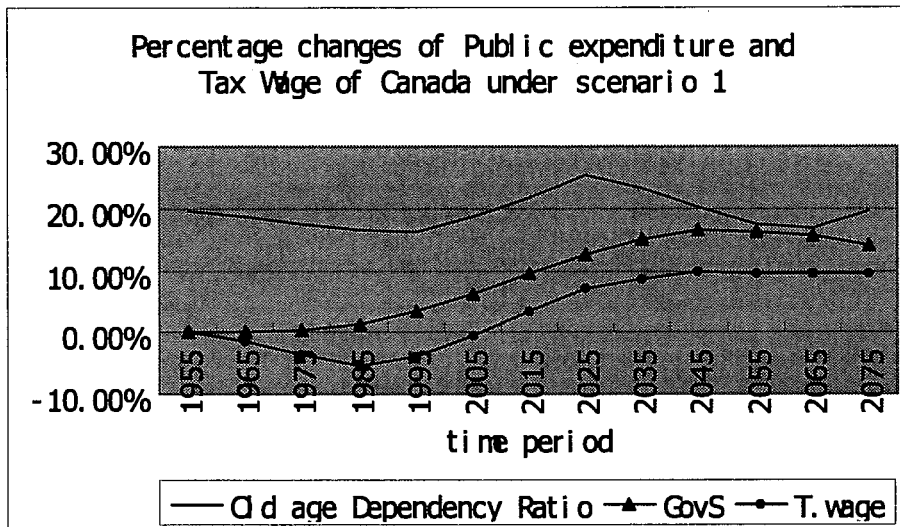


Figure R2

From Figure R3, we can see that the investment and the OADR have the same trend when the region experiences ageing. The reason is that as the middle-age individuals save for retirement, the large size of this age group in these periods leads to large private saving rates, which spur investment. The OADR rises sharply from period 2005 to 2025, and remains high the next three periods. During the same periods, the investment falls down sharply from 17.71 percent to 10.73 percent. This is consistent with lifecycle theory. As individuals start to consume their accumulated wealth when they reach retirement, population ageing is expected to put downward pressure on private savings. Moreover, a slower labor force growth reduces the need for physical capital investment. So we also see the drop in investment (InvS). The interest rate (Int.) is jointly determined by changes in investment and savings. If the drop in savings is less than the decline in investment, we would have a decline trend of interest rate as in the figure R3. We can see that the interest rate has generally an opposite trend to capital per worker as shown in the figure R4.

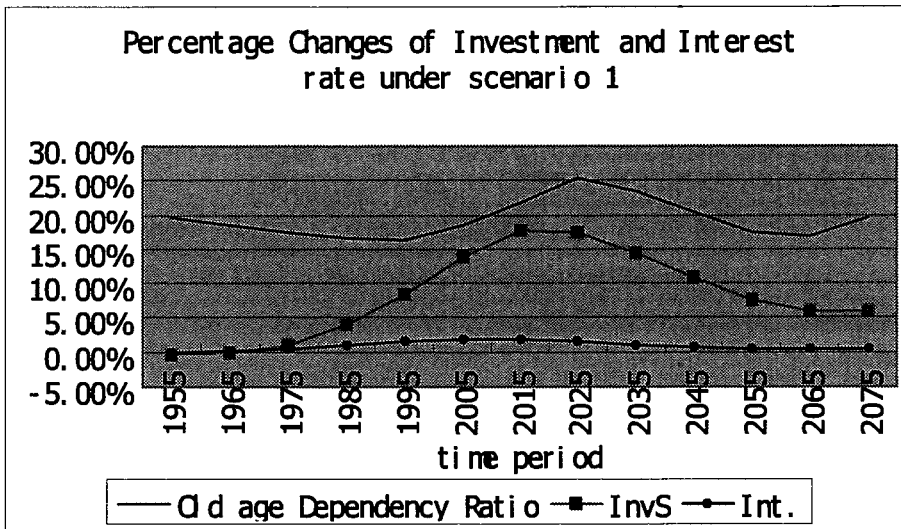


Figure R3

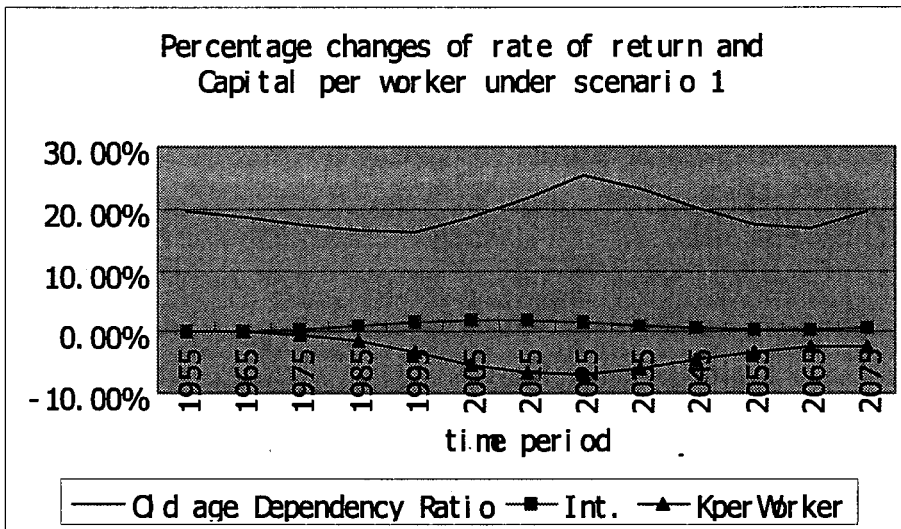


Figure R4

As shown in Figure R5, when the region begins to experience ageing, the output per capita (output/K) begins to decline from the peak. Even when the OADR becomes lower in future periods, the output per capita still remains at low level, which represents a negative effect of ageing on the future output per capita.

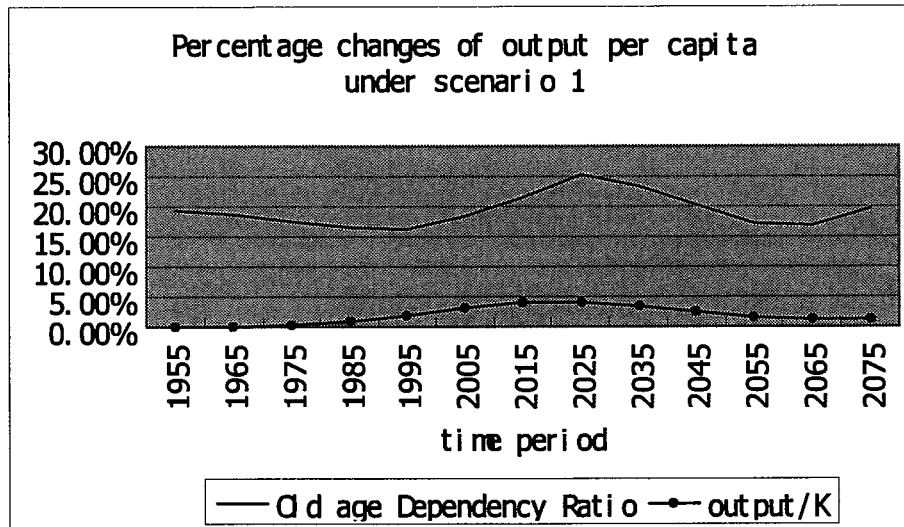


Figure R5

Scenario 2

In scenario 2, we experiment asymmetric demographic shocks on the world economy. The demographic condition of Canada is same as under scenario 1 (Table R2), whereas the population of the Rest of the World is assumed constant over time. For the rest of the world, labor supply is constant, so is the dependency ratio. Wage rate changes little as RoW is subject only to an external shock caused by ageing in Canada. Steady OADR does not impose more tax on workers' income (See Figure R6). Canada experiences ageing, so the tax rate rises as government expenditure increases. Wage rate increases when the baby boom generation enters labor market, and declines when they retire. There is this time a terms of trade effect as the shock is asymmetric across regions. The relatively lower price level of Canada stimulates output (negative terms of trade effect). (See Figure R7)

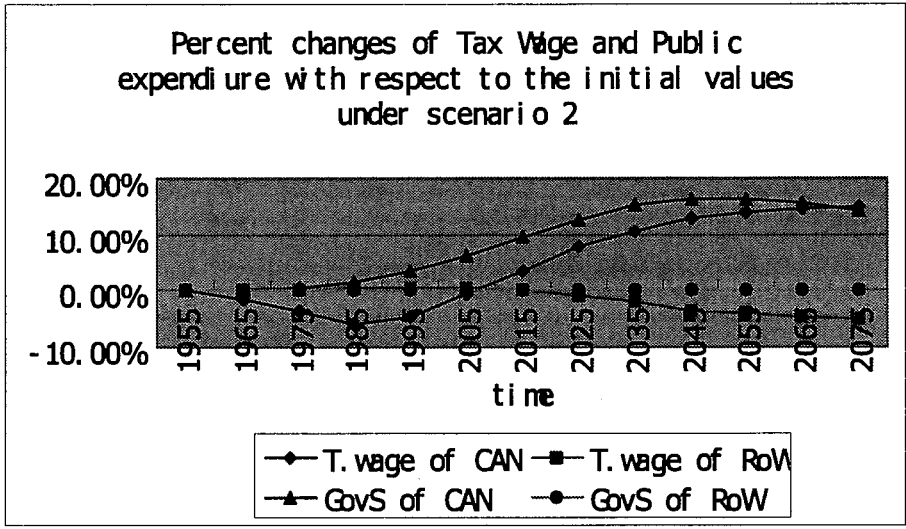


Figure R6

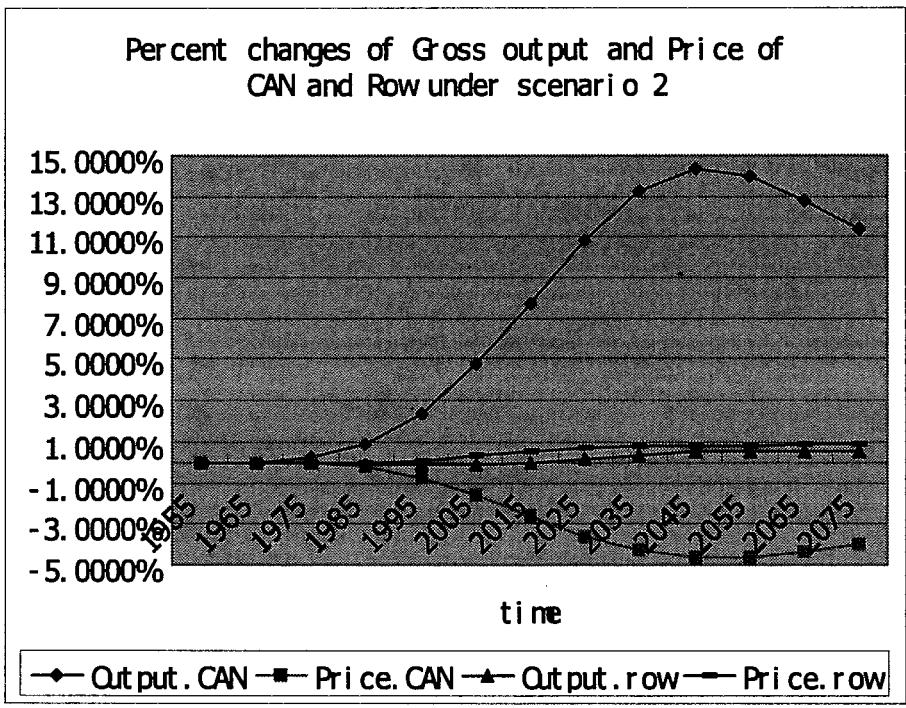


Figure R7

As shown in Figure R8, the output per capita (Output/K) in scenario 1 is higher than under scenario 2 in each period for both regions. It is also worthy to notice that the output per capita of Canada is much higher than RoW under scenario 2.

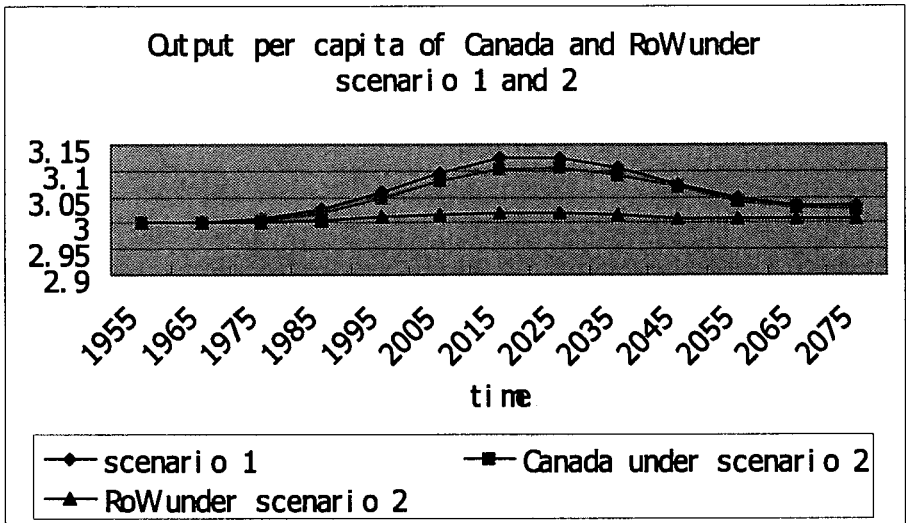


Figure R8

Scenario 3

In scenario 3, to the asymmetric demographic shock of scenario 2, we assume that Canada succeeds in attracting working-aged immigrants in two periods only, 2015 and 2025. So OADR under scenario 3 improves compared to scenario 2. In Figure R9, we can see that the ratio under scenario 3 is lower than that under scenario 2 from 2005 to 2055.

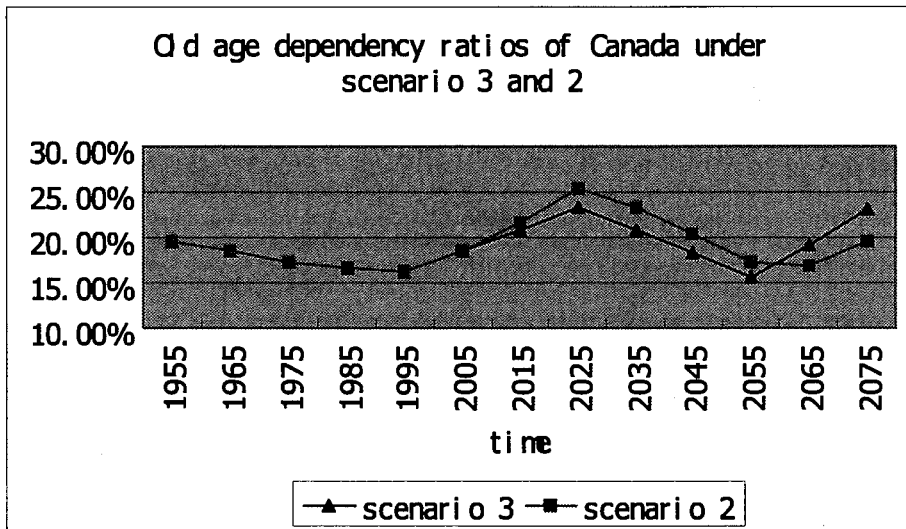


Figure R9

To analyze and estimate the effect of immigration on ageing region's economy, we compare the variables under scenario 3 with those under scenario 2. All the variables have quite the same values before the "migration" happens in the period 2015 and 2025. So the following analysis will focus on Canada's economy after 2015.

As young immigrants enter the labor market, the exogenous variable Labor Supply increases. It is the reason for the lower wage rate in Canada under scenario 3. Figure R10 tells us that wage rate becomes lower after 2035, which causes the demand of Canada's labor market to increase (Figure R11).

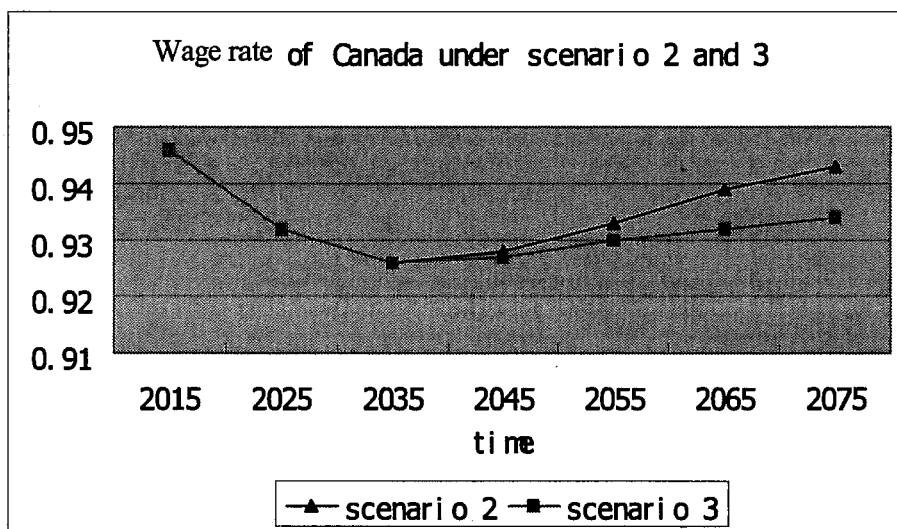


Figure R10

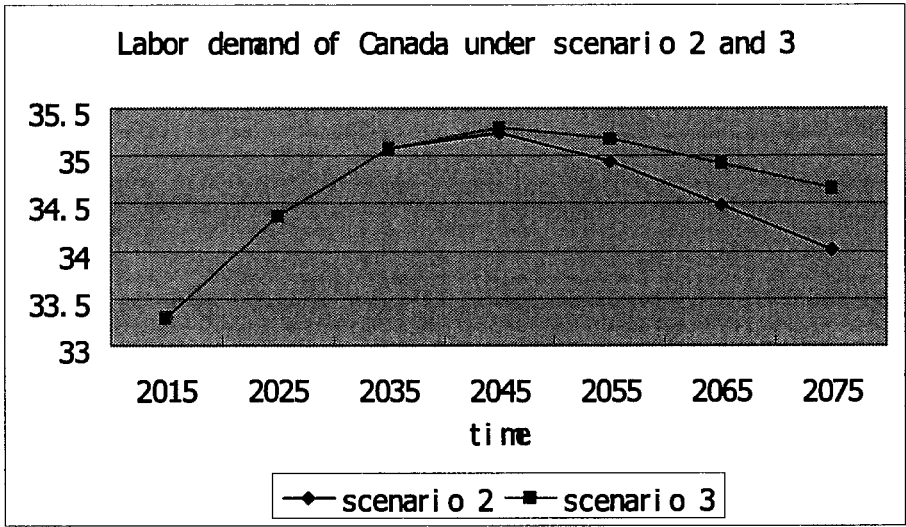


Figure R11

Because the inflow of working aged immigrants do not change the population of retired people, we can see, from figure R12, that government expenditure does not change for three periods from 2015 to 2035. But expenditure rises when some of immigrants begin to reach retirement age.

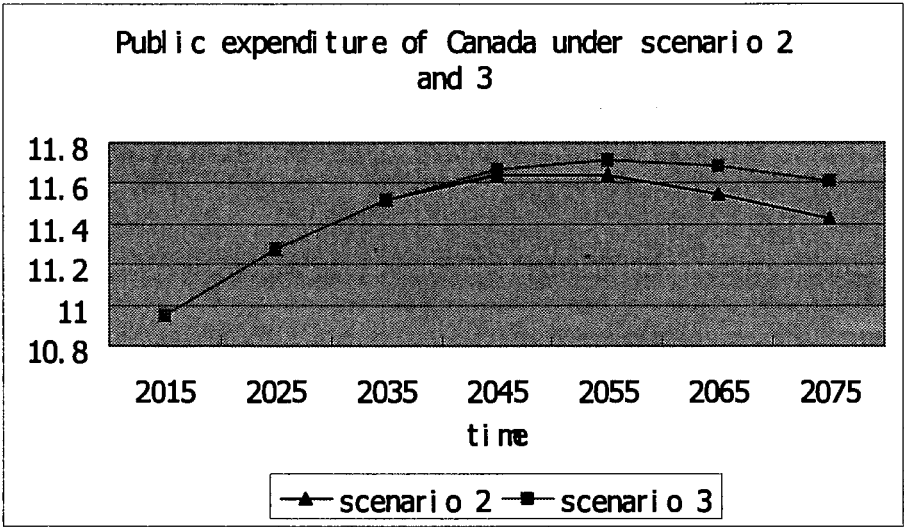


Figure R12

As shown in Figure R13, the tax wage under scenario 3 is lower from 2015 to 2055, because the working-aged immigrants share the burden with the native workers. The higher tax wage after 2055 is partly caused by the higher public expenditure in these periods.

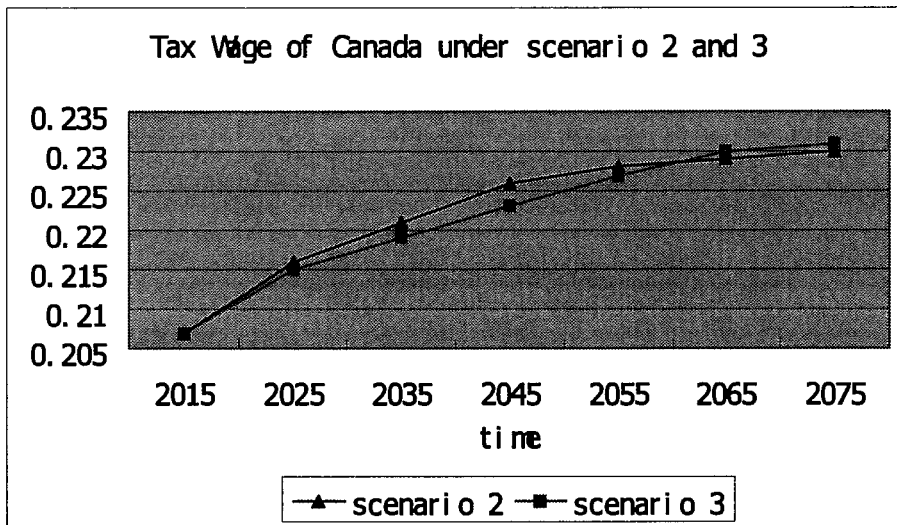


Figure R13

We can see the effect of immigration on the interest rate from Figure R14. Immigration makes the interest rate higher in future periods as it stimulates investment.

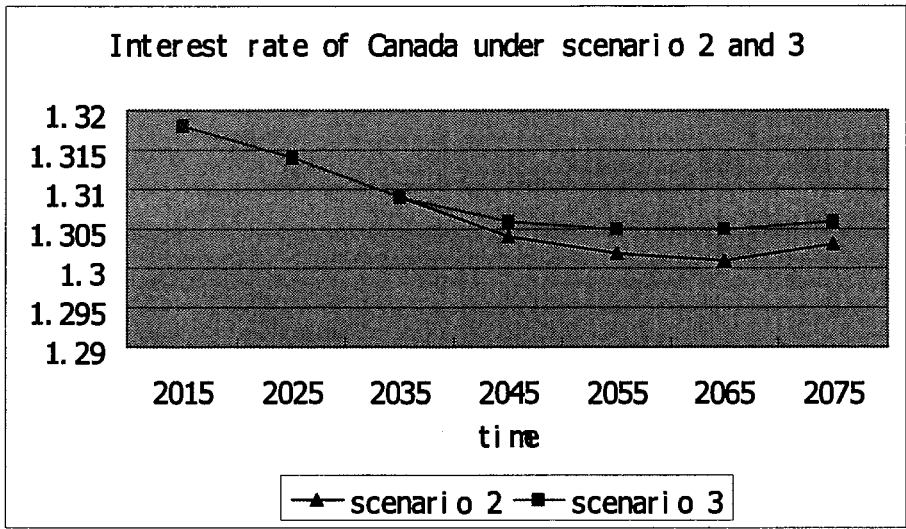


Figure R14

As shown in Figure R15, the output per capita under scenario 3 is higher than under scenario 2. Immigrants increase the labor force in the model and hence raise the size of one of the factors of production compared to scenario 2.

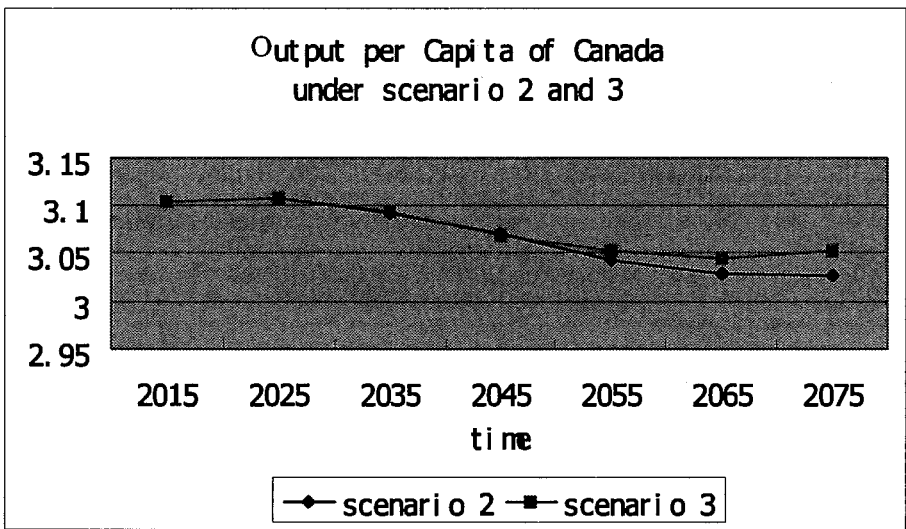


Figure R15

7. Conclusion

In this paper, we review the literature about implications of ageing and immigration in section 2, 3 and 4. As labor supply in the ageing region declines, the wage rises. With the expected increase in government expenditure, heavier fiscal burden and decline in savings may pull the output growth rate down. Attracting immigrants can prevent labor supply from declining, and alleviate the fiscal burden by imposing tax from immigrant workers. Highly skilled immigrant workers can contribute to the industrial innovation and creation. To get a sustainable development, the countries facing ageing may choose an appropriate immigration policy. However, we should not overstate the pessimistic impacts of ageing while neglecting some positive effects, such as encouraged human capital formation, technological progress spurred by labor scarcity, etc.

On the other side, the gap of income between industrial and poor countries exists and is expected to last for a long period. The higher wage may cause workers in poor countries to have more incentive to migrate, even there exists competition between native workers and them. Immigrants have a relatively lower entry wage to natives, but always have a higher rate of wage growth, especially the highly skilled workers.

To address the issues, we use a dynamic, overlapping generations general equilibrium framework, and do simulation experiments. The results reported in this

paper suggest that population ageing could have important implications on economies. From scenario 1, we find that the wage rate increases as the labor supply becomes relatively scarce. Both savings and investment decline. As the change of investment is larger than savings, we obtain a declining interest rate. It is worthy to notice that population ageing slows down the output per capita.

In scenario 2, we impose an asymmetric demographic shock. Canada experiences ageing, whereas the rest of the world has a constant population. There is no immigration permitted in this scenario. We can see a rising public expenditure and tax wage, while the rest of the world has the opposite trends. It is worthy to mention that the output per capita of Canada is much higher than RoW in each period, but both regions experience declining compared with scenario 1.

In scenario 3, we assume that Canada succeeds in attracting immigrants only in two periods, 2005-2015, which provides Canada a lower OADR in the next several periods. As shown in results, immigrants reduce the average wage rate in Canada. The labor demand increases as the wage rate declines, so the immigrants can be absorbed in the labor market. The lower tax rate implies that immigrants share the fiscal burden with natives. Also we got a higher output per capita, which implies a positive effect of immigration on welfare of natives.

The higher wage rate in ageing country may stimulate the workers to migrate,

which provides us an evidence that ageing may spur immigration. The simulation results also suggest that immigration is beneficial for natives. However, it has to be understood that the model is a stylized version of the reality. For instance, in future research, it would be worthwhile to assume that immigrants have different skills than natives, that the labor market is not perfectly competitive, that there exist costs of integrating immigrants, etc.

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Appendix

Figure 1
World Income Distribution, 1960 and 1988

