

**AGING VS IMMIGRATION:
A GENERAL EQUILIBRIUM
INVESTIGATION OF AN INCREASED
IMMIGRATION ON THE CANADIAN
ECONOMY**

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1. - Introduction

Sustained growth of elderly populations is already posing a considerable challenge to policymakers in many societies. After the year 2010, the numbers and proportions of elderly will rise rapidly in most developed and in many developing countries.

This projected increase is primarily the result of high fertility levels after World War II and subsequent decreases in the death rate so that more people reach old age. In most nations of the World, there have been in this century major reductions in infections and parasitic diseases, reductions in infant and maternal mortality, and improved nutrition.

The elderly population also has increased because of worldwide improvements in health services, education, and income. Thus the elderly dependency ratio, defined as the number of retired individuals (aged over 65) divided by the number of working age (between 15-64), which also includes not only the people who have jobs but also those who are in pursuit of one, is expected to increase substantially in the next twenty years.

As the aging process accelerates, the elderly will be an increasingly larger proportion of each nation's total population. This will lead to socioeconomic changes and the impact will be felt not just within individual nations but also throughout the international economy.

Government planning for the allocation of resources is often affected by changes in the numbers and proportions of persons in broad age groups. Any pension system (such as the Canadian Pension Plan (CPP)) in which current receipts are paid out to current beneficiaries depends heavily on the ratio of persons of drawing age to those of contributing age. Keyfitz (1985) states that in a rapidly increasing population that ratio will be low, and the program will seem inexpensive. It will also seem inexpensive in an expanding economy but in a stationary (i.e. of no growth) population and a stationary economy such an unfunded arrangement is much more expensive, and the threat of 'stationarity' is part of the reason for the discontent with social security pension schemes that has been expressed in western countries. Thus economists believe that immigration can play a key role in resolving some of the future potential fiscal crises. Moreover, they speculate that immigrants can contribute in slowing the trend of population aging.

In this research, my goal is to summarize, in section 2, the expected ongoing effects of aging in Canada, emphasizing the overall economic implications. In section 3, I investigate if immigration can be a key in resolving some of the negative affects of aging in Canada. In section 4, I describe a multi-region, multi-sectoral and multi-overlapping generations model developed by Mercenier and Mérette (2002). In section 5, I proceed by reporting the result of a few simulations that investigate to what extent immigration can help to alleviate some of the economic woes of population aging. Finally, I end my paper by offering some concluding remarks.

2. - Aging

- **Economic Implications**

The purpose of this section is to examine the overall effects of aging on the Canadian economy, and more precisely on labour supply, public expenditures, investment, output growth and welfare. In the following discussion, I assume that immigration remains constant at the current level of 2002 (230 000 immigrants per year), consistently with Canadian government's announced target range.

- **Effective Labour Supply on the Economy**

Akbari (1989) states that the younger generation following population aging will most likely focus on education and training to advance their careers (especially if labour is expected to be a relatively scarce input as the population ages). Mérette (2002) suggests the reason for this occurrence is that population aging will encourage human capital formation as the expected real return on physical capital will decrease (which I discuss in the sub-section 'Savings and Investment Implications on the Economy'). Thus this scenario encourages the young (of today) and future cohorts to decrease their investment in physical capital and increase their investment in human capital. The rise in knowledge (that would result from human capital investment) should increase their productivity, and hence their future wages. The future potential increase in salaries may prompt the younger population to pursue their studies. In such a case, productivity would increase even if they were no additional physical capital furnished to the employees.

Scarth (2002) examines the cohort effect for both young and old to determine the overall economic implications of the effective labour supply. Starting with the young, we can speculate that there will be an increase in their wages in the long run from the rise in productivity (due to the increased human capital formation as noted previously). For the elderly (the baby-boomers going into retirement), since they plan to spend a greater portion of their time in retirement (from the increased life expectancy), they may be prompt to save more (if the age retirement were to still be established at 65). Thus there might be a short-term welfare loss initially since higher aggregate savings implies less consumption. But eventually, this increase in savings (from the elderly), once the baby-boomers retire, may translate in a boost in consumption (as they start to dissave) in the long run, thus a growth in GDP. This long-term gain from the increased consumption from the elderly and also from a higher quality of the post-boomers labour force when they reach middle age might counterbalance the welfare drop of the elderly during the initially decline of consumption.

Scarth simulation results (from his analysis on the total cohort effect) indicate that an aging population can be expected to reduce the annual growth rate of the economy by one tenth of a percentage point, which many economists may regard this as a fairly modest loss. This scenario is expected since a lower population will cause GDP growth to fall, but if all agents (young and old) in the economy are given equal weight, the analysis supports the proposition that lower population might be favourable in the long run for the reasons discussed previously.

To sum up, an upside of aging is that the younger population (of today) and future cohorts will invest more of their time in human capital formation thus resulting in increase in their productivity. The overall economic will experience some modification but the net affect of aging could even be a favourable one in the long run, due to the rise in wages of the younger generation (from increased human capital formation) and the increased consumption of the baby-boomers once they reach the age of retirement.

- **Government Expenditures**

Social security plans (such as health care), being an expenditure for government, have received most of the attention in the context of population aging. For instance the World Bank (1994) uses the term "crisis" to state the ongoing effects of aging on the health services. Spencer and Denton (1999) state that the cost of simply maintaining public programs for the Canadian population would also increase two and a half times, in real terms, which is also the expected rate of increase of the size of older population, from now to 2031. Only by cutting per capita expenditure by 60 percent would the total outlay not increase. These alarming numbers illustrate the ongoing impact of aging on government spending, which are mostly fuelled by the rising demand for health care services and old age security.

But one might expect that the same demographic forces that will give rise to public spending will lead to a decrease in some other areas of public budget (such as education) that will at least partially offset the increase in cost in the health care system. It makes little sense to consider in isolation only those expenditure categories (such as

health care and old age security) that might be expected to increase, and then to claim that there is a crisis.

Spencer and Denton (1997) investigates the effects of aging on the public spending to GDP. The results show an increase for health care and social security from 6.2 percent of GDP in 1991 to 8.9 percent in 2031 for the former, and from 4.6 percent to 8.0 percent for the latter. Moreover, the authors project a decrease for education, from 5.8 percent to 5.1 percent also during the same time frame. Those three categories combined imply a rise from 16.6 percent to 22 percent of GDP over the forty-year period.

Summing up, their evidence indicates that the government expenditures necessary to maintain social security and health care at the current per capita levels will rise in the coming decades as a consequence of population aging. Moreover, the decrease in costs (in real terms) in other public services such as education will fail to compensate fully for the rise in costs of both old age social security and health care.

- **Savings and Investment Implications on the Economy**

Following the life cycle hypothesis; people are assumed to accumulate assets during their working years and dissave during their retirement. So to maintain consumption at a steady state after retirement, people must save during their working years to finance retirement consumption. Economists such Cincotta and Engelman (1997) envision that population aging would thus lead to a decrease of the private savings as the number of dissavers will increase relative to the number of savers. Therefore the capital

stock growth rate will slow down, and that would coincide with a slowing rate of (non-effective) labour force growth. That combination could, then, result in a slower economic growth (GDP) even though the productivity level of each unit of labour would increase (since they would be fewer workers with an abundant supply of capital, thus changing the capital intensity of production indicated by many authors such as Scarth 2002).

An upside to scarcity, the expected decrease of capital resulting from the decline of private savings, is that technology changes usually occur when there is a need for it. Innovations, perceived by economists as a source economic growth, would lead to improvements in the productivity of physical capital thus increasing total productivity of the economy. History has also demonstrated that society usually exhibits adaptive mechanism to cope in response to resource scarcity. For instance Malthus (1798) said that population was growing faster rate than food harvesting. Thus the inevitable population growth would collide with the limited projected resources painting a pessimistic view of the impact of population growth. Malthus asserted that the society's institutions would be unable to adjust to changes and pressures of a rapid population growth rate. Moreover, Malthus predicts that a high human density would ultimately reek on the environment and social fabric of a society. His assumptions were made false since the technology advancements in agriculture prevented any fear of population starvation (from the lack of harvest). Also neoliberals, such as Simon (1986) among the most prominent, argued against Malthus statements by stating that a set of evolved institutions coupled with technology progress and creativity provide all the tools for adjusting. Thus potential

technology innovations could at least alleviate any fear of any expected drop in the economic growth.

- **Output and Growth**

The slower growth of the labour force that will accompany future population aging will have a direct and negative effect on the productive capacity of the economy (i.e. GDP growth rate). Some observers such as Antecol, Cobb-Clark and Trejo (2000) anticipate a reduced growth of physical capital resulting from reductions in the aggregate savings rate (as mentioned previously), and a slower productivity growth associated with aging of the work force. Such an impact on potential output, as indicated by Borjas (2000), due to the risk aversion of the elderly of undertaking long term investments will damper the economy into a possible recession. He states that the younger work force is more willing to engage in risky investment whereas the elderly are usually more adverse to risk (since they already possess substantial amount of savings contrary to the younger generation). Such effects (such as the reduced rate of growth of both capital stock and GDP) are much more uncertain, though, than the apparently inevitable effects of slower labour force growth.

An upside to aging is that the level of unemployment should decrease since there would be a large need to replace future upcoming retirees. Thus there might not be a worry on economic growth rate for a change due to a smaller size of the labour force (since a high GDP growth rate usually translates in job creation). But others suggest that this scenario might induce some other negative external effects. For instance, Romer

(1996) states that a larger work force is beneficial to the growth of worldwide knowledge. Moreover, Romer claims that this increase knowledge may be helpful in generating new knowledge (such as research and development) ensuring that Canadian firms can be competitive in the international market. To support his theories, he constructs a conventional production function model in which labour, capital, and knowledge are combined to produce improvements in technology in a deterministic way. The results of Romer's model of 'the dynamics of knowledge accumulation' stipulate that the larger the work force, the more people there are to make new discoveries.

Moreover empirical studies have shown that there is a positive relationship between GDP growth rate and international market competition. Nickell, Waldhini and Wall (1992) test the relationship between international market competition and economic performance. They use microeconomic data sources to consider this relationship. The results show that international market competition plays a substantial role on the impact of productivity. Armstrong, Cowan and Vickers (1994) outline three ways in which competition can be expected to provide incentives for improved efficiency. The first is that international market competition encourages innovations and research and development expenditure. The second is that market competition improves incentives to reduce 'managerial slack' and improve productivity. The last is that international competition tends to 'select' more efficient firms at the expense of the less efficient, thus resulting in overall improvements in productivity.

Summing up, it is true that the decrease in the economic growth rate may not have any effect on unemployment (due to smaller upcoming labour force resulting from aging as noted previously), but it may have some negative external effects preventing Canada from competing in the international market.

- **Living Standards**

The elderly dependency ratio will almost double from now to 2040 to reach 38.5 percent in Canada. Robson (2001) claims that there will be a large increase in costs in the health system to cope with a growing population leading towards retirement. This scenario seems imminent since the baby-boomers represent the majority of the voters in terms of elections.

The increase in the costs of the health care might force governments to reduce spending in other services, most notably the education system. Since there might be a shift of resources towards health care, this raises an alarming concern about average living standards.

Scarth (2002) uses a simple overlapping generation models to calculate the effects of demographic changes on living standards for each cohort (young and old). He starts by using the Diamond Model to simplify his analysis; the model assumes that each individual lives during two periods of time (working years and retired years). Each individual supplies one unit of labour when he or she is young and divides the resulting labour income between first-period consumption and saving: in the second period, the

individual simply consumes the savings and any interest returns he or she earns.

Individuals place their weight between first and second-period consumption based on their preferences. Firms hire labour and rent capital accordingly to their marginal productivity rate.

In his framework, baby-boomers flooded the market; they contributed to a very slow growth in wages. At the age of retirement, they would end up suffering a drop in their living standards since the ratio of capital/labour is relatively high (because of the shortage in the demand of labour). Consequently, interest rate falls and wages rise ultimately. Since wages increase, Scarth foresees a rise in the post-boomers living standards. In his analysis, the younger generation (post-boomers) will enjoy an increase in consumption. Moreover, the younger generation should welcome this change since this increase in wages is higher than a foreseeable increase in the contribution rate (which I discuss in the 'Appendix 1') needed to pay off the pensions of the baby-boomers going into retirement.

In Scarth's analysis, the average living standards (including both generations) should take a small dip of two percent. But he also states that we should not take these results as being perfect since baby-boomers will represent the majority of the population and they will mostly vote to increase the benefits paid to them.

The overall economic implications suggest a possible decline in economic growth of Canada, a rise in public expenditure, and most importantly a drop in total well-being of the Canadian society (accounting for both the living standards of the young and old) due to a future drop of the labour force when the baby-boomers reach the age of retirement. These effects seem imminent regardless of the possible rise of both investments in human capital of the youth and consumption of the baby-boomers once they reach the age of retirement.

Having discussed the effects of aging, we will now focus our attention on immigration; to see if it can resolve some of the economic, demographic woes that may occur in the next twenty years.

3. - Immigration

- Immigration

In section 2, we examined the overall economic implications of the ongoing effects of aging in Canada, when the immigration levels remained constant with Canadian government's announced target range. In this section, we will examine the overall economic and demographic implications if Canada decided to increase its quota on immigration. The purpose is to investigate if immigration can play a crucial role in attenuating some of the negative effects of aging.

Can immigration counterbalance the negative affects of aging? Historically, without the settlement of immigrants through the country, Canada would not have been the culturally, rich, prosperous and progressive nation that it is today. Each culture such as European, Asian, or African bring his or her own unique labour, capital and skills which are essential to the building of a productive Canadian society. Immigration has been and will continue to be an essential tool for social, cultural and economic building of Canada. The question is whether immigration can be a crucial economic instrument against the projected negative impact of aging.

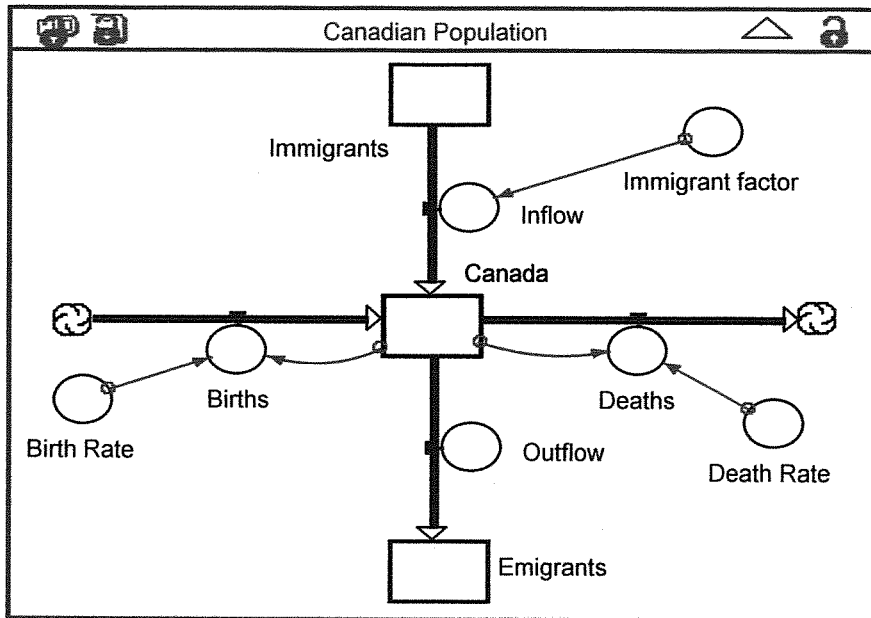
Since the mid 1990's, Canada immigration criteria emphasised more on skills. The new policy was introduced to stimulate the economic growth of Canada and to facilitate opportunities for international trade (which I will discuss later).

But government has to strike the proper reform to maintain the social structure and cultural diversity of Canada from the increasing inflow of foreigners into Canada. Especially if economists believe that immigration is a key in resolving the problems of aging.

The purpose of this part of the paper is to recreate a simulation of the Canadian population (in which births, deaths and annual migration flows are taken into account) from 2001 to 2026 using Stella (version 7.0) to focus on the impact of immigration on the age structure of Canadian population. Later, I investigate the economic effects if the level of immigration were to increase as in the following simulation.

To simplify the experiment, I first use a stock variable to represent Canada (in terms of population), in which I divide the Canadian population into ten cohorts (as assessed by Statistics Canada for the 2001 period). Each cohort has a length period of ten years starting from 0 to 9 then 10 to 19 etc... Once an individual reaches a certain, age e.g. 10, that person moves onto the next cohort, and so on. Then I proceed to use two flows variables, which are the respective birth and death rates of Canada, needed in order to create a simulation of the Canadian population. Then I use two other flow variables, which represents the annual levels of immigration and emigration into Canada to compile a realistic simulation of the Canadian population (all illustrations are represented below). The birth, death and immigration are detailed below. Note that the data (such as immigration, population, birth and death rates) is compiled from Statistics Canada Website.

The illustration of the Canadian population is the following:



- Immigration Factors

The rules for the admission of immigrants deal with four basic categories (which I describe below). Those categories correspond to the three main program objectives: reuniting families, promoting economic development, and protecting refugees. The ‘immigration factor’ in this model is an index of the level of immigration. The level of immigration is a function of the four basic categories of immigration stated below.

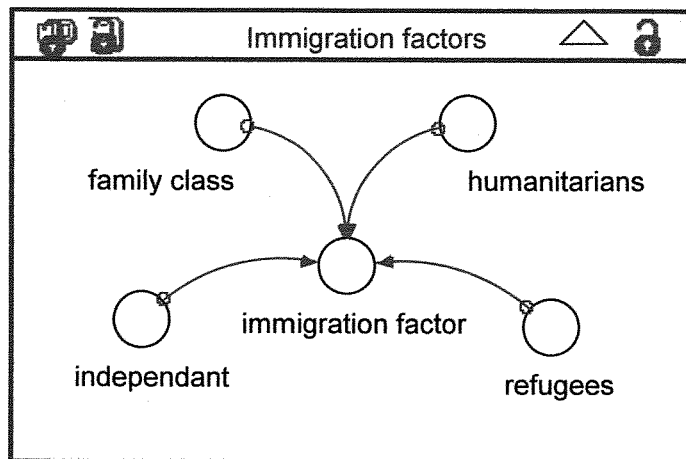
Family class immigrants: immigrants sponsored by close family members already living in Canada.

Independent immigrants: immigrants who qualify for certain types of jobs or have other important assets to bring to Canada. They apply on their own or have more distant relatives living in Canada.

Refugees: persons seeking protection in Canada because they had to leave their native land due to wars or political issues.

Humanitarian designated classes: people in refugee-like situations; other classes of immigrants established for humanitarian or public policy reasons may also be defined by regulation. These classes include: Live-in Caregivers in Canada, Post-Determination Refugee Claimants in Canada, and Undocumented Convention Refugees in Canada.

The illustration of the immigration factors is the following:



- Factors of the Death Rate

The following assumptions are:

Death rate- is being the number of deaths divided by the total population in a given year.

The death rate is a function of life expectancy, as life expectancy increases the death rate decreases. Thus the death rate has a negative relationship with respect to life expectancy.

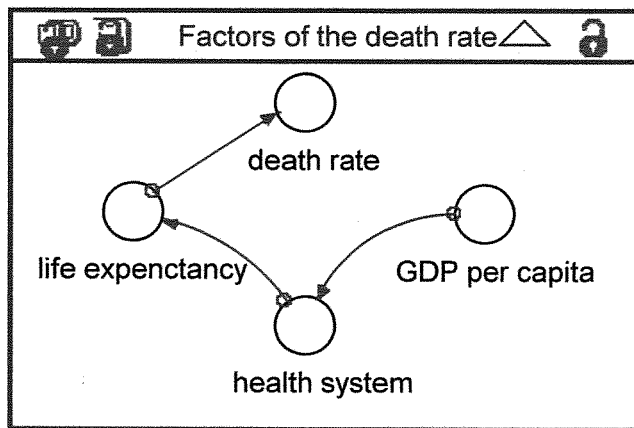
Life expectancy - is a function of health system, as the health system improves life expectancy increases. Thus life expectancy has a positive relationship with respect to the health system.

Health system - is assumed to be a function of GDP per capita, as GDP per capita improves health system increases. Thus health system has a positive relationship with respect to GDP per capita.

GDP per capita – is the total GDP of Canada divided by the population in Canada

To summarize the mechanism of the factors of the death rate; GDP per capita influences the health system, which in turn influences life expectancy to finally influence the death rate.

The model illustration of the factors of the death rate is the following:



- **Factors of the Birth Rate**

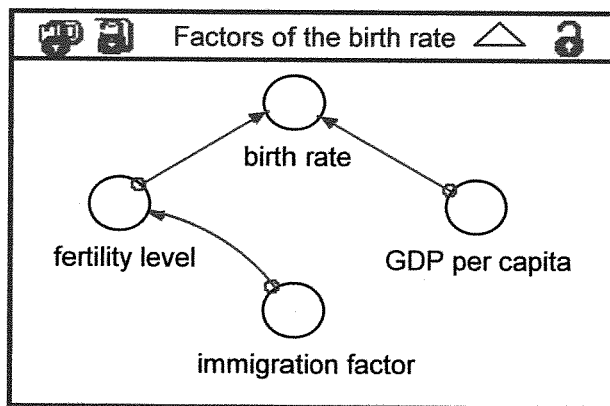
The following assumptions are:

Birth Rate – is the number of births divided the total population in a given year. The birth rate is assumed to be a function of the GDP per capita; as GDP per capita increases the birth rate falls. This assumption is based on Easterlin hypothesis (1980), which can be seen in Appendix 2. Thus birth rate has a negative relationship with respect to GDP per capita for industrialized countries (in a linear regression of birth rates in respect to GDP for the most industrialized countries).

Fertility Level (or fertility rate) – is the estimated number of children per couple. The fertility level is a function of the immigration factor, as immigration rises the fertility level should increase (note that new arrivals children are considered as natives and hence have the same fertility level as their counterparts). Thus immigration has a positive relationship on the fertility level. This in turn, has a positive relationship on the birth rate.

To summarize the mechanism of the factors of the birth rate; GDP per capita and immigration factor are the main factors that influence the birth rate. GDP per capita has a direct influence on the birth rate. Whereas immigration factor influences the fertility level, which in turn influences the birth rate.

The model illustration of the factors of the birth rate is the following:



Our goal is to project the age structure of the Canadian population projected for 2026, so later I will be able to analyse the impact of increasing immigration over the age composition of the population. We start off by using the data compiled from Statistics Canada of the year 2001 (as mentioned previously) to run the model through 2026. Note that the data projections for the Canadian population compiled from Statistics Canada of

the year 2026 are in black and the ones in red (for the same period) are from the Stella results. Also, the last column represents the population difference (in absolute value) of the both projections of the year 2026.

AGE STRUCTURE (both sexes)

	population 2001 in thousands	population 2026 in thousands		difference of the 2026 projections (in absolute value)
age 0-9	3,742.50	3,525.10	3,525.40	3 000
age 10-19	4,157.60	3,755.00	3,754.60	4 000
age 20-29	4,197.30	4,096.70	4,095.40	13 000
age 30-39	4,894.20	4,950.10	4,951.60	15 000
age 40-49	5,044.00	4,903.10	4,903.50	4 000
age 50-59	3,740.60	4,664.50	4,666.00	15 000
age 60-69	2,428.90	4,939.60	4,939.10	5 000
age 70-79	1,827.20	3,484.00	3,484.90	9 000
age 80-89	820.90	1,469.50	1572.5	103 000
age 90+	149.20	402.90	501.7	98 800
Total	31,002.40	36,190.60	36,394.70	204 100

Source: Statistics Canada (2001); Population projections for 2001 and 2026

As one can see the numbers for each cohort from the Stella simulation are close to those of the projections of Statistics Canada. To illustrate this point, the difference between the total population in both models only differ by approximately 204 100. Moreover for most age groups excluding the last two cohorts (age 80-89 and 90+) the discrepancies is almost non-apparent e.g. the total difference in absolute value excluding the last two cohorts is roughly about 68 000 individuals.

We can calculate (from the age structure table above) that in 2001 roughly 16 percent of the Canadian population is over the age of 60 whereas this number is expected

to grow at 28 percent by 2026. From this analysis, we can conclude that Canadian population will rapidly age.

This simulation exercise succeeded in replicating the population projection of a position to Statistics Canada for the purpose of later adjusting the level of immigration. To investigate how the age structure would shape if the number immigrants doubled from the level of 2001. I will discuss further this scenario in 'Aid in the Demographic Transition' section of the paper.

- **Role of Immigration**

The purpose of this section is to examine the impact of immigration on the fiscal challenge, demographic transition, domestic markets and finally on the work force.

- **Fiscal challenge**

In this section, we will investigate if immigration can play a role in resolving the future potential fiscal balance crisis (as illustrated in section 2).

Can simply applying a strict immigration policy reform (which takes age, education and work experience into account) satisfy the government long run fiscal challenge? Storesletten (2000) demonstrates that an influx of skilled immigrants, for the next 20 to 30 years in an age group ranging from 20 to 49 years of age, can help resolve the fiscal challenge in the United States.

The new policy must be able to satisfy its objective in which new immigrants are able to attain jobs. If so, the government would levy taxes of those incomes to pay for the future expected rise in health costs (as mentioned previously). Moreover, the government might not occur any fiscal debt but actually might accumulate a much-needed surplus.

Storesletten investigates the changes to the fiscal balance if immigration rose to roughly 45 percent in terms of effectives from the base year of 1990. Note that in his calculations he takes into account the immigration policy reform as mentioned previously. His results indicate that the government will obtain a surplus from 1995 to 2035 if we exclude interest payments.

To conclude Storesletten demonstrates that a strict immigration policy can have a positive impact on the fiscal reform to counterbalance the affects of aging in an industrialised country.

- **Aid in the Demographic Transition**

In section 2, we examined some of the negative effects of population aging on the Canadian economy. In this section, we will investigate if immigration can reverse or at least slow the trend of population aging.

Canada has a very small net birth rate (birth rate minus death rate ≈ 4 in 1000) mostly due to a low fertility level. Moreover Canada has a fertility level of 1.49 children per couple. This number is clearly inferior to 2.1 children per couple also known as the

minimum rate level for the renewing of a generation. An upside is that roughly 74 percent of immigrants¹ come from developing countries with high birth rates. Hence, Canada hopes that these new arrivals (while keeping their high birth rate trends) may increase the total fertility level of the country.

Using Stella once more, I ran the same model as previously described above. This time, I simulate a model where the immigration would double from the initial level of level 2001.² Moreover, I assume that the new arrivals satisfy the criteria of the immigration policy (mentioned previously). In order to account for those criteria, I created a filter in the 'immigrants' stock variable so that the majority of immigrants range between the 20 to 49 years of age. The purpose of this simulation is to investigate if immigration can smooth out the age pyramid.

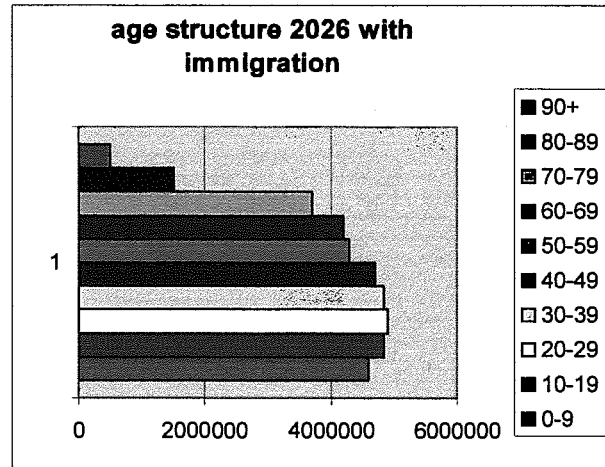
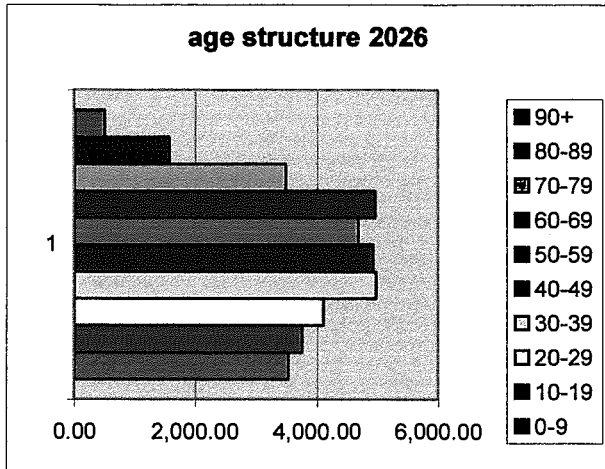
The results are the following:

Projection of the Canadian population with increased immigration (Stella results)

Year	2001	2006	2011	2016	2021	2026
Population	31,002,400	32,532,628	33,831,851	35,127,460	36,569,738	38,138,184
Immigrants	403,925	405,774	415,490	433,981	462,354	502,385

¹ Data furnished by Statistics Canada, 'Immigrants and Emigrants of Canada' 2000-2001

² From the data of 'Immigrants and Emigrants of Canada' the number was 205,711 in 2000



Comparing both age structures, we can calculate (from the simulations above) that roughly 28 percent of the Canadian population will be over the age of 60 (as mentioned previously) whereas this number is expected to be significantly lower at 20 percent for the same period with the increased inflow of immigrants. Thus the population will be a lot younger with the inflow of immigrant since they come at a relatively young age and have a greater birth rate. The projections suggest that increasing immigration quotas can help reverse somewhat the trend of population aging.

- Promoting International Trade and the Domestic Economy

Immigration may also encourage international trade, which is needed to diversify Canada links to abroad. As it is known, Canada's economic situation is highly dependent on the US market. Canada exports over 80 percent of its goods to their neighbouring country. Thus Canada should try to attempt to spread its exports internationally to avoid this high dependency with the United States. One possible solution envisioned by economists (such as Ronningen) is through immigration. Ronningen (2000) states that

immigrants are more likely to be self-employed than natives. Moreover, they would help in improve somewhat on the Export/Import trade, which they would develop with their home country.

Furthermore Meade (2002) states the level of employment growth that is created by recent immigrants from other countries is equal to or greater than, that of the growth created by the relocation of domestic U.S. residents within the United States. This includes job creation as well as consumed goods and services. Moreover when immigrants start their own businesses, they create jobs, which are often filled by other immigrants from their same country of origin. Based on Antecol, Cobb-Clark and Trejo (2000) findings, Canada and Australia are better at attracting more skilled workers than the United States (even if we excluded a high level of illegal immigrants that enter the U.S.); the same (the level of employment growth that is created by recent immigrants) has and will keep occurring in other developed countries such as Canada.

Also Meade notes that retailers across the country have discovered the economic potential of ethnic markets and have redesigned their marketing strategies to tap into this new source of revenue. This spending ripples through the economy, which creates jobs and revenue for both government and business.

Moreover Meade claims that the assumption, in which the fewer jobs will be left as immigrants arrive, is false. Meade (2002) indicates immigrants have practically no negative effect in the labour market on any person except other immigrants. Furthermore

employment has grown more rapidly in high-wage industries and declined at a slower rate in low-wage industries through immigration. This is because immigrants fill low-wage jobs that often no one else will take (e.g., meat packing and canning) and thus less skilled natives move into better jobs.³

To the extent that any displacement of natives by immigrants can be detected for the nation as a whole, the effects are “trivial”.⁴ In Meade’s studies both wage growth and decline appear to be unrelated to immigration.

In sum, the baseline analysis suggests that immigration raises national output, and on net, improves the economic well being of the native-born. Industrialized countries benefit most from immigrants whose skills are very different from those of natives.⁵

- **Preventing a Work Shortage**

In section 2, we examined that a slower growth of the labour force that will accompany future population aging will have a direct and negative effect on the productive capacity of the economy.

Thus immigrants may also prevent a work shortage, with the departure of baby-boomers from the work force starting in the next 10 years; there will be large vacancy for those positions to be filled up. As noted in section 1, an aging population can be expected

³ Simon, 1995

⁴ Passel, Fix, Zimmerman, Enchautegui, 1994 p54

⁵ Smith and Edmonston, 1997, p.142

to reduce the annual growth rate of the economy due to a reduced labour force. So there is a need for an increasing population since a large proportion of the population will cease to work. The vacancy filled by foreigners would be essential to continue the economic growth of Canada. Note that a large proportion of those jobs are well paying so once those jobs are filled, transfers (e.g. from income taxes) can already be going toward paying for health care and other government expenditures.

To illustrate this point Spencer and Denton (2003) forecast a simulation of an increased immigration on the Canadian GDP growth rate. They express GDP growth rate as a simple accounting identity of the sum of the rates of growth of the population, the proportion of the population from which the labour force is drawn, the overall labour force participation rate, the employment rate, and the aggregate labour productivity ratio. In Spencer and Denton's frameworks, GDP will grow at a slower rate in 2001-11, and at slower rates in the subsequent decades due to population aging if the net birth, the fertility rate and the net immigration level remain constant at their 2002 levels (which they call 'status quo' scenario).

Then they compare the 'status quo' scenario with a scenario of increased immigration in which they assume a 50 percent increase in annual immigration, starting in 2003-04.⁶ Their results (in comparing the increased immigration scenario with the 'status quo' scenario) are that the rates rise above by about a third of a percentage point in the 2001-11 period and by a little more in the subsequent decades.

⁶ The number of immigrants thus becomes 345,000 in every year

In sum, higher levels of immigration could have an immediate and continuing effect on GDP growth rate but (within their accounting framework) only a negligible effect on the growth of per capita.

The overall implications of the role of immigration suggest that immigration might lead to annual fiscal surplus that would be needed to pay for health care for instance. Furthermore, immigrants may increase international trades since they would develop links with their home countries and studies have shown that they are more likely to start their own businesses and create jobs. Finally, immigration may prevent an inevitable work shortage (due to aging) thus helping the economic growth of Canada. These possible scenarios paint an optimistic picture of the contribution that immigrants can make to Canada.

In the next section, I will examine the overall effects of immigration in Canada to evaluate if an increase in immigration is beneficial or a detriment to Canadian economy.

- **Effects of Immigration**

The purpose of this section is to examine to overall effects of immigration on the Canadian economy (prior to the previous section which I investigated their potential role). More precisely, I discuss the effects of immigration on capital productivity and on the labour force. In the first section, we examined that average living standards should take a small dip due to population aging. In this section, we will investigate if the overall gains accruing from increased immigration can be beneficiary to the Canadian economy.

- **Capital Productivity vs Labour Quality**

Withers (2000) states that Canadian immigrants tend to have more schooling than natives. Even in comparison with the United States, Canada is more successful in attracting well-educated immigrants (even if we exclude the arrival of Latin Americans in the USA as mentioned previously). Withers (2000) has shown that a greater number of people create more demand for goods and services and provide an increase in the number of workers available to meet the demand. But a broader issue is not whether immigrants can raise the aggregate national income but per capita income. Krugman (1990, page 3) states: "Productivity isn't everything, but in long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output worker". This is contrast with Malthus' (1798) states that more people leads existing ultimately to diminished marginal productivity and so to a slowdown in growth.

Empirical studies, such as Reitz (1998) who has conducted linear regressions on both investments and immigration, suggest that there is positive linkage between investment (and foreign capital flows funding that investment) and immigration. Moreover, Withers (2000) has found that the linkage is such that immigration has kept private investment at a fairly constant share of the expanding GDP in developed countries. However this outcome may not have stopped a reduction in the level of capital per head. This negative effect needs to be set against a possible positive benefit from

labour quality. Various studies have shown⁷ that immigration has increased the skills possessed in the workforce.

The overall question is to what extent a decline in the stock of capital per head is compensated by improvements in the quality of labour?

Some CGE models, such as Passel's (1994), calculate the costs of immigrants in the United States. Passel's results suggest that there might be a small positive affect through immigration.

Also it is true that migrant workers may displace other resident workers. But the scenario usually neglects that immigrants can boost spending on goods and services, which in turn increases demand for the labour to produce those goods and services. They are not only workers but also consumers. Moreover many of them bring capital funds with them and they may induce others to spend. Furthermore, McDonald and Worswick (1999) suggest that there is no increase in the unemployment rate with the arrival of immigrants in developed countries.

To sum up, a lot of economic review of immigration has focused on the relatively short-run effects on aggregates such as unemployment, wages, inflation, public finance and the foreign debt. Yet the general finding in all of these areas is that the effects have been reasonably balanced, the gains of the Canadian economy would be marginally positive.

⁷ Reitz 1998

- **Effects of Immigrants Workers to the Economy**

Borjas (2000) states even though immigrants arrive at an economic disadvantage, their opportunities improve rapidly over time. Within a decade immigrants earnings overtake earnings of natives of comparable socio-economic background. Other studies suggested that immigrants did not fringe on unemployment opportunities.⁸ In addition, they are less likely to claim welfare assistance than their counterparts of comparable income. Moreover, the next generations are usually more successful economically since they acquire additional knowledge from human capital formation through education. The empirical evidence, therefore, painted a very optimistic picture of the contribution that immigrants can make to the industrialized economy.

But nowadays, the picture seems more pessimistic. In the United-States, the newest waves start out at such an economic disadvantage that they may never reach earning parity of those of natives.⁹ The large-scale migration of less skilled in developed countries (such as Canada) has done some harm to the economic opportunities of less-skilled natives. Moreover, this occurrence may have been one of the reasons of the recent decline in the relative wages of less educated workers in Canada.

Wright and Maxim (1993) suggest that since immigrants create additional competition in the labour market, the wages of native workers fall. At the same time, however, native-owned firms gain, because they can hire workers at lower wages; and many native consumers gain because lower labour costs lead to cheaper goods and

⁸ Meade (2002)

⁹ Borjas (2000)

services. Moreover, highly skilled foreigners will induce "external effects" on the productivity of natives. Thus Borjas (2000) estimates in the U.S. that the total gains accruing to those who consume immigrants' services exceed the losses suffered by native workers, and hence society as a whole is better off.

To support his statements, Borjas calculates the overall net gain in the United-States, which he calls the immigration surplus. His results show that there will only be a gain of about \$7 billion (a gain of \$140 billion for owners minus \$133 loss for employees). Thus the increase in the per capita income of natives is small (less than \$30 a year). But the small size of this increase masks a substantial redistribution of wealth.

The net gain from immigration remains small even with an unrealistically high estimate of the impact of immigration on native earnings. Also the beneficial fiscal gain tends to neglect the increase population size. Thus there will be an increasing cost on government programs such as police protection, maintenance of roads, and preservation of parks, which haven't been taken into account.

In summary, immigration entails both gains and losses for the native population. The winners and the losers are typically different groups, and that policy parameters can be set in ways that attempt to maximize gains and minimize losses. The debate over immigration policy is not a debate over whether the entire country is made better off by immigration – the gains from immigration seem much too small, and could even be outweighed by the costs of providing increased social services.

The overall economic implications through immigration suggest a possible increase in the economic growth of Canada. Firms gain from an increased competition of the labour force (due to immigration) as they can hire workers at lower wages; and native consumers gain because lower labour costs lead to cheaper goods and services. In contrast, the costs of providing social services such as security, maintenance and park preservation can even exceed the gain from immigration. In addition, there exist socio-cultural and diplomatic issues that can arrive from an increased immigration flux, in which I discuss in the latter part of this section.

- **Socio-cultural and Diplomatic Issues**

The purpose of this section is to examine some of the obstacles that results from immigration. More precisely discuss the problems of implementing an immigration policy reform, over-crowding and finally political issues that may occur from immigration.

- **Notable Obstacles**

Attracting only skilled workers for next thirty years would be a major barrier. Note that immigration includes not only workers but also the whole family unit. It would be very difficult politically to exclude a person's family member (most notably spouse and children) even though it is possible that only one member might have working visa. Also another obstacle is the family class situation, which is recognized by Canada in the immigration policy of 1978. Once an immigrant as integrated (e.g. financially) into Canada, he might want to bring some of his relatives such as his parents in through the

boarder. These apparent scenarios will make the immigration policy reform (as discussed previously) much harder to implement. In addition, empirical studies¹⁰ have documented that middle-aged immigrants highly exceeds younger ones. They also note that one fifth of foreigners stay within a period of ten years or less after their first arrival (to complete their education for instance) into Canada. The reason is that they would return to aid in the economic development of their home country once possessing knowledge from abroad.

To sum up, while admitting a high number of high-skilled immigrants might be feasible from a domestic political point of view, attracting mostly high-skilled young aged immigrants might, in practice, be infeasible.

- **Over-crowding**

A concern is whether there are enough positions in the labour market for an increasing population, and will they be able to integrate into the Canadian economy? If yes, will they destroy other well-established markets leading to an increase in unemployment? If immigrants only move toward large markets, will there be dynamic socio-cultural problem?

As noted by Berridge (2002), Greater Montreal, Toronto and extending Ontario cities, the Calgary/Edmonton corridor and south-western B.C. account for 51% of the population in Canada. Moreover, his results indicate almost 80% of new immigrants are

¹⁰ Warren and Peck (1980); Jasso and Rosenzweig (1982); Brattsberg (1996)

destined for the 4 biggest cities in Canada and half exclusively to the Greater Toronto region.

Berridge states that Europeans crime rates have started raising ominously. These difficulties in part are due to an increasing immigration, which is a concern for the 4 biggest cities in Canada. Moreover, immigration will increase the cost on government programs such as police protection, maintenance of roads, and preservation of parks.

- **Political Issues**

Multiethnicity is already omnipresent, even irreversible. International migration coming from third world countries has dominated the migratory flux, transforming in important ways the ethnic and racial composition of countries. Thus multiculturalism has been the object of many political debates. Cincotta and Engelman (1997) state there is a fear that a high immigration rate might induce a brake down in Canada socio-cultural climate. For example, the province of Québec wants to favour its French culture but with an influx of foreigners this will be a hard climate to control. Also, both skilled and unskilled workers fear the presence of immigrants might fringe on their career opportunities (leading to an increase of unemployment).

The overall obstacles suggest that implementing an immigration policy reform (as mentioned before), in practice, would almost be unfeasible. Also, immigrants usually flock towards big cities, creating an over-crowding situation leading to a possible a rapid rise in crime rates for instance. Furthermore, not to neglect, there are political issues such

as a tear in the socio-cultural climate of Canada and fear that immigrants might fringe on their career opportunities of natives.

In the next part we will construct a model to reproduce the Canadian economy to later analyse first the affects of aging and then proceed by adding other factors such as immigration.

4. - Model

This section presents the methodology used in determining the impact of aging on the Canadian economy. The methodology used here has been adapted from two papers written by Mercenier and Mérette (2002). My model is a simplification of the model developed by Mercenier and Mérette (2002). The main difference is that, I do not separate general equilibrium model into six Canadian regions, fourteen industrial regions and twenty-five occupational groups. I conduct the Canadian economy as a whole, to simplify the research on determining the impact of aging on the economy. Must notably, I will investigate the effects on labour and capital demand, wages and interest rate, income taxes and prices. I start off by explaining the procedures of the model in detail. First, I present the various preliminaries sets and indexes. Next, I illustrate the various equations for both the producer and household's equations. Finally, I discuss the data and calibration needed to conduct the model.

- **Sets and Indexes**

The inter-provincial regions are denoted as i or j whereas the Rest Of the World is indexed as row .

The sectoral compassion in each region is noted as s for sectors, whereas labour is characterized in 3 ways: by the set of their qualification, occupation, and type, which are denoted respectively by $iqual$, $iprof$ and $itype$.

The generation composition is indexed as g where gj and gm are noted as the working generation and retired generation respectively.

First we will start from the producer side then the household's to finish off by analyzing the data.

- **From the Producer's Side**

A firm makes its production decisions to maximize profits or in the case of this model to minimize its costs. Firms use both intermediate goods and value added (capital demand and labour demand) to satisfy their constraint. Where intermediate goods are a factor of sectoral composition of the economy. Whereas value added depends on both the interest rate (for capital) and wages (for labour). Where labour, as mentioned previously, depends on qualification, occupation, and type.

- The Producer's Equations

Firm's constraint tries to minimize its costs through intermediate inputs, capital demand and labour demand

First we will demonstrate how do firms allocate their resources starting from composition of gross output and continuing for each of the sectoral components:

- Gross output ($Z_{j,s,t}$) is represented by a Cobb-Douglas form as function of both intermediate goods ($Q_{j,s,t}$) and value added ($X_{j,s,t}$):

$$Z_{j,s,t} = (ScCoZ_{j,s,t} \cdot Q_{j,s,t}^{A|Q_{j,s}}) \cdot X_{j,s,t}^{1-A|Q_{j,s}}$$

Where $ScCoZ_{j,s,t}$ is a scaling parameter of intermediate inputs and $AlQ_{j,s}$ is the factor share of the aggregate of intermediate inputs

- The aggregate intermediate goods ($X_{j,s,t}$) in itself is illustrated as a CES: (constant-elasticity of substitution)

$$X_{j,s,t} = (1 - AlQ_{j,s}) \cdot Z_{j,s,t} \cdot P_{j,s,t} / PX_{j,s,t}$$

Where the ratio $P_{j,s,t} / PX_{j,s,t}$ is the ratio between price of net output to the price of intermediate input and is represented by sectoral composition of intermediate demand ($XS_{ss,j,s,t}$)

$$XS_{ss,j,s,t} = AlXS_{ss,j,s,t} \cdot (PX_{j,s,t} / PC_{j,s,t})^{SigX_{j,s}} \cdot X_{j,s,t}$$

- The value added ($Q_{j,s,t}$) is also represented by a Cobb-Douglas form of both the capital ($Kdem_{j,s,t}$) and labour demand ($Ldem_{j,s,t}$)

$$Q_{j,s,t} = ScCoQ_{j,s,t} \cdot Kdem_{j,s,t}^{AlK_{j,s}} \cdot Ldem_{j,s,t}^{1 - AlK_{j,s}}$$

Where $ScCoQ_{j,s,t}$ is a scaling parameter of the capital demand and $AlQ_{j,s}$ is the factor share of the demand of capital

- Capital demand ($Kdem_{j,s,t}$) is the aggregate demand of capital times rent ($Rent_{j,t}$).

Labour demand ($Ldem_{j,s,t}$) is the aggregate labour services times wages ($Wage_{j,s,t}$) and

in its turn is represented by the type of labour ($Ltype_{j,s,itype,t}$):

$$L_{type,j,s,itpe,t} = A_{Type,j,s,itpe} \cdot \left(\frac{Wage_{j,s,t}}{W_{Type,j,s,itpe,t}} \right)^{SigLDem_{j,s}} \cdot L_{dem,j,s,t}$$

Where $A_{Type,j,s,itpe}$ is a parameter share of the type of labour. $SigLDem_{j,s}$ is the elasticity of the labour demand and $Wage_{j,s,t} / W_{Type,j,s,itpe,t}$ is the ratio of net wages to the wages of the different types of labour

- The type of labour ($L_{type,j,s,itpe,t}$) in its turn is characterized of the different levels of professions:

$$L_{prof,j,s,itpe,iprof,t} = A_{Prof,j,s,itpe,iprof} \cdot \left(\frac{W_{Type,j,s,itpe,t}}{W_{Prof,j,s,itpe,iprof,t}} \right)^{SigLType_{j,s}} \cdot L_{Type,j,s,itpe,t}$$

Where $A_{Prof,j,s,itpe,iprof}$ is a parameter share of the type of profession.

$SigLType_{j,s}$ is the elasticity of the labour demand and $W_{Type,j,s,itpe,t} / W_{Prof,j,s,itpe,iprof,t}$ is the ratio of the wages of the different types of labour to the wages of the different types of occupations

- The type of qualification ($L_{Qual,j,s,itpe,iprof,igual,t}$) in its turn is characterized of the different levels of professions:

$$L_{Qual,j,s,itpe,iprof,igual,t} = A_{Qual,j,s,itpe,iprof,igual} \cdot \left(\frac{W_{Prof,j,s,itpe,iprof,t}}{W_{Qual,j,s,itpe,iprof,igual,t}} \right)^{SigLProf_{j,s}} \cdot L_{Prof,j,s,itpe,iprof,t}$$

Where $A_{Qual,j,s,itpe,iprof,igual}$ is a parameter share of the type of qualification.

$SigLProf_{j,s}$ is the elasticity of the type of profession. $W_{Qual,j,s,itpe,iprof,igual} / W_{Prof,j,s,itpe,iprof,t}$

$w_{j,s,it} / w_{i,prof,t}$ is the ratio of the wages of the different types of qualification to the wages of the different types of occupations.

- **From the Household's Side**

In microeconomic models, a household chooses its purchases to maximize its level of satisfaction, which economists call *utility*. His budget constraint is that the present value of his lifetime consumption cannot exceed his initial wealth plus the present value of his labour income. The household problem is to choose the path of consumption to maximize his lifetime utility subject to his budget constraint.

In this model a household maximize his utility by choosing between bonds and capital stock. His wage is derived from the production he supplies to the producer. He might decide to consume the entirety of his income or bestow a portion of his earnings to next generation. Moreover he can receive an inheritance from the previous generation and can claim his pension once retired from the income taxes, which he had paid to the government during his working years of his life.

- The Household Equations

The amount of consumption ($Con_{j,t,g}$) and borrowing ($Lend_{j,t+1,g+1}$) of an agent constitutes the household budget constraint. Consumption (and Borrowing) is equal to the total of his wealth being his lifetime income earnings (including taxes on wages), any bonds or capital accumulation that he might possess, the amount of pension in which he

is entitled to after his retirement. Not to neglect the initial inheritance minus any bequest in which that agent might want to bestow to the next generation yields to the following equation:

$$\begin{aligned}
& 1 + \tau^k \cdot PCon_{j,t,g} \cdot Con_{j,t,g} + Lend_{j,t+1,g+1} = \\
& 1 - \tau^w - CTR_t \cdot \sum WQual_{j,it,ye,iprof,iqual,t} \cdot Lsup_{j,it,ye,iprof,iqual,g} \cdot EP_g \\
& + (\sum RintJ_{i,t-1} \cdot (PGov_{i,t} / PGov_{i,t-1}) + PGov_{i,t-1} + Bij_{i,j,t,g} - \\
& \tau^k \cdot \sum RintJ_{i,t-1} \cdot [(PGov_{i,t} / PGov_{i,t-1}) - 1] \cdot PGov_{i,t-1} \cdot Bij_{i,j,t,g} + \\
& \sum RRet_{i,t} \cdot Pint_{i,t-1} \cdot Kij_{i,j,t,g} - \tau^k \cdot \sum (RRet_{i,t-1} - 1) \cdot PInv_{i,t-1} \cdot \\
& Kij_{i,j,t,g} + (1 - \tau^w) \cdot Pens_{j,t,g} + Inh_{j,t,g} - Beq_{j,t,g}
\end{aligned}$$

Where τ^k and τ^w are respectively the tax rates on capital and wage.

The sum of the bequest of last generation ($\sum Beq_{j,t,gm} \cdot Pop_{j,t,gm}$) times the interest rate of inheritance ($InhR_{j,g}$) is what is transferred to working generation. Thus inheritance ($Inh_{j,t,g} \cdot Pop_{j,t,g}$) is what is given to working generations once the last generations exits the model:

$$Inh_{j,t,g} \cdot Pop_{j,t,g} = InhR_{j,g} \cdot \sum Beq_{j,t,gm} \cdot Pop_{j,t,gm}$$

Where $Pop_{j,t,g}$ is the number of individuals living in region j of an age group g at period t

The pension benefits ($Pens_{j,t,gm}$) that are transferred to retirees are proportional to the rate of pension replacement ($PensR_j$) and the sum of each of the individual's lifetime labour income:

$$\text{Pens}_{j,t,gm} = \text{PensR}_j \cdot \frac{1}{5} \sum \text{WQual}_{j,s,it\text{ype},i\text{prof},i\text{qual},t} \cdot \text{Lsup}_{j,it\text{ype},i\text{prof},i\text{qual},gj} \cdot \text{EP}_{gj}$$

Where we can denote that the sum of retiree's lifetime earnings as being the sum of the wage qualifications ($\text{WQual}_{j,s,it\text{ype},i\text{prof},i\text{qual},t}$) of each unit of labour supplied ($\text{Lsup}_{j,it\text{ype},i\text{prof},i\text{qual},gj}$) in respect to their earning profile (EP_{gj}).

Moreover retiree's lifetime income is divided in five since each individual works a total of five periods.

The first order condition of the household's budget constraint in respect to consumption and bequest are:

$$\text{Con}_{j,t,g+1} = \frac{(1 + (1-\tau^k_{j,t}) \cdot \text{RRet}_{j,t} \cdot \text{PCon}_{j,t,g})^{\text{Sig}_j}}{(1+\rho_j) \cdot \text{PCon}_{j,t+g}} \cdot \text{Con}_{j,t,g}$$

$$\text{Beq}_{j,t,g} = \text{BeqR}_{j,g} \cdot \text{Pcon}_{j,g,t} \cdot \text{Con}_{j,t,g}$$

Household must choose in the second step between the final available goods s :

$$\text{ConS}_{j,s,t,g} = \text{ALConS}_{j,s,g} \left(\frac{\text{PCon}_{j,t,g}}{\text{PC}_{j,s,t}} \right)^{\text{sigCon}_{j,g}} \cdot \text{Con}_{j,t,g}$$

$$\text{PCon}_{j,g,t} = \sum \text{ALConS}_{j,s,g} \cdot \text{PC}_{j,s,t}$$

Where $ConS_{j,s,t,g}$ is the consumption of good s , $PCon_{j,g,t}$ the price of consumption and $ALConS_{j,s,g}$ the parameter share toward consumption of good s

Holding of bonds ($Bij_{i,j,t,g+1}$) and physical capital ($Kij_{i,j,t,g+1}$) are defined as:

$$Pgov_{i,t} \cdot Bij_{i,j,t,g+1} = \frac{\sum Bij_{i,j,g}}{\sum Bij_{j1,j,g}} \cdot Lend_{j,t,g+1} - \frac{\sum Pin_{j1,t}}{\sum Pin_{j1,t}} \cdot Kij_{j1,j,t,g+1}$$

$$Kij_{i,j,t,g+1} = Kij_{i,j,g+1} / Kstock_{i,t} \cdot Kstock_{i,t}$$

It is assumed both bonds and capital are perfect substitutes, thus it doesn't matter how households allocate their wealth in terms of bonds or capital accumulation.

- The Investors Equations

Investors maximize their utility by accumulating the desired capital stock. They have the choice between many technologies at their disposal. Investors rent capital up to a point where their marginal revenue product equals their rental price. The cost of capital depends on three factors:

- the interest rate, which is the rate of return of capital stock
- the depreciation rate, at which capital can lose its value due to depreciation
- the price of capital, which can be perceived as being a change in the value of the already existing capital stock

The capital stock of each region ($K_{j,t+1}$) is the total amount of investment ($Inv_{j,t}$) including the depreciation rate ($DepR_j$) to the existing capital stock ($K_{j,t}$)

$$K_{j,t+1} = Inv_{j,t} + (1 - DepR_j) \cdot K_{j,t}$$

The expected rate of return ($R_{j,t}$) on capital is defined as the expected real rental rate of capital ($Rent_{j,t}$) including the depreciation rate ($DepR_j$) to the ratio of the price of investment ($P_{j,t} / P_{j,t-1}$):

$$R_{j,t} = Rent_{j,t} + (1 - DepR_j) \cdot P_{j,t} / P_{j,t-1}$$

Similarly to consumption, investors must choose between the available technologies to optimize their constraint, which yields to the following conditions:

$$Inv_{j,s,t} = \frac{A_{j,s,t} \cdot P_{j,t} / P_{j,t-1}^{\sigma_{j,s,t}}}{\sum_s A_{j,s,t} \cdot P_{j,t} / P_{j,t-1}^{1-\sigma_{j,s,t}}} \cdot Inv_{j,t}$$

Where $Inv_{j,s,t}$ is the investment toward good s , $P_{j,t}$ the price of technology and $A_{j,s,t}$ the parameter share toward investment

Actual investment ($Inv_{j,t}$) is defined as the existing capital stock ($K_{j,t}$) including a rate of depreciation ($DepR_j$):

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

- The Government Equations

The government receives taxes from the working agents and firms and redistributes that revenue toward public purchases such as most notably health services, education sector and to finance pension regime going toward the retirees. Like the consumers the government also has a budget constraint, which is, the present value of its purchases of goods and services must be less and equal than its initial wealth plus the present its tax receipts. Note that government purchases must be less or equal to taxes minus any debt that the government may have occurred throughout the years.

Similarly to investment, the government must allocate its resources between consumption and interest debt payments:

$$PGov_{j,t}^{1-sigGov_j} = \sum ALGov_{j,s} \cdot PC_{j,s,t}^{1-sigGov_j}$$

$$GovS_{j,s,t} = ALGov_{j,s} \cdot PGov_{j,t} / PC_{j,s,t}^{1-sigGov_j} \cdot Gov_{j,t}$$

Where $GovS_{j,s,t,g}$ is the expenditure toward public goods, $PGov_{j,g,t}$ the price of technology and $ALGov_{j,s,g}$ the parameter share toward government purchases

The pay-as-you-go pension benefits ($Pens_{j,t,gm}$) are financed by the contribution rate (CTR_t) of total wage earnings of each worker:

$$\Sigma Pop_{j,t,gm} \cdot Pens_{j,t,gm} = CTR_t \cdot \Sigma Pop_{j,t,g} \cdot EP_g \cdot \frac{\Sigma WQual_{j,ittype,iprof,iqual,t} \cdot Lsup_{j,ittype,iprof,iqual,g}}{\Sigma WQual_{j,ittype,iprof,iqual,t} \cdot Lsup_{j,ittype,iprof,iqual,g}}$$

The government budget constraint is the sum of the taxes received from Incomes, Pensions, Bonds, Physical Capital which are transferred to pay for government purchases such as Education ($GovE_{j,s,t}$) and Health ($GovH_{j,s,t}$):

$$\begin{aligned} & PGov_{j,g,t} Bond_{j,t+1} + \\ & \Sigma Pop_{j,t,g} \cdot [\tau_{j,t}^w (\Sigma WQual_{j,ittype,iprof,iqual,t} \cdot Lsup_{j,ittype,iprof,iqual,g} \cdot EP_g) + \tau_{j,t}^w \cdot Pens_{j,t,g} + \tau_{j,t}^{Con} Pcon_{j,t,g} Con_{j,t,g} \\ & + \tau_{j,t}^k \Sigma (Rint_{i,t-1} \cdot PGov_{j,t} / PGov_{j,t-1} - 1) \cdot PGov_{i,t-1} \cdot Bij_{i,j,t,g} \\ & + \tau_{j,t}^k \Sigma (RRet_{i,t-1} - 1) \cdot Pinv_{i,t-1} \cdot Kij_{i,j,t,g}] \\ & = PGov_{i,t-1} \cdot Gov_{j,t} + \Sigma (GovH_{j,s,t} + GovE_{j,s,t}) + \\ & (Rint_{i,t-1} \cdot PGov_{j,t} / PGov_{j,t-1}) + PGov_{j,t-1} \cdot Bond_{j,t} \end{aligned}$$

Where $\tau_{j,t}^{Con}$ & $\tau_{j,t}^w$ are the tax rate on consumption and wages respectively.

The foreign trade and Rest of the World equations are tools which enables us to calculate the total domestic and foreign demands which will be used to investigate the interaction in the trade patterns which can alter dramatically due to relative price fluctuations between Country 1 and Country 2 which I will undergo to explain later on in the result part of this research.

- The Foreign Trade Equations

The price of intermediate goods ($PC_{j,s,t}$) is determined as the sum of the expenditure share towards intermediate goods ($ALCI_{ii,j,s}$) of the price of net output ($P_{ii,s,t}$):

$$PC_{j,s,t} = \sum ALCI_{ii,j,s} \cdot P_{ii,s,t}$$

The total demand is the sum of all sectoral composition of Consumption, Investment, Public purchases and Intermediate goods ($XS_{s,j,ss,t}$) and proportional to the expenditure share towards intermediate inputs and to the ratio of the price of intermediate inputs to the price of net output:

$$E_{ii,j,s,t} = ALCI_{ii,j,s} (PC_{j,s,t} / P_{ii,s,t})^{1-SigC_{j,g}} (\sum Pop_{j,t,g} \cdot Cons_{j,s,t,g} + InvS_{j,s,t} + GovS_{j,s,t} + \sum XS_{s,j,ss,t})$$

- The Rest of the World Equations

The demand of the rest of the World ($E_{j,row,s,t}$) is comprised of the sectoral composition of the international demand ($EO_{j,row,s}$) and is proportional to the ratio of the price of international price to the price of total net output ($P_{row,s,t} / P_{j,s,t}$):

$$E_{j,row,s,t} = EO_{j,row,s} (P_{row,s,t} / P_{j,s,t})^{\eta^s}$$

Furthermore, to ensure the budget constraint of the demand of the rest of the World as a whole we must take into account the ratio of the price total net output to the price of rest World:

$$\sum \sum P_{jj,s,t} E_{jj,row,s,t} / \sum P_{row,s,t} = \sum E_{row,jj,s,t}$$

- Market Equations

To ensure the equilibrium conditions:

- of goods, total net output must equal to sum of total demand and to the public expenditures:

$$Z_{j,s,t} = \sum E_{j,ii,s,t} + GovH_{j,s,t} + GovE_{j,s,t}$$

- of full employment, the sum of the each of unit of labour supplied must equal the sum of their qualification

$$\sum Pop_{j,t,g} \cdot Lsup_{j,ittype,iprof, ical,g} EP_g = \sum LQual_{j,s,ittype,iprof, ical,t}$$

Where wages of qualification ($WQual_{j,ittype,iprof, ical,t}$) is determined by the ratio of expected rate of return over the sectoral composition of the rate of return:

$$WQual_{j,ittype,iprof, ical,t} = Rent_{j,t} / Rent(0)_j$$

- of capital allocation, the existing capital stock must equal the total demand of capital:

$$Ksc0_j \cdot Kstock_{j,t} = \sum Kdem_{j,s,t}$$

- of interest rates, real interest rate must equal the expected rate of return and inflation which in our model is the ratio of the price of public expenditure:

$$Rint_t = RRet_{j,t} \cdot PGov_{j,t+1} / PGov_{j,t}$$

- of the market to prevail, the sum of the withdrawal of the total population must equal to the sum of bonds and capital in respect to their prices:

$$\sum \sum Pop_{j,t,g+1} \cdot Lend_{j,t,g+1} = \sum PGov_{j,t} \cdot Bond_{j,t} + PInv_{j,t} \cdot Kstock_{j,t}$$

- **Data and Calibration**

The study is based on Social Accounting Matrix (SAM), which is consistent with macroeconomic data in terms of production, investment, consumption, and aggregate demand...

My goal is to assess the impact of Canadian immigrants on the Canadian born population within the framework of the life cycle theory of consumption, savings and investment which was first developed by Mondigliani (1966). He states "if the consumer smoothes consumption over life, she will save and accumulate wealth during her working years and then dissave and run down her wealth during retirement"

Moreover the model uses overlapping generation models (because of its dynamic nature) to calculate the demographic effects on living standards for each cohort. There are

six age groups each lasting for a period of ten years. They start off at the 15 years of age, at which time they immediately start working up to the age of 64 in which they retire. Thus they work in their first five age periods, and retire in the last one (thus exiting to model at the age of 74).

In addition, the assumptions are that 1) the children (first generation) bear no burden to their parents and can provide for themselves (but can ultimately receive bequest from the previous generation). 2) Each individual lives the entirety of his life span. (i.e. each person is alive at any time during the six periods) 3) When the individuals of the last generations die they are replaced by a new generation who enters the labour force. 4) Each individual works at one moment of his or her life (thus no unemployment)

The Model is composed of three regions, which are Eastern Canada, Central-Western Canada and the rest of the World. This is an open economy meaning that there is a flurry of inter-provincial trades between the two Canadian regions and international trade flows with the rest of the World.

There are only two commodities being exchanged in each region. We will denote them as being the service sector composed of education, health, public administration etc... and the non-service sector comprised of both the primary and manufacturing sectors.

Labour is also divided into three categories. These categories determine 1) the type of labour 2) the occupation of the each person 3) the level of qualification of each worker. The first category states the type of labour, which is divided into two groups being labour-intensive and capital-intensive. The second category specifies the professions of each person, which is divided into two groups being employees of the private sector and the public sector. The third category illustrates the qualifications of each worker, which is divided into two groups, which are high-skilled workers and low-skilled workers.

The calibration consists in reproducing a set of macroeconomic data in conjuncture to the Canadian economy.

The parameters of the model are the following:

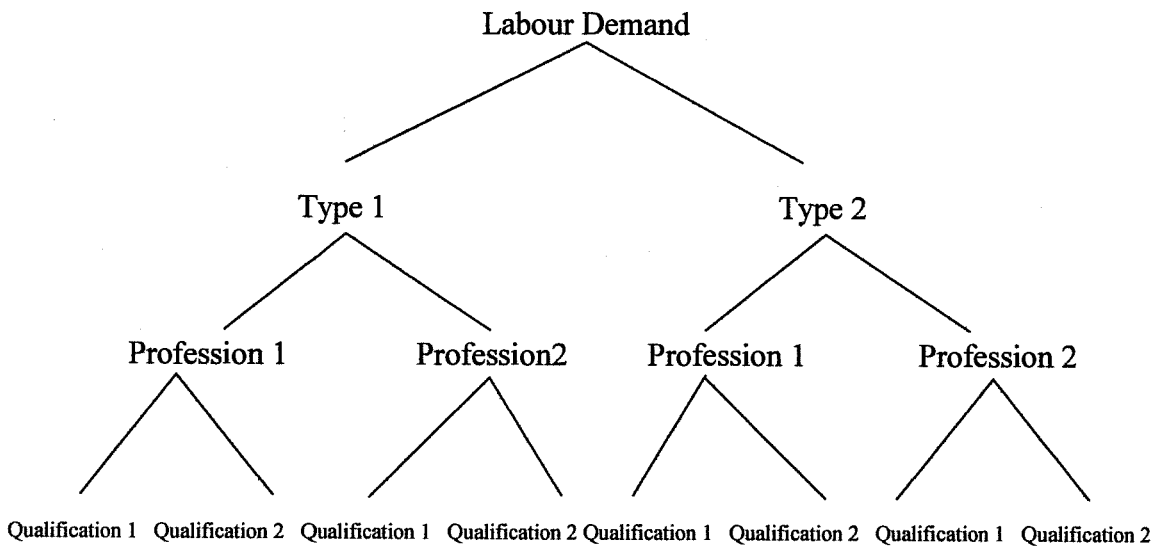
Elasticity of Labour Demand	3.0	Price elasticity	3.0
Elasticity of Labour Type	3.0	Interest Rate	1.4
Elasticity of Labour Profession	2.5	Depreciation Rate	0.3
Elasticity of Value Added	3.0	Bequest Rate	0.5
Elasticity of Consumption	2.5	Inheritance Rate	0.2
Elasticity of Investment	3.0	Discount Rate	-0.17
Elasticity of Government Expenditure	3.5		
Elasticity of Consumption	1.5		

Since the model is symmetric, all the elasticity's and rates are the same in each region.

To verify the constraints we must calibrate certain parameters so that the economy follows certain equilibrium conditions such as the total supply equals total demand.

For technologies:

Labour demand must be equal the sum of the type of labour, which in turn is the sum of the occupation of labour, which is the sum of the qualification of labour. Thus there are a total of 8 different scenarios shown below:



For balancing SAM (Social Accounting Matrix):

GDP must equal the sum of value added (VA) plus consumption (C), investment (I) government expenditure (G) and the sum of net exports, which equal to 0 since the model is symmetric.

Gross output must equal to the sum of capital production (K) and labour demand (Ldem), which in turn is equal to sum of labour type seen previously. Capital share must equal total capital production over gross output, thus labour share must be 1 minus capital share. Value added share is total value added over GDP. These equations must be ensured

so that the SAM is balanced out. In our model the SAM is supposed to look as the following:

Social Accounting Matrix

	C	I	G	VA	Ldem	K	C1	C2	Total
C							60	60	120
I							20	20	40
G							20	20	40
VA							50	50	100
Ldem				50	40	60			150
K				50	40	60			150
C1									
C2									
Total				100	80	120	150	150	300

Since the model has two countries (Canada and Rest of the World) with a GDP of 150 units respectively, total GDP in the World would be 300 units. As we can see in the bottom line of the SAM the sum of capital production (120), labour demand (80) and value added (100) is equal to 300 units same as the total of the sum of consumption, investment, government expenditures of both countries (C1 and C2) combined (150 + 150). In the last column of the SAM, we can see that the assumptions are also satisfied since the sum of C (120) + I (40) + G (40) + VA (100) is equal to 300 unit same as the sum of labour demand (150) and capital (150).

For balancing the trade flows:

Imports must equal exports, to verify the equation (in our model) imports is equal to the total demand of each sector from region i to region j and thus exports is the total demand of each sector from j to region i. Moreover total demand of each sector is equal to GDP, which is the sum of C + I + G + VA of each sector.

Balancing other conditions: (to ensure the integrity of the model)

Labour supply must equal labour demand, which is (labour supply) the sum of each of the workers type, occupation and qualification divided by the sum of the population in contrast to their earning profile. Total pension accumulation must equal to the contribution pension rate of the wages of each unit of labour. Total investment, consumption, government purchases is equal to I, C, G of each of their sectors furthermore capital stock is equal to total investment depreciated over time.

Balancing the household and government equations:

As mentioned before, household optimizes his or her utility (consumption and savings) subject to their life income (including taxes). Government maximizes its utility (public finances and purchases) subject to the level of taxes levied from the household including any debt it may have occurred.

Last we verify equilibrium conditions:

The trade balance must equal to zero, to verify the equation net total demand from region i to j minus net total demand from region j to i is nil.

Walras' law must be fulfilled this is done by subtracting GDP to sum of demand and government purchases to health and education.

The asset balance must be verified i.e. the rate of return on human and physical capital (such as education and savings) of the sum of each agent must equal the total amount of bonds and capital stock. Thus their subtraction will be equal to 0.

5. – Results

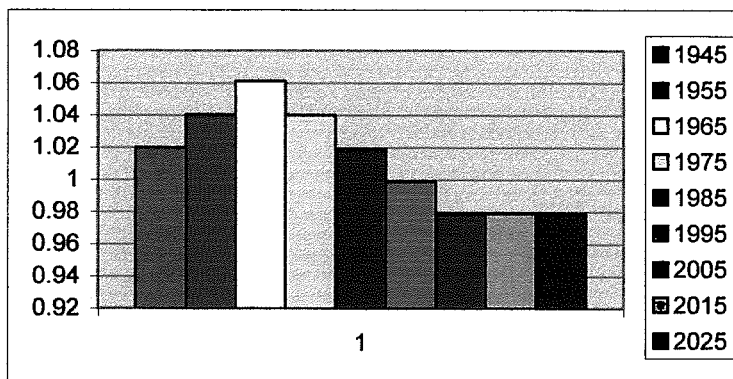
In this section, I conduct four simulations. The first simulation imposes a symmetric demographic shock on both countries. Next, I experiment a simulation with asymmetric demographic shock between two countries (Canada and the Rest of the World). In the third simulation, I present a scenario similar to the second one, but this time I introduce an increased level of immigration. Finally, I simulate a model similar to the previous one, but in this case, I assume that immigrants' productivity level differ from the level shown by native-born residents. Note that I will give my own critical analysis of the results in the 'conclusion' section of my research.

- **Symmetric Demographic Shock**

This simulation consists of a period of sustained population growth rate followed by a period of a rapid decline. Note that all results can be seen in Appendix 3.

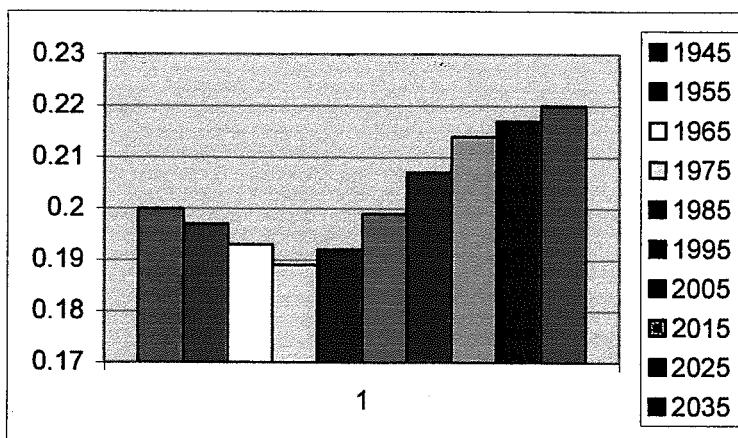
The reason for this experimentation is to reproduce the baby boom and baby bust period that has occurred between 1945 and 2005. The baby boom takes place during the first three periods (10 years a period). The baby bust follows the next three periods until 2005. In the simulation experiment, I assume that the growth rate of the population for the upcoming two periods (from 2005-2025) is the same to the level of 2005. Then the population growth rate smoothes to a level of no growth by 1945.

Population Growth Rate



The simulation suggests that tax rate of each individual declines (from 20% in 1945 to 18.8% in 1975) initially since the level of growth is high. In contrast, after 1975 this trend is reversed. The reason is that the population growth rate is declining, therefore the new generation would see an increase in there tax rates (from 18.8% in 1975 to 22% in 2035) necessary to payoff for the increased costs of the health care system. Thus this scenario will continue through out the century.

Tax Wages



Wages decline (from 1 unit in 1945 to 0.937 in 2035) due to the entry of a growing number of workers. This trend subsequently alters when the number of workers starts declining (from 0.937 unit in 2035 to 0.956 in 2065).

Since wages decrease initially, the compounded interest rates (done over a ten year span) increase (from 30% in 1945 to 31.2% in 1975) since the ratio of capital/labour is relatively low. After 1975 this trend starts to be reversed due the shortage of labour demand (the compounded interest fall to 30.8% by 2035). Productivity increases since fewer workers are furnished with a relatively abundant supply of capital.

Investment per sector increases (from a 9.9 units in 1945 to 11.7 in 2015) at first due to a rise in the rate of return of investment. Then investment per sector falls gradually (from 11.7 units in 2025 to 10.6 in 2065) during the latter stage of the experiment. Thus output grows from 100 units in 1945 to 115 in 2035, and then stabilizes at a lower level of 111 units in 2065.

- **Asymmetric Demographic Shock**

The purpose for the simulation is to run the baby boom baby bust trend as done previously. This time, however, we only experiment on the first country (Canada) and speculates no changes for the second country (Rest of the World). The objective here is to investigate the trade patterns and interactions between the two countries. Note that all results can be seen in Appendix 4.

I assume here for Canada the same demographic as in the previous experiment. For the Rest of the World, I assume a constant population.

Tax wages increase in Canada (from 18.8% in 1975 to 22.6% in 2035), as in the previous experiment. The reason is that domestic (Canadian) prices with respect to foreign prices of commodities decreases. To payoff the upcoming pensions woes an additional tax hike for Canada would be necessary. In contrast, taxes decrease (from 20.1% in 1975 to 19.3% in 2035) in the Rest of the World.

Wages decline (from 1 unit in 1945 to 0.99 in 1975) as before with the growing number of workers. However, contrary to the previous simulation experiment, wages do not increase and keep declining (from 0.99 unit in 1975 to 0.93 in 2035) in Canada. Wages increase slightly (from 1 unit in 1945 to 1.01 unit in 2035) for the Rest of the World since the relative price of their output increases.

The compounded interest rate rise (from 30% in 1945 to almost 32% in 2005) then fall (to 30.4%) for Canada (for the same reasons previously mentioned), whereas the Rest of World rates increase by small fraction (from 30% in 1945 to 30.6% in 2005).

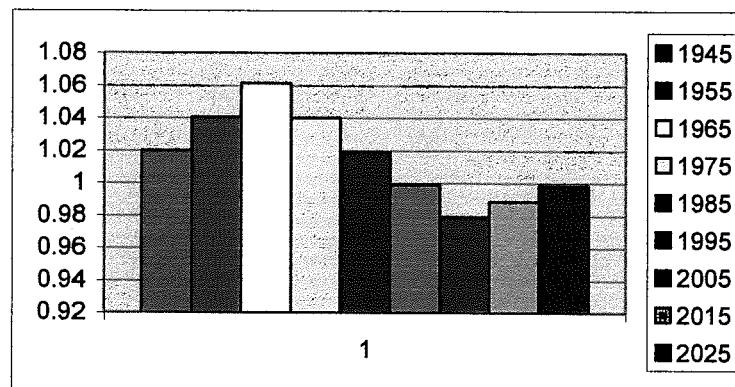
Investment per sector rises in Canada (from 10 units in 1945 to 11.6 in 2035) then falls (to 10.6 in 2065) for the same reason mentioned previously. In contrast, we notice a small increase (from 9.9 units to 10.06 in 2035) in the investment per sector for the Rest of the World (due to an increase in their interest rates). Output follows the same pattern

as the previous simulation for Canada (a rise from 100 units in 1945 to 114 in 2035, then stabilizes to 109 unit from 1085). Whereas it rises ever so slightly for the Rest of the World (at 100.5 units) since investment increases.

- **Asymmetric Demographic Shock with Immigration**

The purpose of the simulation is to investigate the effects of increased immigration on a country (Canada). We run the same simulation as done for the asymmetric demographic shock. This time, we make the assumption that immigration helps alleviate some of the drop of growth rate of the population for country one (Canada) after the baby bust period (from 2005-2025). Note that all results can be seen in Appendix 5.

Population Growth Rate



Wages drop and keep on dropping for a long period (from 1 unit in 1945 to 0.927 in 2035) of time. The reason is that immigration tends to increase the growth rate of the population.

The simulation suggests that tax wages decline (from 20% in 1945 to 18.8% in 1975) initially since population growth rate is high. In contrast, the tax rate rapidly returns to its previous level (from 18.8% in 1975 to 23% in 2055) during the baby bust period (after 1975), then increases for a long period of time at a higher rate than in the previous simulation. For the Rest of the World wage taxes decrease slightly (from 20% in 2005 to 19% in 2055).

Since wages decrease (from 1 unit in 1945 to 0.94 in 2005) in Canada, the compounded interest rate increases (from 30% to almost 32% in 2005) due to a drop in the ratio of capital-labour. Furthermore, the rate remains at a higher level (at 30.6% starting from the year 2035) throughout the time horizon since the growth rate of the supply of labour declines).

Output is higher due to an increase in the stocks of capital and labour. Output rises from 100 units in 1945 to 114.4 units in 2035.

- **Asymmetric Demographic Shock with Immigration Productivity**

The purpose of the simulation is to investigate the effects of increased immigration on a country (Canada) assuming this time that immigrants are twenty percent less productive than their native counterparts during the first 20 years of entry into the country (from 2005-2025). Following that period, the productivity of immigrants is assumed identical to the level of Canadian natives. Note that all results can be seen in Appendix 6.

Similarly to the previous simulation, wages suffer a sustained continuous drop (from 1 unit in 1945 to 9.27 in 2035) throughout the time span of the experiment. Moreover, the simulation illustrates that tax wages decline (from 20% in 1945 to 18.8% in 1975) initially since the growth rate of the supply of workers is high. In contrast, the tax rate rapidly returns to its previous level (from 18.8% in 1975 to 21.7% in 2025) during the baby bust period (after 1975). For the Rest of the World tax wages decrease slightly (from 20% in 2005 to 19.6% in 2025) for the same reasons mentioned in the previous simulation.

Since wages decrease (from 1 unit in 1945 to 0.946 in 2005) in Canada, the compounded interest rate increases (from 30% to almost 32% in 2005) due to a drop in the ratio of capital/labour as the number of workers increases. In contrast to the previous experiment, this rate takes a small dip then keep rising (to 32.4% in 2045) since the immigrants' productivity begins to reach parity to those of natives. But shortly afterwards, the compounded interest rate falls (to 31.4% in 2065) since the overall labour productivity decreases (due to a rise of labour demand coming from abroad).

Investment per sector increases from 10 units in 1945 to 11.03 in 2025 (for the same reasons mentioned above) but at a relatively slower pace than the previous simulation.¹¹ The main factor behind the relative decline in investment growth is the lower productive contribution of immigrants (as stated above). Moreover, investment per sector stays relatively high (at 10.7 units beginning from the year 2085) throughout the

¹¹ Established at 11.6 in 2025

following periods. Thus output grows at a slower pace (from 100 units in 1945 to 109 units in 2035) than the previous simulation¹² due to the relative decline of investment.

¹² Established at 114.4 in 2025

6. - Conclusion

From the last simulation, the increased in labour supply from immigration despite their lower productivity level raises gross domestic product in Canada in the long run. The reason is that investment increases. Also, public purchases also increase to offer public services to an over-growing population. However, the increased labour supply resulting from immigration does not reduce tax on wages. The simulation suggests that immigration would not generate sufficient fiscal surplus to reduce future taxation. The reason is the new inflow of immigrants tends to drop wages and domestic relative output prices

Note that the model does not take into account any socio-cultural effects that might come from an over increased immigration. Moreover it would be hard to determine if over congestion in large cities and resources exploitation as mentioned before would outweigh the added knowledge that immigrants would contribute to a nation.

As a final remark, Canada should be careful in its decision on increased immigration, even though it is apparent that aging will induce some negative economic that may be impossible to overcome.

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8. - Appendix

Appendix 1

History of Canadian Pension Plan (CPP)

The CPP is a pay-as-you go system unlike a private pension plan which people pay money into a fund while they work and get it back, with interest, when they retire. Instead a good part of the pension payments to the currently retired are paid out of contributions revenues, all of which are levied on those currently working.

A major problem was the late establishment of pension plans in many countries, the first public pension in Canada was created in 1927 but the actual system was established in 1966, and modifications to pension plan were slow to develop in rise to of baby boomers going in to retirement.

2 major problems were:

- The low tax rate toward pensions to begin with, in 1966 the contribution rate was only at 3,6 percent and that rate on pensions never increased until 1987. The rate only increased at an annual average of about 0.2 percent from 1987 to 1996 (to a tax rate of about 5.6 percent)
- Another problem is that the reserve (e.g. Quebec) are already drawing to an end, at the end of 1994 was at \$14.6 billion but the withdrawals exceeded the entries \$4.8 billion vs \$4.5 billion (not including the administration costs)

These scenarios should lead to a complete drainage of the reserve in the year 2006.

Method of not depleting the reserves, is an increase in pension taxes:

- About 7.6% in the upcoming years
- 8.9% in roughly ten years
- at 13% by 2023

To counteract this scenario a new pension sequence has been established in 1998, its goal is to rapidly increase the contribution rate from 6 percent in 1997 up to 9 percent in 2003 but at that rate the contribution would remain stable for a good time length, the reason is the government wants to capitalize (as Chili in 1985) partially the pension regime to around 20 percent, part of the revenues of the placement generated by the reserve would be invested to be used to compensate the rise in taxes and to prevent a hike of 13 percent in 2023. (All data provided by the Analyse Actuarielle du régime de rentes du Québec 2000)

Appendix 2

Easterlin hypothesis

“The Easterlin, or ‘cohort size’, hypothesis posits that, other things constant, the economic and social fortunes of a cohort (those born in a given year) tend to be vary inversely with its relative size, approximated by the crude birth rate in the period surrounding the cohort’s birth (Easterlin, 1980). The linkage between higher birth rates and adverse economic and social effects arises from what might be termed ‘crowding mechanisms’ operating within three major social institutions – the family, school and labour market. Empirically, the most important application of the hypothesis has been to explain the varying experience of young adults in the United States since World War II, although there is some evidence of its relevance to the experience of developed countries more generally in this period. The hypothesis has led to recognition of the possibility of a self-generating fluctuation in current and future United States experience with a period of around four to five decades.”

Appendix 3: Symmetric demographic shock

Symmetric demographic shock

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	Ldem	Output
1945	1.02	1.3	0.2	1	9.984	10	33.333	30	100
1955	1.0404	1.302	0.197	1	9.971	10	33.318	30	99.981
1965	1.0612	1.305	0.193	0.998	9.991	10.033	33.293	30.102	100.15
1975	1.04	1.312	0.189	0.991	10.107	10.135	33.296	30.428	100.79
1985	1.0192	1.319	0.192	0.979	10.391	10.346	33.414	31.123	102.27
1995	0.9988	1.324	0.199	0.965	10.84	10.631	33.781	32.115	104.62
2005	0.9788	1.324	0.207	0.95	11.381	10.954	34.486	33.289	107.71
2015	0.9788	1.319	0.214	0.94	11.734	11.274	35.521	34.376	111.03
2025	0.9788	1.313	0.217	0.937	11.771	11.519	36.599	35.087	113.69
2035	1	1.308	0.22	0.94	11.429	11.654	37.39	35.24	114.94
2045	1	1.305	0.219	0.946	11.073	11.641	37.602	34.951	114.64
2055	1	1.305	0.219	0.952	10.766	11.552	37.394	34.485	113.49
2065	1	1.307	0.219	0.956	10.6	11.426	36.942	34.012	112.04

Note: Since the model is symmetric, the values for both countries will be identical

Legend

Time: Time period

G. rate: Population growth rate

Int.: Rate of return

T. Wage: Tax Wage

Wage: Income

InvS: Investment by sector

GovS: Public expenditure by sector

Kdem: Capital demand

Ldem: Labour demand

Output: Gross output (and not GDP)

Appendix 4: Asymmetric Demographic Shock

Appendix 4a.

Asymmetric Demographic Shock for Canada (Country 1)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1.02	1.3	0.2	1	10.002	10	33.333	30	100	1
1955	1.0404	1.301	0.197	1	10.007	10	33.336	30	100.01	1
1965	1.0612	1.304	0.193	0.998	10.059	10.033	33.342	30.102	100.21	1
1975	1.04	1.309	0.188	0.992	10.206	10.135	33.398	30.428	100.89	0.998
1985	1.0192	1.314	0.191	0.98	10.493	10.346	33.584	31.123	102.41	0.992
1995	0.9988	1.318	0.199	0.963	10.899	10.631	34.002	32.115	104.73	0.984
2005	0.9788	1.318	0.207	0.946	11.362	10.954	34.7	33.289	107.71	0.974
2015	0.9788	1.314	0.216	0.932	11.652	11.274	35.653	34.376	110.82	0.964
2025	0.9788	1.309	0.221	0.926	11.662	11.519	36.609	35.087	113.25	0.957
2035	1	1.304	0.226	0.928	11.348	11.654	37.288	35.24	114.32	0.954
2045	1	1.302	0.228	0.933	11.023	11.641	37.45	34.951	113.96	0.954
2055	1	1.301	0.229	0.939	10.752	11.552	37.237	34.485	112.83	0.956
2065	1	1.303	0.23	0.943	10.604	11.426	36.818	34.012	111.44	0.96

Appendix 4b.

Asymmetric Demographic Shock for the Rest of the World (Country 2)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1	1.3	0.2	1	9.982	10	33.333	30	99.997	1
1955	1	1.301	0.2	1	9.964	10	33.315	30	99.974	1
1965	1	1.301	0.2	0.999	9.931	10	33.284	30	99.941	1
1975	1	1.303	0.201	0.999	9.9	10	33.231	30	99.896	1
1985	1	1.304	0.201	1	9.896	10	33.161	30	99.863	1.001
1995	1	1.305	0.201	1.002	9.937	10	33.109	30	99.881	1.003
2005	1	1.306	0.2	1.005	10.01	10	33.114	30	99.987	1.005
2015	1	1.305	0.198	1.008	10.066	10	33.19	30	100.18	1.007
2025	1	1.305	0.196	1.012	10.087	10	33.299	30	100.38	1.008
2035	1	1.304	0.193	1.013	10.06	10	33.396	30	100.52	1.008
2045	1	1.304	0.192	1.014	10.035	10	33.438	30	100.57	1.008
2055	1	1.304	0.191	1.014	10.004	10	33.441	30	100.56	1.009
2065	1	1.304	0.19	1.014	9.99	10	33.413	30	100.51	1.009

Appendix 5: Asymmetric Demographic Shock with Immigration

Appendix 5a.

Asymmetric Demographic Shock with Immigration for Canada (Country 1)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1.02	1.3	0.2	1	10.002	10	33.333	30	100	1
1955	1.0404	1.301	0.197	1	10.007	10	33.336	30	100.01	1
1965	1.0612	1.304	0.193	0.998	10.059	10.033	33.342	30.102	100.21	1
1975	1.04	1.309	0.188	0.992	10.206	10.135	33.398	30.428	100.89	0.998
1985	1.0192	1.314	0.191	0.98	10.493	10.346	33.585	31.123	102.41	0.992
1995	0.9988	1.318	0.199	0.963	10.899	10.631	34.002	32.115	104.73	0.984
2005	0.9788	1.318	0.207	0.946	11.361	10.954	34.7	33.289	107.71	0.974
2015	0.9788	1.314	0.215	0.932	11.651	11.274	35.652	34.376	110.82	0.964
2025	0.9788	1.309	0.219	0.926	11.665	11.519	36.607	35.087	113.25	0.957
2035	1	1.306	0.223	0.927	11.378	11.673	37.29	35.298	114.43	0.953
2045	1	1.305	0.227	0.93	11.119	11.716	37.482	35.19	114.44	0.953
2055	1	1.305	0.23	0.932	10.928	11.684	37.356	34.925	113.78	0.954
2065	1	1.306	0.231	0.934	10.868	11.615	37.077	34.666	112.96	0.955

Appendix 5b.

Asymmetric Demographic Shock with Immigration for the Rest of the World (Country 2)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1	1.3	0.2	1	9.982	10	33.333	30	99.997	1
1955	1	1.301	0.2	1	9.964	10	33.315	30	99.974	1
1965	1	1.301	0.2	0.999	9.931	10	33.284	30	99.941	1
1975	1	1.303	0.201	0.999	9.9	10	33.23	30	99.896	1
1985	1	1.304	0.201	1	9.896	10	33.161	30	99.863	1.001
1995	1	1.305	0.201	1.002	9.936	10	33.108	30	99.88	1.003
2005	1	1.306	0.2	1.005	10.008	10	33.112	30	99.985	1.005
2015	1	1.305	0.198	1.008	10.061	10	33.186	30	100.17	1.007
2025	1	1.305	0.196	1.011	10.074	10	33.291	30	100.36	1.008
2035	1	1.305	0.194	1.013	10.037	10	33.377	30	100.5	1.008
2045	1	1.305	0.192	1.014	10.011	10	33.401	30	100.54	1.009
2055	1	1.305	0.191	1.015	9.992	10	33.391	30	100.53	1.009
2065	1	1.306	0.19	1.015	9.992	10	33.366	30	100.5	1.01

Appendix 6: Asymmetric Demographic Shock with Immigration Productivity

Appendix 6a.

Asymmetric Demographic Shock with Immigration Productivity (Country 1)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1.02	1.3	0.199	1	10.002	10.000	33.333	30	100	1.000
1955	1.0404	1.3	0.196	1	10.007	10.000	33.335	30	100.01	1.000
1965	1.0612	1.301	0.192	0.998	10.059	10.033	33.341	30.102	100.21	1.000
1975	1.04	1.304	0.188	0.992	10.206	10.135	33.398	30.428	100.89	1.000
1985	1.0192	1.309	0.191	0.98	10.492	10.346	33.585	31.123	102.41	0.998
1995	0.9988	1.314	0.198	0.963	10.896	10.631	34.001	32.115	104.73	0.994
2005	0.9788	1.318	0.206	0.945	11.355	10.954	34.697	33.289	107.7	0.987
2015	0.9788	1.318	0.215	0.932	11.636	11.274	35.642	34.376	110.81	0.978
2025	0.9788	1.303	0.217	0.915	11.028	11.519	36.585	35.087	111.1	0.970
2035	1	1.294	0.228	0.902	10.146	11.673	36.638	35.298	109.46	0.969
2045	1	1.324	0.251	0.92	11.083	11.716	35.792	35.19	112.48	0.975
2055	1	1.317	0.247	0.924	10.833	11.684	36.138	34.925	112.33	0.966
2065	1	1.314	0.245	0.926	10.742	11.615	36.130	34.666	111.8	0.964

Appendix 6b.

Asymmetric Demographic Shock with Immigration Productivity (Country 2)

Time	G. rate	Int.	T. wage	Wage	InvS	GovS	Kdem	LDem	Output	Price
1945	1	1.300	0.200	1	9.982	10	33.333	30	99.997	1.000
1955	1	1.300	0.200	1	9.963	10	33.315	30	99.974	1.000
1965	1	1.301	0.200	0.999	9.931	10	33.284	30	99.94	1.000
1975	1	1.301	0.200	0.999	9.899	10	33.230	30	99.895	1.000
1985	1	1.303	0.201	1	9.896	10	33.160	30	99.861	1.001
1995	1	1.304	0.201	1.002	9.938	10	33.108	30	99.879	1.001
2005	1	1.305	0.200	1.005	10.017	10	33.113	30	99.987	1.003
2015	1	1.306	0.198	1.009	10.095	10	33.196	30	100.18	1.003
2025	1	1.304	0.196	1.009	9.967	10	33.332	30	100.34	1.003
2035	1	1.304	0.195	1.006	9.642	10	33.299	30	100.22	1.001
2045	1	1.309	0.196	1.007	9.762	10	32.951	30	99.936	1.004
2055	1	1.311	0.195	1.01	9.844	10	32.828	30	99.855	1.007
2065	1	1.312	0.194	1.012	9.872	10	32.823	30	99.883	1.008