A Population Aging Analysis for Canada Using the National Transfer Accounts Approach

Marcel Mérette, Department of Economics

Patrick Georges, Department of Public and International Affairs

Qi Zhang, Department of Economics

University of Ottawa

Abstract:

This paper develops a new data set for Canada using a new accounting methodology called National Transfer Accounts (NTA). NTA permit to build an accounting system that takes consideration the factor age into national accounts. NTA are consistent with national accounts and allows the estimation of lifecycle patterns for income and consumption from private and public sources. It also allows the calculation of lifecycle deficit or surplus of an economy. In this paper, we calculate the lifecycle deficit from 2004 to 2007. Moreover, the projection for lifecycle deficits in Canada is conducted for the period between 2007 and 2056 by applying the demographic projections for the next five decades. The projection results show that labour income will need to increase rapidly or consumption needs to be cut significantly to compensate for the pressure on the lifecycle deficit resulting from population aging.

1. Introduction

Canada's population[1] is currently aging at an accelerated rate. The demographic projections suggest that the number of elderly (65 or older) in Canada will be in 2036 more than twice than in 2011. The proportion of elderly with respect to total population will increase from 13.2% to 24.5%. From 2036 to 2056, that proportion will slowly rise up to 27.2%.

This rapid change in the age composition of the population suggests that it is likely worthwhile to investigate the potential impact of demographic change on the economy. However, the current national accounts system used to evaluate economic performance ignore totally the age factor. National Transfer Accounts (NTA) are a new way of measuring stocks and flows in an economy that take into consideration of age. NTA permit to quantify lifecycle patterns for labour income and consumption. For any individual of age "g", we can then calculate the difference between consumption and labour income. When consumption dominates labour income for the whole population during a given period, the economy is considered to have a lifecycle deficit (LCD).

In this paper, there are three tasks: first, this paper is to develop a data set that permits to study the lifecycle patterns for labour income and consumption for individuals of all ages; second, this paper measures the economic lifecycle for the Canadian economy for years 2004 to 2007; third, this paper estimates the evolution of LCD

[1] The number of population projection is from United Nations Commission for Social Development for the 5th Anniversary of the 2002 United Nations Second World Assembly on Aging.

between 2007 and 2056 by applying demographic projections.

The main results suggest that age profiles of consumption are different in Canada compared to the the U.S., for instance, especially with respect to health consumption. The net lifecycle deficit[2] of Canada in 2006 equals 9% of total labour income. By assuming per capita age profile based on 2006 observations and using demographic projections, the aggregate lifecycle deficit will increase from 100$ billion to 300$ billion between 2006 and 2056. Two thirds of the growth of aggregate lifecycle deficit comes from changes in the age composition of the population. To maintain the aggregate lifecycle deficit to its 2006 level, the average growth rate of labour income needs to increase from 0.23% in the benchmark projection to 0.65%, or the average growth rate of consumption needs to decline from 0.59% in the benchmark projection to 0.21%.

This paper is organized as follows. In section two, some literatures are reviewed with a focus on the topic of this paper. In section three, this paper describes the data and methodology for consumption and labour income. The fourth section of the paper projects future profiles of consumption and labour income at the aggregate level. In the fifth section, this paper discusses the impact of population aging on LCD at the aggregate level according to various scenarios. Section six concludes.

2. Literature Review

Many previous studies attempt to quantitatively investigate fiscal and economic issues

[2] Lifecycle deficit equals to consumption minus labour income.

related to demographic changes in Canada.

For instance, estimating high pressures on retirement income systems with the anticipated sizable withdraw from the labour market of the baby boomers. Gunderson (1998) recommends flexible retirement programs to encourage Canadians to remain in the work force over age 65. Kesselman (2004) concludes that although mandatory retirement opens employment and promotion opportunities for younger workers, government still needs to make better use of an aging working force. This will be beneficial not only to individuals but also to the overall economy.

Robson (2009) demonstrates that demographic transition will bring a huge pressure (from 15% in 2007 to 19.4% in 2056 of GDP) on Canada's current age-sensitive government programs such as health care, education, elderly and family transfers. He also considers the Canadian government poorly prepared for the big challenge of population aging. His quantitative assessment suggests that the decreasing number of young people will reduce the cost on education and family programs far less than the expected increase in the cost of health care services. Pressures from aging would increase health spending by 1.9$ trillion between 2007 and 2057 according to his figures.

Denton and Spencer (2009), using a simple approach, conclude that output per capita will decline by almost 10% between 2006 and 2036 under constant labour productivity scenario. To keep output per capita constant, the annual increase of labour productivity will have to be 0.41% higher for the period from 2011 to 2016, 0.63% higher for the period from 2016 to 2021, and 0.61% higher for the period from 2021 to 2026. Guillemette (2003) claims that the downward pressure of working population will require strong labour productivity growth for the upcoming decades to maintain the past growth rates in output per capita. The objective of this paper is similar to Robson (2009), Denton and Spencer (2009), and Guillemette (2003) but using a new, boarder and consistent data set originally built. The approach taken is called National Transfer Accounts[3].

3. National Transfer Accounts

NTA are an accounting system developed to measure and analyze the age dimension of a macro-economy, which can be quite relevant in a period of demographic transition. NTA estimate the the intergenerational transfers at the aggregate level in a way consistent with National Income and Product Accounts, and measure how the economic resources are spent and received across age groups. In contrast to national accounts, NTA measure the economic flows across age groups arisen by the disparities between the resource needs and satisfaction (Mason et al., 2006; Lee et al., 2009).

This section briefly introduces NTA. NTA include two major new concepts. One is lifecycle deficit (LCD) or lifecycle surplus (LCS); the other one is age reallocation.

[3] NTA are an international project founded in the U.S. and now involving 33 countries. The institutions involved in this project include the Center for the Economics and Demography of Aging, University of California at Berkeley, the Population and Health Studies Program, and East-West Center. Research teams cover 33 countries of scholars. The information about NTA is from http://www.ntaccounts.org. The 33 countries include Australia, Argentina, Austria, Kenya, China, Brazil, Finland, Mozambique, India, Canada, France, Nigeria, Indonesia, Chile, Germany, Senegal, Japan, Colombia, Hungary, South Africa, Philippines, Costa Rica, Slovenia, South Korea, Jamaica, Spain, Taiwan, Mexico, Sweden, Thailand, United States, United Kingdom, and Uruguay. Ronald Lee and Andrew Mason are co-principal investigators.

LCD describes the extent to which resources flow from groups in surplus to those in deficits as LCD must be equal to zero in steady state (Lee 1994a; Lee 1994b). The economic flows occur in both public and private sectors. In the public sector, the age reallocation is driven by local, regional, and central governments through public programs, such as education, pensions, health care, and national defence. In the private sector, the age reallocation is mediated by markets, households, families, voluntary agreements, social traditions, and other behaviour patterns.

There are two major categories with respect to age reallocation. One is net transfers which equals inflows minor outflows transfers. Transfers include household transfers (e.g. health, education, others, and saving), in-kind transfers (e.g. health and education), and cash transfers (e.g. grants, taxes, social security, and pensions). The second one is asset-based reallocation, which includes asset income and saving. The asset income in the private sector includes imputed rent, operating surplus, capital share of mixed income, and property income. In the public sector, it includes capital, other non-financial assets (e.g. land and minerals), and credit (e.g. public debt and student loans).

There are two accounts in NTA: one is a flow account, which measures the inflows and outflows across age groups in a certain period (e.g. a calendar year or fiscal year); the other one is a wealth account or stock account which measures the value of the stock under each flow. The flow account should be balanced: inflows equal outflows, by the following equation:

$$Y_L + Y_A + Tr_I = C + I_K + Tr_O \quad (1)$$

The inflows include labour income Y_L, asset income Y_A (i.e. returns to capital, land and credit), and transfer inflows Tr_I. The outflows include consumption C, investment in capital, land and credit I_K, and transfer outflows Tr_O. Saving is equal to investment in capital, land and credit. Equation (1) is calculated during a given period for individuals of each age. This equation is rearranged as

$$C - Y_L = Y_A - S + (Tr_I - Tr_O)_{\text{private}} + (Tr_I - Tr_O)_{\text{public}} \quad (2)$$

The left hand side of the equation is defined as the LCD. The first term in right hand side of the equation is the amount of asset-based reallocations, and the second and third terms are net transfers. To balance this equation, we must have the LCD equals to the age reallocations which are the asset-based reallocations plus net transfers.

The fundamental interest of NTA is the shape of economic lifecycles. Studies so far suggest a LCD for young and old individuals which means that they consume more than they produce. However, working age individuals produce more than they consume to generate a LCS. Economic and social factors drive the shape of economic life cycles. For example, wages, historical work experience, culture, and politics affect labour income. Consumers' preferences, market prices, interest rates, and political systems affect consumption. The resource reallocations occur between the young and old individuals in LCD on one side and working age individuals on the other side. The economic resource flows in society through three channels:

government institutions, families, and markets (Lee, 1994a; Lee, 1994b). Mason et al. (2006) identify cross-sectional or longitudinal economic flows[4]. The forthcoming book (Lee et al., 2011) comprehensively demonstrates the relevance of NTA in the context of population aging for 23 countries.

The results of previous studies show that the value of resources involving age reallocation is substantial in the whole economy. For instance, Mason et al. (2006) report that the amount of consumption exceeding labour income by young (i.e. individuals younger than 23) and old (individuals older than 57) population captures 44% of total labour income in the U.S.. Mason et al. (2009) also calculate that the amounts of LCD from both young and old individuals cover 65% and 52% of total labour income in Philippines and Germany, respectively.

3.1 Data and Methodologies of Constructing Consumption Profiles

NTA age profiles of consumption and production must refer to individuals, not to households, but most expenditure surveys are conducted under household categories. To allocate consumption expenditures from household to individuals is a challenge. The consumption part includes private and public consumption with three components: education, health, and other consumption.

3.1.1 Private Consumption Profile

[4] In Mason et al. (2006), cross-sectional economic flow is defined as the resources within a household, e.g. from parents to children. The longitudinal flow is defined as the resources saved when the individual is young and consumed when this individual is old.

The data to construct private consumption are extracted from the Survey of Household Spending (SHS) for the period 2004 to 2007[5]. For each year of SHS, there are household and personal files. The former part includes the information on household level, such as household spending on education and health. The latter part includes the information on personal level, such as persons' age and employment status. Information of individuals' age (single year) and household consumption on goods and services from these two sources has to be combined to allocate expenditures (e.g. education, health and others[6]) to family members within each household.

3.1.1 A. Private Education Consumption

In household sector, the variable "total expenditure on education" measures private consumption on education. The allocation of private expenditure from household to family members is based on the attendance rate of school of this individual's age. The attendance rate of school is estimated based on the enrolment rates available in "Survey of Labour Income Dynamics (SLID)". The variable chosen is "full/part time student for reference year"[7]. One dummy variable is generated to estimate enrolment rates as a percentage or a probability (%). This variable is equal to one if the individual is full-time student, part-time student, or a mixture of both; otherwise, zero. The respondents of school attendance in SLID are aged from 16 to 69. Thus, there are

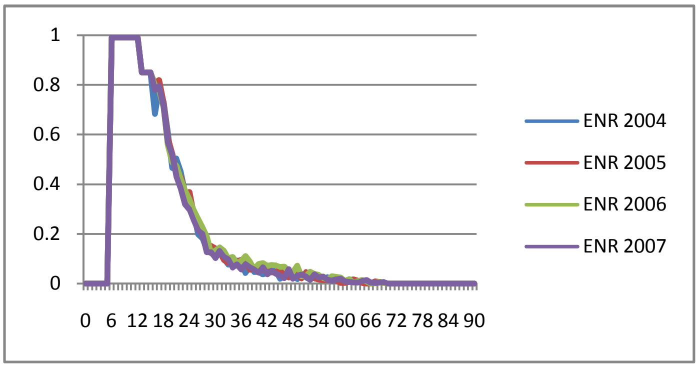
[5] Personal files for SHS in Canada started only in year 2004.

[6] Other private consumption is defined as a residual of total private consumption deducted by private education and health consumption.

[7] The variable is defined as: If the individual is a full-time student, this variable is equal to one; if the individual is a part-time student, this variable is equal to two; if the individual has a mixed status of full-time and part-time student, the variable is equal to three.

three arbitrary but reasonable school attendance ratios given to complete the allocation the whole age range, from 0 to 90 years old. The individuals between age 0 and 5 and older than 69 are not attending school (i.e. enrolment rate is zero); the individuals between age 6 and 16 have enrolment rates 0.99[8]. As Figure 1 shown below, the school enrolment rates drop dramatically around age 24, and are below 0.2 after age 30.

Figure 1: Enrolment Rates Estimated from SLID (2004-2007)



There are multiple methods of allocation private education expenditure on individuals. However, the limitation of information imposes of a difficulty of method selection. The following method is chosen to suit the best the data challenge, and the alternatives are discussed in "Appendix 1".

In this part, the challenge is to combine SLID and SHS information. In household j, for example, there is member i $(i = 1, \ldots, \mathrm{n})$. In this household, total education expenditure for household j is CFE_j, which is allocated across members i within household j. The enrolment rate for each age, $ENR(a)$, where a represents age

[8] The study by Hicks (1997, Statistic Canada) provides more details of this assumption.

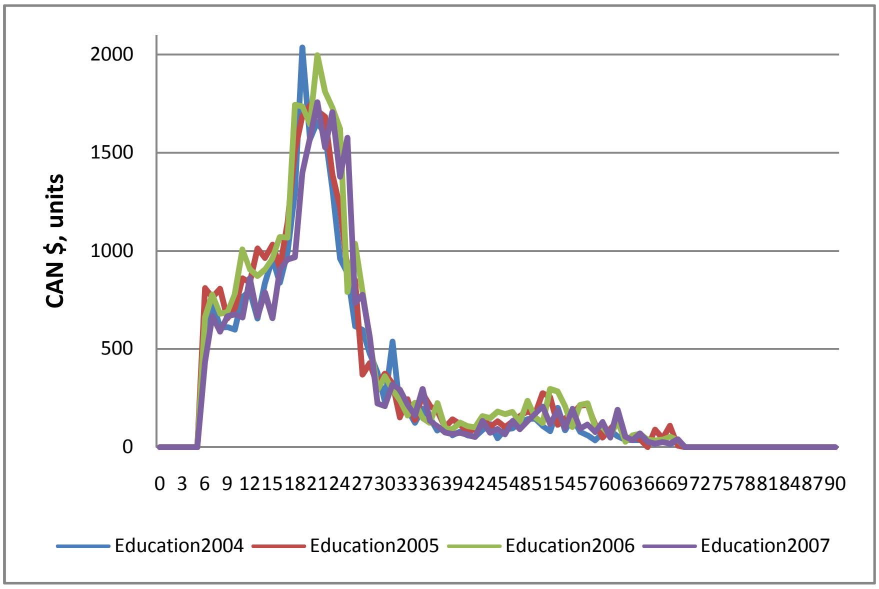
group a, is calculated as an average based on the school attendance of the SLID participants at each age. For household j, the education expenditure is assigned on each member by the ratio of individual i's ENR over the sum of all the members' ENR. i.e.

$$CFE_{ij}(x) = \frac{ENR_i(x)}{(\sum_i ENR_i(x))_j} . CFE_j \quad (3)$$

More specifically, if the education expenditure is \$4,000 in household j, and there are four members with ages 10, 20, 45, and 50. The ENR calculates for those ages are 0.99, 0.6, 0.1, and 0.05, respectively. The sum of those ENR in household j is 1.74 ($0.99 + 0.6 + 0.1 + 0.05 = 1.74$). As an example, the first individual's education expenditure is that $CFE_j(20) = \frac{0.99}{1.74} . \$4{,}000.$

The results are showed in Figure 2. From 2004 to 2007, the trend and level of private education expenditure at each age is relatively similar. This age profile shows that private education expenditure increases largely around age 18, reaches the maximum at 21 years old, and drops dramatically around age 23. After age 28, per capita private education consumption is below \$500 for all years covered.

Figure 2: Private Education Consumption Per Capita, CAD \$, (SHS, 2004-2007),



3.1.1 B. Private Health Consumption

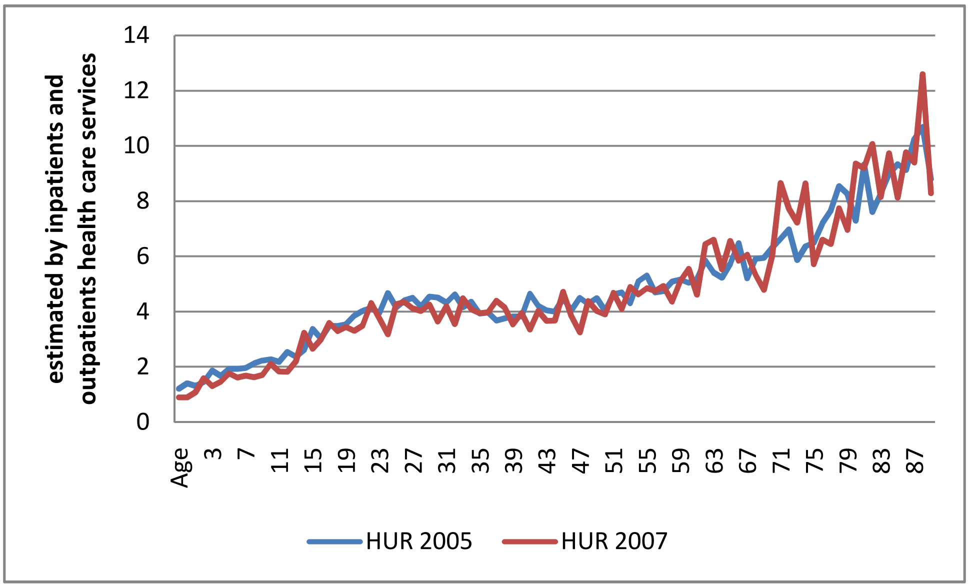
Three elements finance the Canadian health care system: private out-of-pocket expense, private insurance, and public programs (see Chart 1).

< Chart 1: Framework of Financing of health care 2004. See Appendix 1>

The variable to estimate the age profile of private health consumption is "total expenditure on health care" from SHS. Private health expenditure is allocated from a household to individual members according to health care utilization rates. Canadian Community Health Survey (CCHS, 2005 and 2007) includes the information to estimate health care utilization rates. Health care utilization is reasonably separated by two parts: outpatient and inpatient. Outpatient utilization is approximated by the number of consultations with medical doctors, including family doctors or general practitioners, and other medical doctors but not eye specialists; inpatient utilization is approximated by the number of nights as patients, including hospital, nursing home or convalescent home. The measure of health care utilization is the sum of the number of consultations with medical doctors and the number of nights as patients in the past 12 months.

Simple regression method is applied to estimate the individual profile of private health care consumption by each single year of age. As the missing information of children under age 12 in CCHS, the growth rates of health care utilization for individuals with age 13 to 24 apply to children with age 0 to 12. The health care utilization rates (Figure 3) increases from youth to elderly with a relatively flat slop for the age between 27 to 60. The number of times of inpatient and outpatient health care services doubles from 6 to 12 after age 60, reflecting a higher demand for health services.

Figure 3: Health Care Utilization Rates Estimated from CCHS, 2005 and 2007[9]



Household health expenditure is then regressed on the number of household members

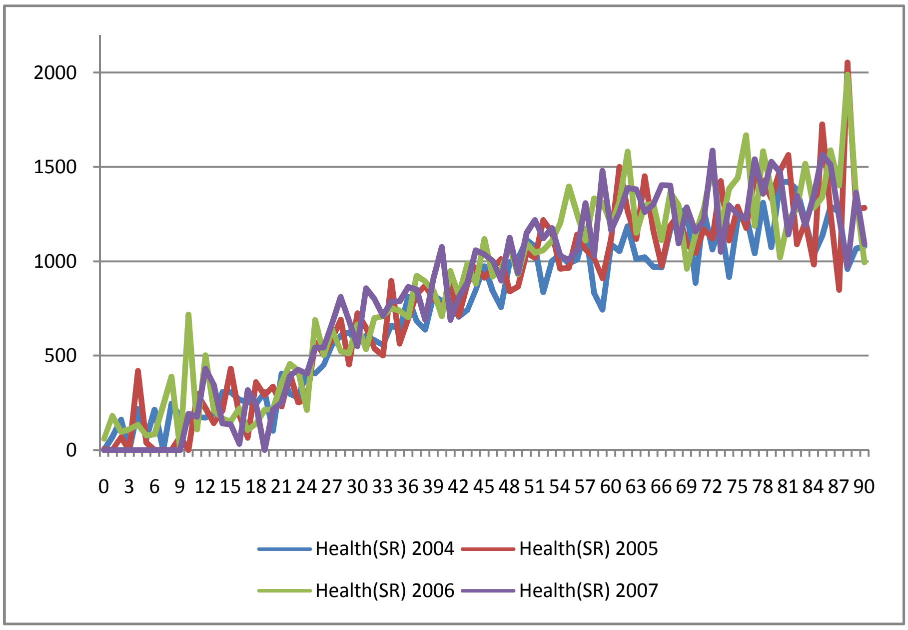
[9] Note that we assume that the growth rates for age 12 to 23 are the same for age 0 to 11.

in each year of age, $P_j(a)$. The regression equation is

$$CFH_j = \sum_a \beta_h(a).P_j(a) + \varepsilon_j \quad (4)$$

Sharing the pattern of health care utilization rates, private health consumption (Figure 4) increases continuously from youth to elderly. The results reflect that private health consumption for teenagers or younger children is very low in Canada, and this is likely because most cost for children is covered by government public plans.

Figure 4: Private Health Consumption Per Capita, CAD $, SHS, 2004-2007, under Simple Regression Method



3.1.1 C. Other Private Consumption

Other private consumption is defined as the residual of total private consumption by deducting education and health consumption. As the age-related feature of alcohol and tobacco, separated allocation methods are applied for different items within other private consumption part.

Simple regression method is used to allocate alcohol and tobacco consumption:

$$CFALC_j = \sum_a \beta_{alc}(a).P_j(a) + \varepsilon_j; \tag{5}$$

$$CFTOB_j = \sum_a \beta_{tob}(a).P_j(a) + \varepsilon_j, \tag{6}$$

where, $CFALC_j$ represents private alcohol consumption, and $CFTOB_j$ represents private tobacco consumption.

Equivalence scale method[10] is applied to allocate the rest of other private consumption. Other private consumption of household member j is assumed proportional to an equivalence scale that is equal to 1 for adults aged between 20 or older. It declines linearly from age 20 to 0.4 at age 4, and is constant at 0.4 for those age 4 or younger. The formula for this method is

$$\begin{cases} \quad 1 & if\ a \geq 20 \\ \alpha(a) = 1 - 0.6 * \frac{20-a}{20-4} & if\ 4 \leq\ a \leq 20 \\ \quad 0.4 & if\ a \leq 4 \end{cases} \tag{7}$$

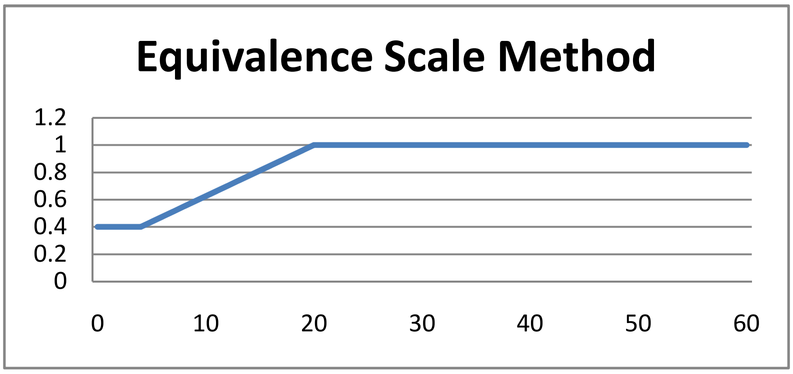
The path of the equivalence scale $\alpha(a)$ is shown in the chart below. This scale is then use to allocate private health consumption to member i in household j by this equation:

[10] I use the scale to allocate other private consumption that is recommended by NTA manual book (Mason et al., 2009).

$$CFX_{ij} = CFX_j.\frac{\alpha(a)}{\sum_a \alpha(a).P_j(a)} \tag{8}$$

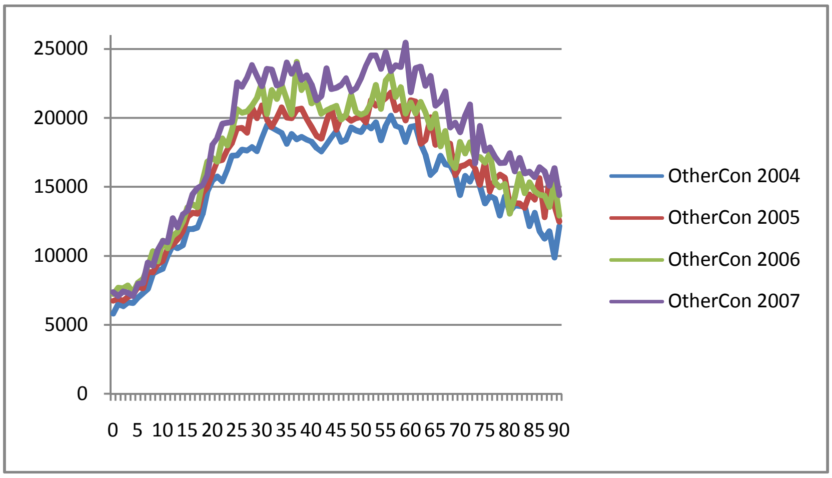
where a is the age of individual in in this household.

Figure 5: Equivalence Scale Method



The level of other private consumption (Figure 6) increases from 2004 to 2007, and is higher for middle age groups in each year.

Figure 6: Private Other Consumption Per Capita, CAD $, SHS, 2004-2007



3.1.2 Public Consumption Profile

As private consumption, public consumption consists of education, health and others. In Canada, to our knowledge, there is no administration data about public health and education consumption by single year of age. Thus, surveys data are used as a complementary tool to allocate aggregate level of public consumption by estimating age profile.

3.1.2 A. Public Education Consumption

Public education consumption includes two parts: formal and informal education consumption. Formal education consumption refers to the government spending on primary, secondary, and higher education levels. Informal education consumption[11] refers to government expenditure on culture, religious studies, and other types of education. According to their characteristics, the former one is measured at the level of per student, but the latter one is measured at the the per capita level.

The age profile of enrolment rate estimated from SLID to reallocate the aggregate level of public education consumption of each education level. "Expenditure by Funding Source and Transaction Type, 2004-2007[12]" from OECD includes the government expenditure by education level. Public formal education consumption by age $CGEC^f(a)$ is estimated by summing unit cost per student per level c_l (where l is education level, $l \in$ {primary, secondary, post-secondary school}) weighted by the number of students by age in each level $cgec^f(a)$. It is

$$CGEC^f(a) = \sum_l cgec^f(a).c_l \quad (9)$$

[11] The data do not permit to include public informal education consumption allocation.
[12] The assumption of school age is that primary and secondary school is for age 6 to 16, and the post-secondary school is for age 17 or older.

The unit cost of public education consumption per student at each level of education is estimated by dividing public education consumption at level l by the estimated number of students at that level. The estimated number of students by age multiplies the enrolment rate (by age) by the number of individuals in the population (by age). Unit cost of public education within each education level is constant by age.

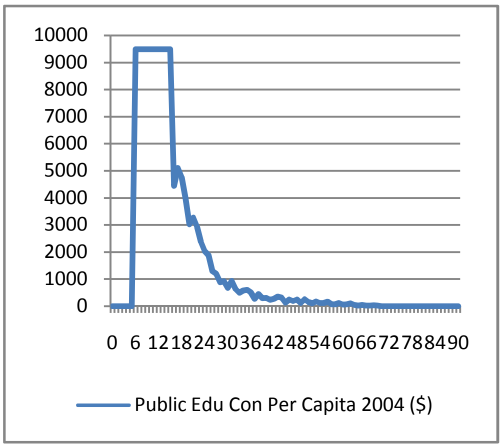
The enrolment rates multiplied by the size of the population by age to obtain the number of people enrolled in school under each age. i.e.

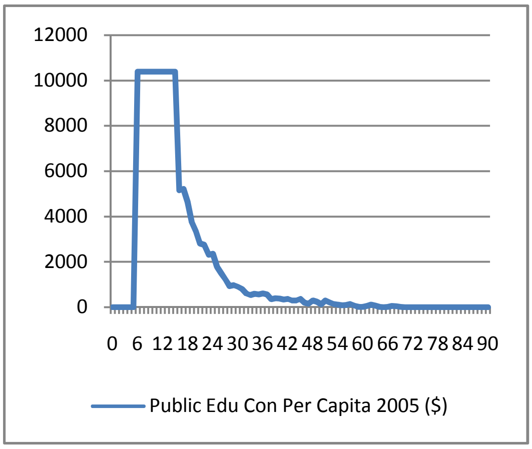
$$enrolment\ rate\ (a) * pop(a) = person\ enrolled\ (a)$$

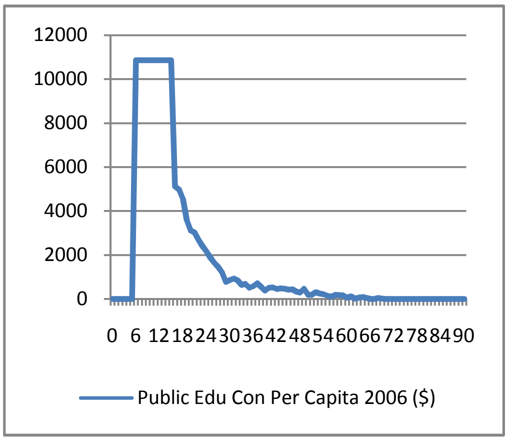
The public education expenditure is allocated to each single year of age based on the population enrolled.

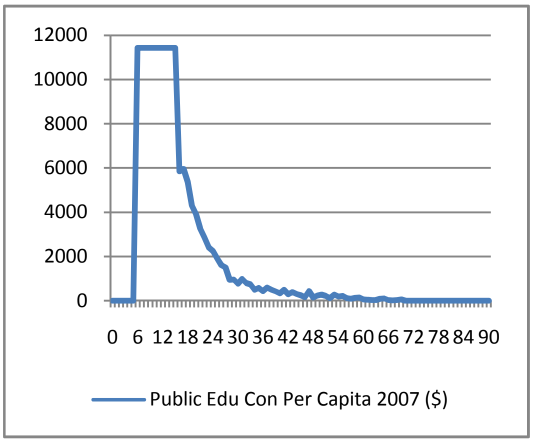
The shape of age profile of public education consumption (Figure 7) is the same as the enrolment rates of school estimated above. The maximum per capital level of public consumption on education increases across years, from around \$9,500 in 2004 to above \$15,000 in 2007. Government expenditure on education has grown significantly over the four years covered.

Figure 7: Public Education Consumption Per Capita, CAD \$, 2004-2007









3.1.2. B. Public Health Consumption

Public health consumption includes health care cost paid by individual and reimbursed through public programs, direct spending on health care personal services offered by government health institution and hospitals, and collective services (e.g. health education and prevention programs) provided to the public. Thus, these age profiles are estimated using the methods described in the section on private health spending. Collective services is assumed to be consumed equally by each member of population.

As our knowledge, administration data for public health consumption by government do not exist by each age group in Canada. Sharing the information from household survey, public health consumption is allocated within each age group based on the estimated health utilization rates (Figure 3). The data source of public health expenditure data is National Health Expenditure Trends, 1975-2009 (Appendix 1, Table 1). Public health consumption by age $CGHC(a)$ is estimated by summing unit per patient weighted by the number of patients by age.

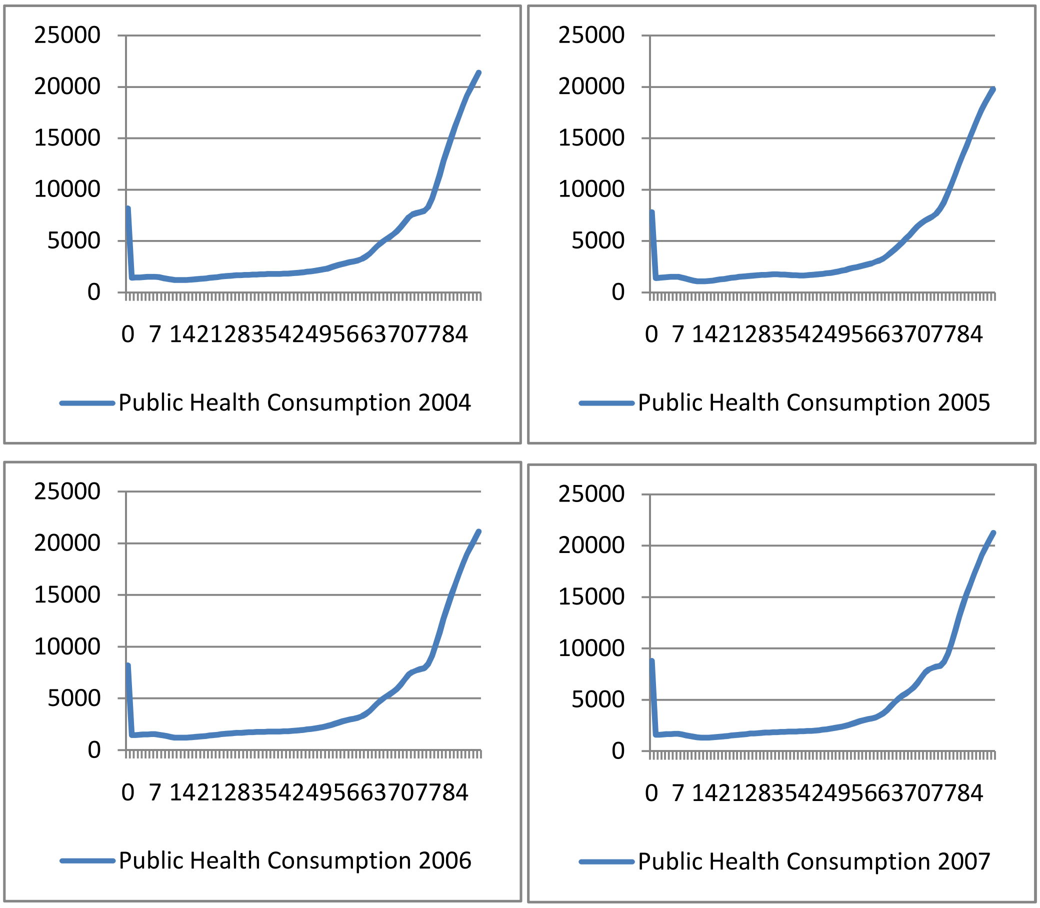
$$CGHC(a) = \sum_h cghc(a).c_h \tag{10}$$

where c_h is the unit cost of one patient per number of consultation of medical doctor. Since the data of pubic health consumption are by age groups, extra information is needed to reallocate the amount to single year of age. One option is to apply the individual age profile of health utilization rates from household survey[13].

The shapes of per capita profile of public health consumption (Figure 8) are consistent with health care utilization rates for years 2005 and 2007. However, the levels in 2006 and 2007 are much larger than the ones in 2004 and 2005. Differently from private health consumption, the figures show that public consumption on health is larger for new babies than older children. This reflects probably a difference between private and public consumption on health. The data suggest that the cost of health care for babies is mostly covered by government plan or public programs.

Figures 8: Public Health Consumption Per Capita, CAD $, 2004-2007

[13] For example, public health consumption for age group 20 to 24 is $1,557. The health care utilization estimated from CCHS are 3.44, 3.31, 3.49, 4.31 and 3.74 for age from 20 to 24, respectively. Thus, the amount to be allocated on age 20 is $293.14 (i.e. $1,557*[3.44/(3.44+3.31+3.49+4.31+3.74)]), $281.62 on age 21, $297.08 on age 22, $366.84 on age 23, and $318.32 on age 24.



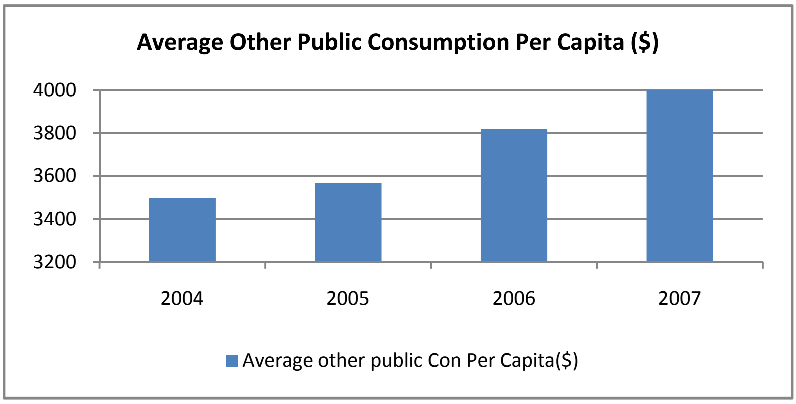
3.1.2. C. Other Public Consumption

Other public consumption includes public consumption(e.g. national defence, justice and police) which is not targeted to a specific group in the population. Thus, the amount is equally allocated to all members of population:

$$CGXC(a) = \sum cgxc(a).c \tag{11}$$

Other public expenditure (Figure 9) is the residual of public education and health expenditure from total provincial and territorial government expenditure.

Figure 9: Provincial and Territorial Government Other Expenditure (excluding education and health expenditure), Per Capita, CAD $, 2004-2007



3.1.2 D. Total Public Consumption

Total public consumption equals the sum of public education consumption, public health consumption, and other public consumption.

$$TCGC(a) = CGEC(a) + CGHC(a) + CGXC(a) \qquad (12)$$

The next section compares the per capita profiles on Canada to those on the U.S.[14].

3.1.2. E. Comparison of Consumption Age Profile of Canada with the U.S.

Figure 10: a) Per Capita Consumption, Private and Public by Sector, Canada, CAD $, 2006

[14] The results on the U.S. were generated by Gretchen Donehower (University of California, Berkeley, Department of Economics and Demography) is from NTA team.

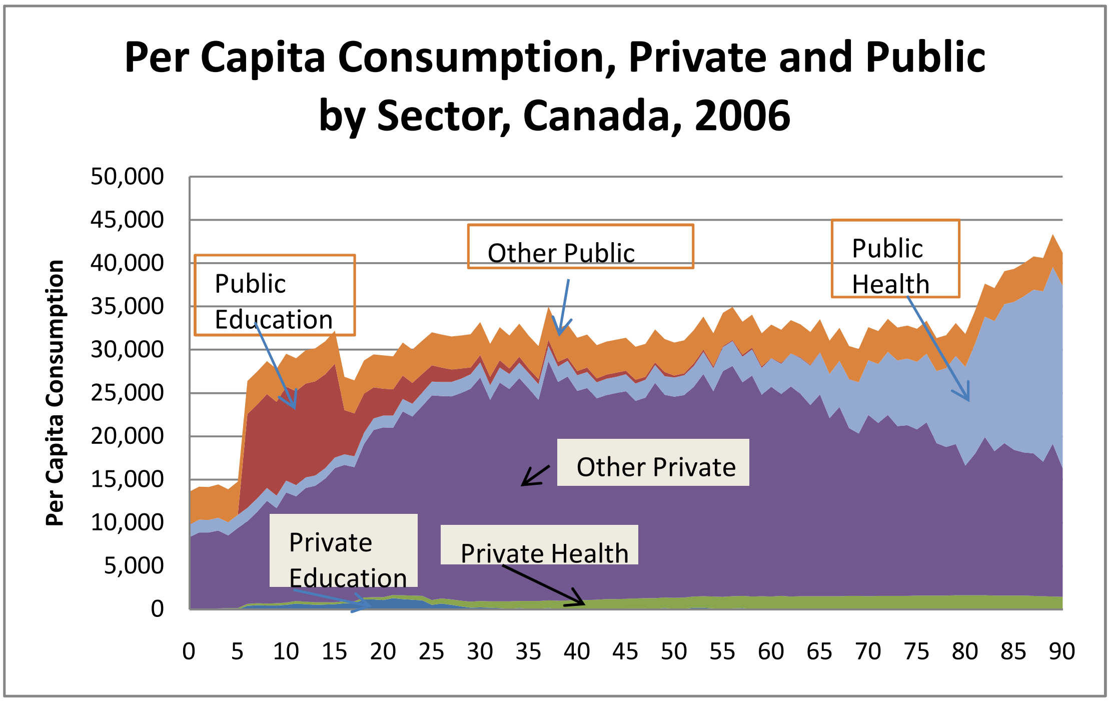


Figure 10: b) Per Capita Consumption, Private and Public by Sector, the U.S., 2003[15]

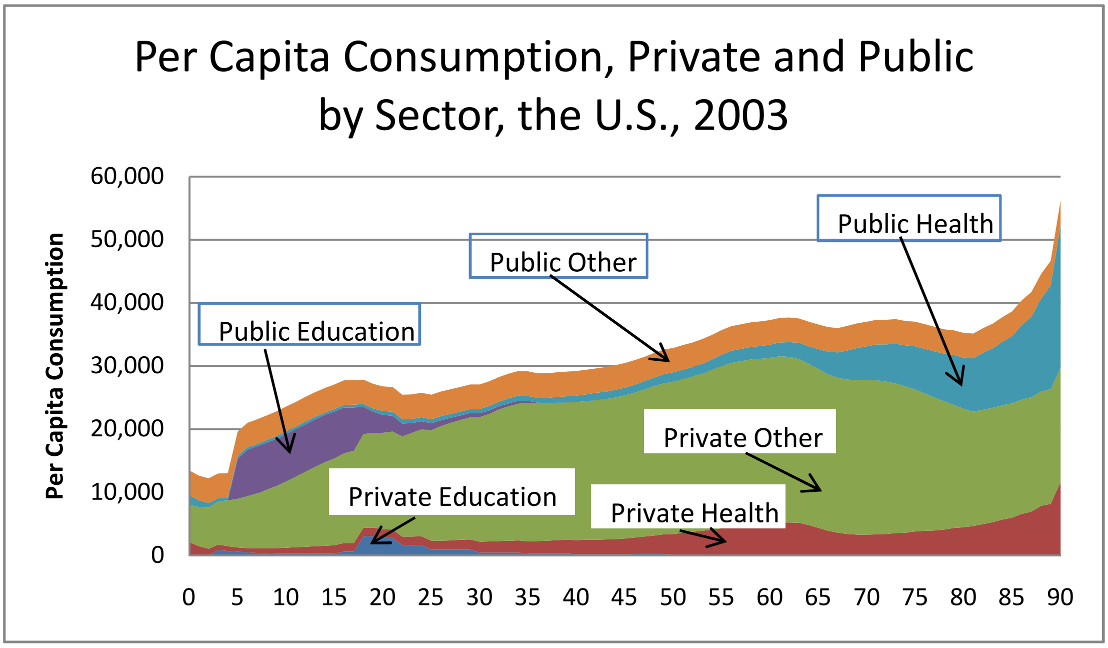


Table 2: A Summary of Per Capita Consumption Profiles for Canada (2006) and the U.S. (2003)

[15] Data source of the U.S. (2003) is from NTA website: www.ntaccounts.org.

	Canada (2006) % of Total	U.S. (2003) % of Total
Consumption	100%	100%
Private Consumption	67.38	73.02
Education	0.74	1.24
Health	3.21	9.68
Others	63.42	62.10
Public Consumption	32.62	26.98
Education	5.66	4.25
Health	14.70	10.17
Others	12.26	12.56

Table 3: Comparison Health and Education Consumption for Canada (2006) and the U.S. (2003), by Percentage (%)

Age group	CAN	U.S.
Private Education age 25- / Total Education for whole ages	8.48	15.46
Public Education age 25-/ Total Education for whole ages	78.21	73.50
Private Health age 65-/ Total Health for whole ages	8.05	22.71
Public Health age 65-/ Total Health for whole ages	57.15	39.41

Figures 10 report per capita private and public consumption for Canada (2006) and the U.S. (2003). Private education consumption for Canada is flatter but with larger span than in the U.S.. Private health consumption for Canada is also flatter and slightly increases from young to old. The U.S. figure shows larger size with a peak around age 60, and increases again around age late 70s. For both countries, other private consumption takes a larger share than private education and health consumption. Public education in Canada is proportionally larger than the one in the U.S.. Public health in Canada increases dramatically around age 80s; on the contrary, the U.S. figure does not increase as much as Canada's. Other public consumption is flat everywhere in both countries.

Ratios in Table 2 and 3 help further compare differences between Canada and the U.S... Table 2 indicates that private consumption with respect to total consumption is 67.38% in Canada and 73.02% in the U.S.. There is about 6 percentage points difference between two countries. The difference is mostly due to health. Private health consumption in the U.S. is about 6 percentage points larger than in Canada. Figures for public consumption are inversed. Public consumption in Canada is 32.62% but only 26.98% in the U.S.. Public education consumption in Canada is about 1 percentage point larger than in the U.S., but public health consumption in Canada is about 4 percentage points greater than the one in the U.S.. The other public consumption is basically the same for both countries.

Table 3 reports ratios on the distribution across ages. The share of private education consumption for age group younger than 25 over total education consumption for all is 15.46% in the U.S. and only 8.48% in Canada. However, the same ratio for public education consumption reaches 78.21% in Canada and 73.50% in the U.S.. In other words, the allocation of public education consumption is more concentrated towards young age groups in Canada, while it is the opposite for private education. On health care, 22.71% of private health consumption is allocated to the 65 and over in the U.S., while the ratio is 8.05% in Canada. Conversely, public health consumption for elderly in Canada is 18 percentage points larger than in the U.S. with ratios equal to 57.15% for Canada and 39.41% for the U.S..

3.1.3. Labour Income

The second part of LCD is labour income. Labour income in principle refers to workers' compensation as a return from working, including labour earnings, employer-offered benefits, and taxes paid to government as workers. Labour income also includes the labour share of entrepreneurial income. Without more accurate information, two-thirds of the operating surplus of entrepreneurial income is considered as labour income, and the remaining part as capital income. This is consistent to labour income as defined in NTA approach, which includes compensation of employees (i.e. wages and salaries, deferred payment, etc), labour's share of mixed income (i.e. 2/3 of self-employment income), and fringe benefits (i.e. workers' compensation benefits).

The data (i.e. the variables of wages and salaries, self-employment income, and worker's compensation benefit) are taken from SLID from years 2004 to 2007. In SLID, wages and salaries are defined as "wages and salaries, before deductions[16], and also called employment income". Self-employment income is defined as "self-employment net income, including both farm and non-farm net income. It may also be called self-employment income or self-employment earnings". Worker's compensation benefit is defined as "workers' compensation benefits". SLID covers individuals with age of 16 or older.

Self-employment income should be allocated to family members who are reported as

[16] Here "before deduction" means before direct labour income tax deduction, rather than indirect tax.

self-employed or as unpaid family workers. For some countries, the unpaid family workers take an important share of the total amount of labour income (e.g. Mexico). Thus, for those countries, they should pay attention on the allocation of the income of unpaid family workers. However, for Canada, the unpaid family worker income does not take a significant share of the total labour income. Thus, it is not necessary to reallocate the earnings for the unpaid workers because the percentage of unpaid family workers over the whole sample is small, i.e. 0.3%, and the percentage of number of unpaid workers over the number of self-employment workers is 0.8% (278/33,954=0.008 from Table 4). In any case, the reallocation of earnings towards the unpaid family workers would not affect the shape of labour income profile.

Table 4: The Cross Tabulation of Working Status between Unpaid Family Workers and Self-employed Workers

Unpaid family workers	Self-employed workers		
	0	1	Total
0	36,270	33,676	69,946
1	0	278	278
Total	36,270	33,954	70,224

The shapes of per capita profiles of labour income and its components (Figure 11) do not change much across years. The highest level of per capita labour income increases from around $42,500 in 2004 to around $48,000 in 2007. Individuals between age 23 and 56 are the high labour income earners (above $30,000).

Figure 11: Labour Income Per Capita Profile from SLID, CAD $, 2004-2007

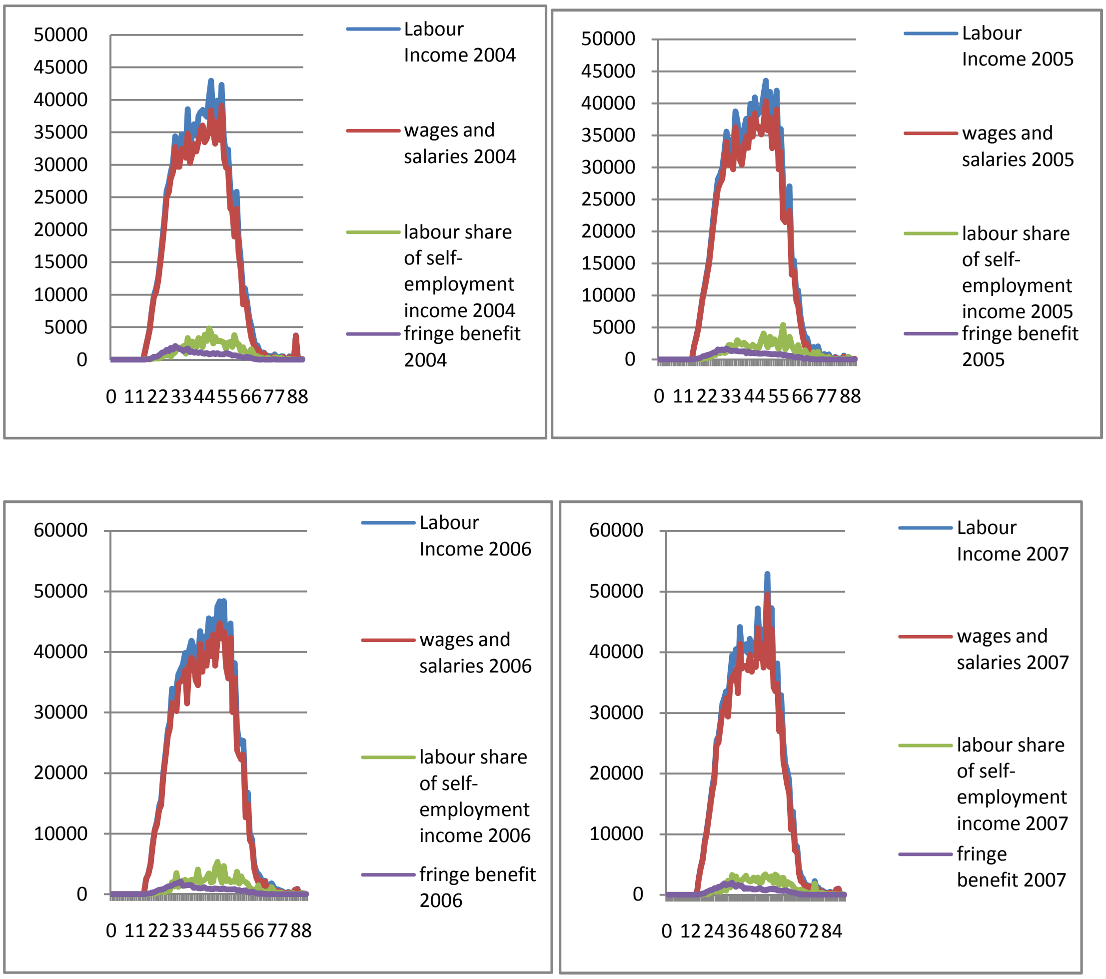
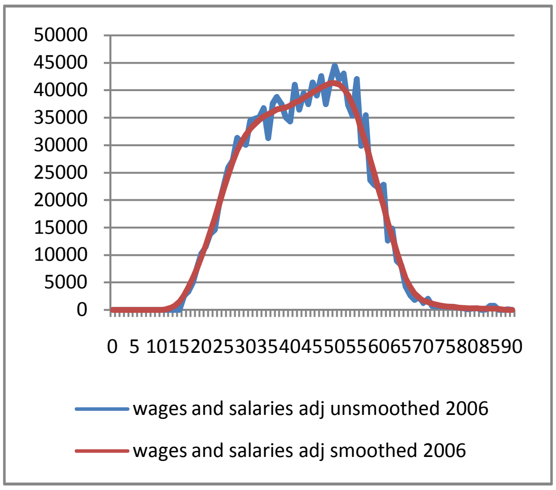
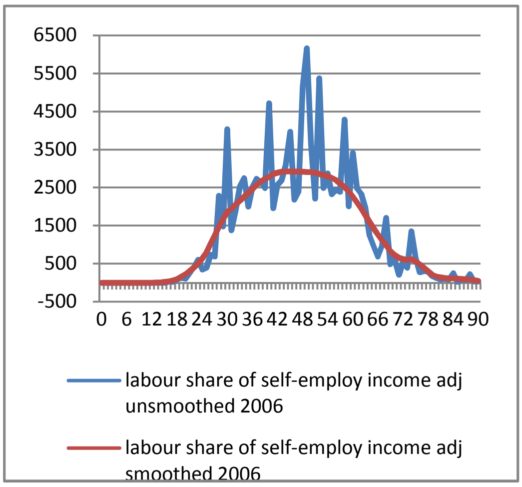


Figure 12 shows the smoothed age profiles of the components of labour income in 2006. Smoothing reduces the noise of per capita profile, but keeps the main features of each curve. Again, the high wages and salaries earners (above $30,000 per capita) are individuals between age 30 and 56. The level of self-employment income is relatively low at $1,500-$2,750 between age 30 and 65.

Figure 12: Wages and Salaries, Labour Share of Self-Employment Income Per Capita, Unsmoothed and Smoothed Profile, 2006





3.2 Macro Control

The purpose of macro control is to ensure that the values in per capita profile are consistent with the aggregate values in national accounts. Macro control indictors of national activities over a fixed period are based on internationally accepted accounting principles, and include all flows in an economy. There are two steps in macro control. The first step is to sum over ages and individuals the value of final goods and services of the reference year, same for labour income. The macro control of consumption and labour income values are reported in National Income and Product Accounts (NIPA).

The second step is to make sure that per capita profiles match with aggregate values reported in national accounts. Assume that $AP_{unadj}(a)$ be the amount in per capita profile, $Pop(a)$ be the population by age, $MacroControl$ be the aggregate level taken from NIPA. A new parameter, called θ, is calculated by:

$$\theta = \sum_a AP_{unadj}(a)Pop(a)\,/MacroControl \qquad (13)$$

Thus, the after-adjusted per capita and aggregate profile are given by:

$$AP_{adj}(a) = AP_{unadj}(a)/\theta, \quad (14)$$

with the following constraint:

$$MacroControl_{adj}(a) = AP_{adj}(a)Pop(a) \quad (15)$$

According to the equations (14) and (15), age profiles are adjusted proportionally by age to satisfy macro control[17].

3.2.1 Consumption Macro Control

The macro control values for consumption are based on "Final uses in GDP". After adjustment under NTA, the total NTA consumption refers to national account terms "final consumption expenditure", "general government final consumption expenditure", "household final consumption expenditure" with "NPISH[18]s' final consumption expenditure."

The macro control for private consumption of health and education are obtained from the classification of private consumption by categories. The residual part of private consumption goes as macro control for the NTA variable "other". Likewise, the macro control for public consumption of health, education and other public consumption converts to the classification of public consumption by categories.

The values of consumption taken from NIPA include indirect taxes on consumption

[17] The application of NTA in some particular cases is different with UN guidelines. The other information source is from IMF Government Financial Statistics (GFS). The data source for Canada from OECD outbook which follow the UN guidelines.
[18] NPISH represents non-profit institutions serving households.

(e.g. taxes on retail sales). In NTA, consumption must represent the amount before consumption taxes. Thus, the estimation of taxes on products should be deducted from the amount reported in the household survey.

3.2.2. Labour Income Macro Control

Macro control for labour income is estimated from NIPA and includes compensation of employees, labour's share of mixed income, and labour's share of taxes on net production and on imports less business subsidies. Labour's share of mixed income is estimated to be equal to two-thirds of the household mixed income (the remaining part is capital income).

Taxes on production includes taxes on products payable on producing, delivering, selling or transferring good and services, with taxes on owning or using land, buildings or other assets used in production and labour. In SLID, wages and salaries, labour share of self-employment income, and workers' compensation benefits are before deduction of direct tax. Although there is no needs to adjust direct labour income tax, the indirect taxes that belongs to labour income needs to be added to obtain the final labour income per capita profile in NTA[19].

3.3 Smoothing

[19] In NTA, we need to reallocate indirect taxes to asset income, labour income, and consumption by appropriate rules. The amount of "taxes on products" goes fully on consumption. In the category of "taxes on factors of production", for example, corporation tax is reallocated 28% to capital income, and 72% to labour income; real property tax is reallocated 100% to asset income, but null to labour income. Please note that 28% and 72% are the asset and labour income share in production calculated with NTA methods. The labour income is calculated from employees' compensation, and 1/3 of mixed income taken from NIPA; the asset income is calculated from net property income, and 2/3 of mixed income taken from NIPA as well. At the end, the share of asset and labour income is 28% and 72%, which is specifically for Canada.

The per capita profiles are noisy as for some age groups the number of observations is small. Smoothing[20] the components of per capita profiles, except for education[21], is to reduce the sample variance, but not to weaken the real feature of the data such as larger health spending for individuals over 65 and newborns.

4. Results

The results of smoothed consumption, labour income, and LCD of Canada, 2006 are shown in Figure 13 a), b) and c).

Figure 13: a) Per Capita Profile of Labour Income and Consumption (Smoothed Data), Canada, 2006

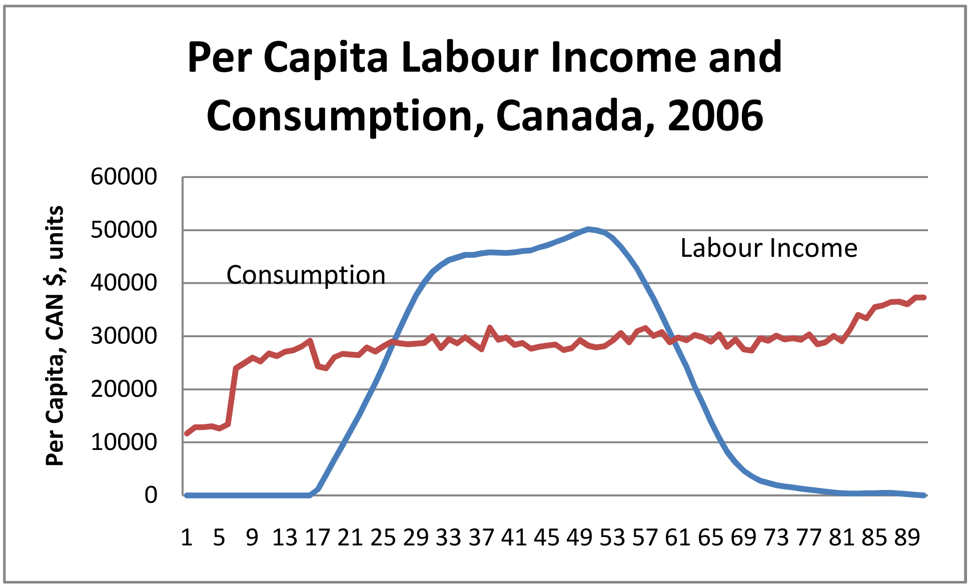


Figure 13: b) Per Capita Profile of LCD (Smoothed Data), Canada, CAD $, 2006

[20] Smoothing is complemented by applying Friedman's Super Smoother in R programming.
[21] No smoothing on per capita education consumption is recommended by NTA methods. One possible reason is that by the feature of education consumption the noise should be kept.

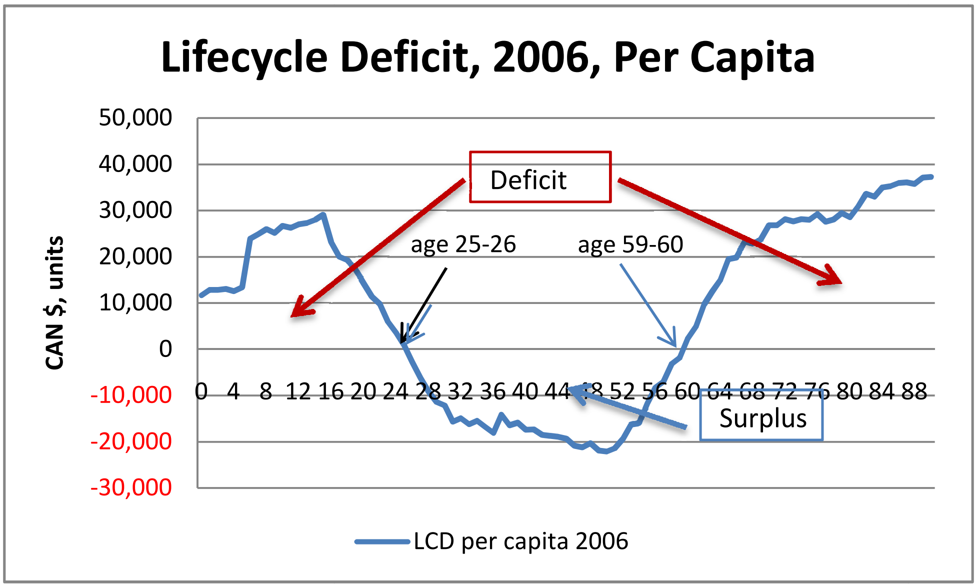
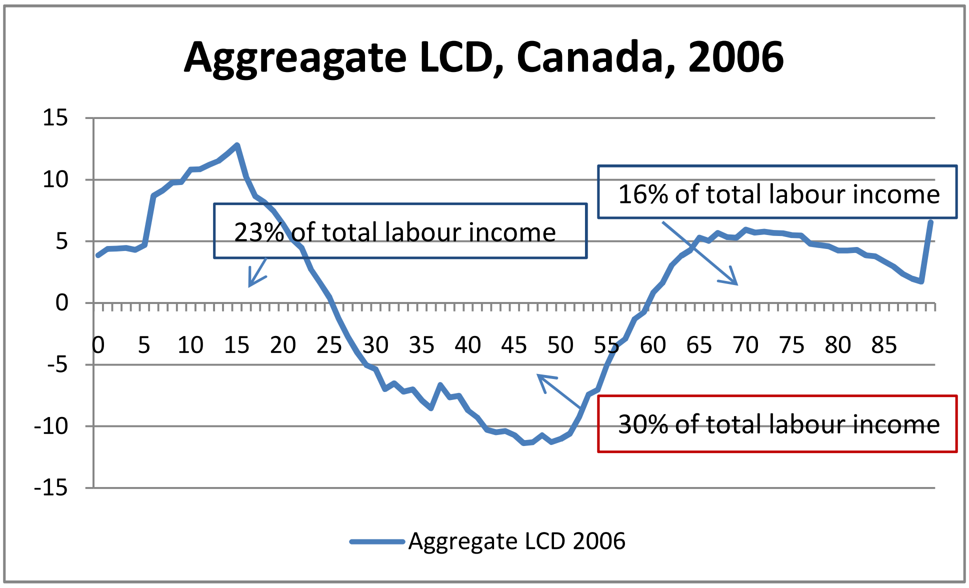


Figure 13 a) reports per capita profile of LCD for Canada 2006. As most countries, the young age groups from age 0 to 25 and the old age groups with age 60 or older consume more than they produce, and the middle age groups 26 to 59 contribute more than they consume. Figure 13 b) reports the difference between consumption and labour income. In Canada 2006, LCD per capita for age 60 or older is larger than the LCD per capita for age 25 or younger.

Figure 13: c) Aggregate Age Profile of LCD (Smoothed Data), Canada, CAD $ billion, 2006



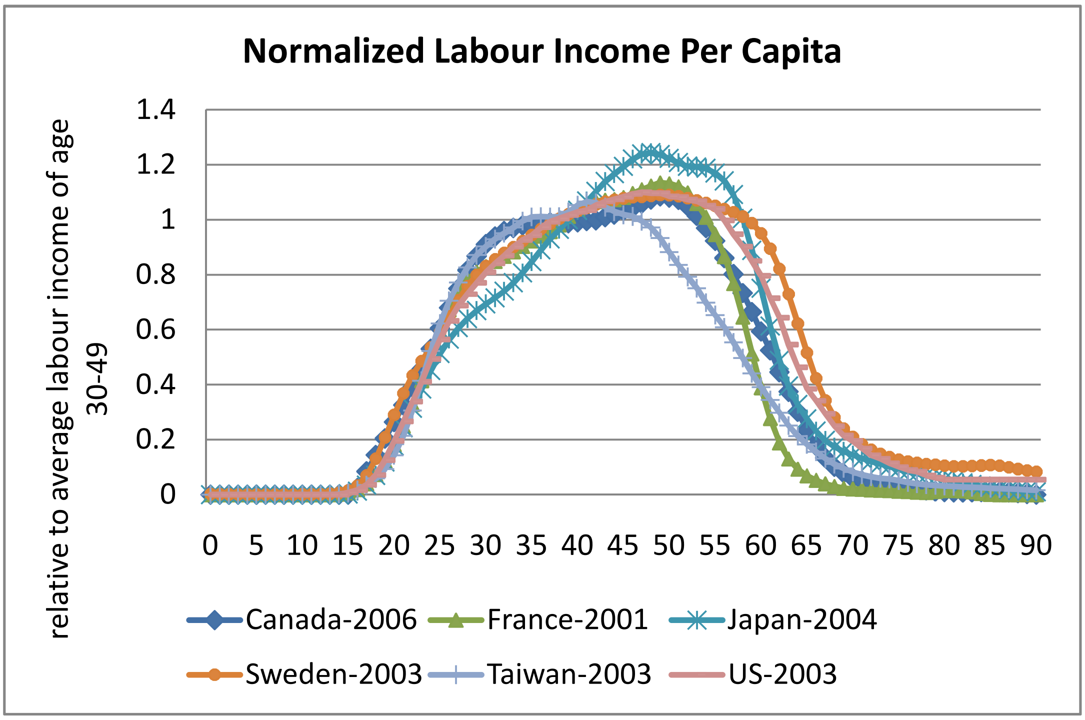
Mason et al. (2006) and Lee (1994 b) show that if an economy were in golden-rule steady state, the LCD would be zero. From Figure 13 c), in 2006, the aggregate LCD of age 0 to 25 equals to 23% of total labour income, and the aggregate LCD of age 60 or older equals to 16% of total labour income. The total LCD (i.e. sum of young and old LCD) covers 39% of total labour income. The LCS of age 26 to 59 of the Canada economy equals only 30% of total labour income. Thus, the net LCD for Canada in 2006 is 9% of total labour income.

4.1 Comparison with Other Countries

This section compares the results on Canada to other countries. First, in Figure 14 a), per capita labour income profiles are similar across countries till age 40s and various for the age groups 40s to 70s. Labour income per capita is higher in Japan than in other countries for ages 27 to 57, and is lower in Taiwan than the rest of countries for ages 47 to 60. Per capita labour income in Canada starts to decline earlier than the U.S., Sweden, and Japan, but later than Taiwan and France.

Table 5 reports the peak age, and the share of labour income for age under 25 and above 65 across countries. The peak age in Canada is similar to most countries except Taiwan. The share of labour income per capita for age under 25 is slightly higher in Canada than the rest countries at 7.83%. The share of labour income per capita for above age 65 is lower in Canada (2.91%) than in most countries except for France at 1.15%.

Figure 14: a) Comparison of Normalized Labour Income Per Capita Profile



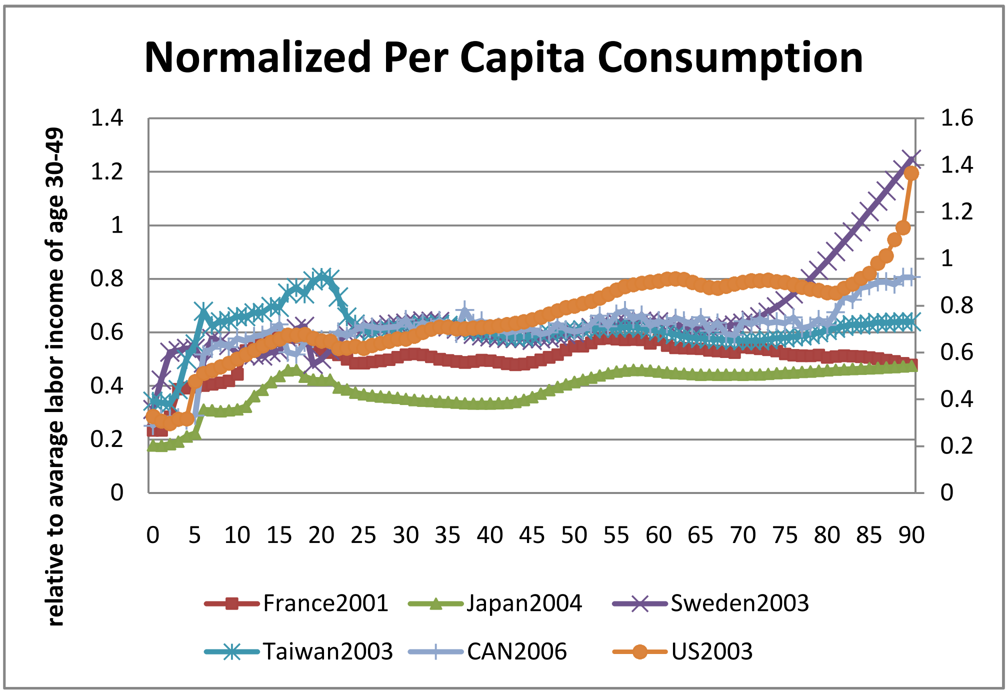
Data source: Information for France, Japan, Sweden, Taiwan, and the U.S. is from NTA website: www.ntaccounts.org.

Table 5: A Summary of Per Capita Labour Income of Selected Countries

	U.S. (2003)	Canada (2006)	Sweden (2003)	France (2001)	Japan (2004)	Taiwan (2003)

Peak Age	47	49	49	49	48	41
Share under age 25 (%)	6.04	7.83	7.07	7.01	5.66	6.89
Share above age 65 (%)	7.76	2.91	9.60	1.15	5.73	4.19

Figure 14: b) Comparison of Normalized Consumption Per Capita Profile



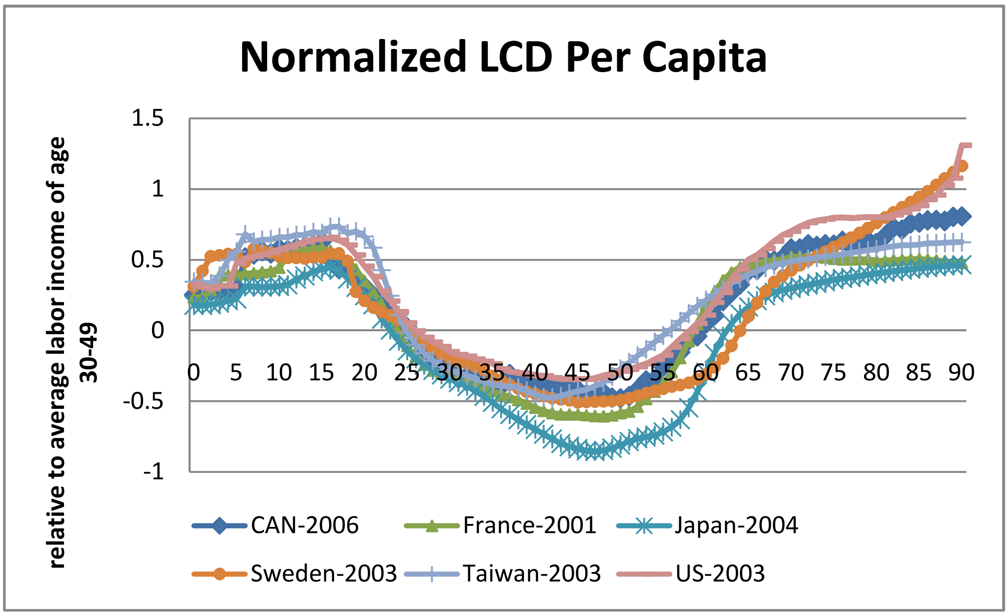
Data source: Information for France, Japan, Sweden, Taiwan, and the U.S. is from NTA website: www.ntaccounts.org.

The shape of the consumption age profiles for all the countries are relatively similar but there still exist important differences. To facilitate comparison of the profiles of all countries, all the age profiles of consumption are normalized by dividing the average of per capita labour income from age 30 to 49[22]. In Canada, consumption grows slower than Taiwan till age 24, and increases at the similar level till around age 78, and grows faster than Taiwan for age 80s or older. Compared to the U.S., the path of

[22] As mentioned in Mason et al. (2006), the level and shape is sensitive to the scalar chosen. However, if the calculation is based on percentage of changes, the choice of scalar will not affect the results.

consumption in Canada is under the one of the U.S. for most ages (except ages 21 to 36). The growth rate in the U.S. is higher than in Canada after age 40s, and increases dramatically for age 80s in the U.S.. However, the shape of consumption in Canada is relatively flat after 40s and increases at a slower rate at an earlier age (late 70s) than in the U.S.. The higher growth rates of consumption for older age of elderly are likely due to the difference of health systems in the U.S. and Canada. In France and Japan, the shape of consumption is flatter than in other countries, and there is no large increase at the older ages. In Sweden, per capita consumption increases rapidly at the old age.

Figure 14: c) Comparison of Normalized LCD Per Capita Profile



Data source: Information for France, Japan, Sweden, Taiwan, and the U.S. is from NTA website: www.ntaccounts.org.

In all countries, children and elderly consume more than produce, and hence generate a LCD. Young population starts to produce as much as consumption in Taiwan at age 23, in the U.S. at age 26, in Canada at age 25, and in Japan and European countries (e.g. France and Sweden) at age 23. Adults stop to produce more than consumption at age 59 in the U.S. and France, at age 60 in Canada, at age 65 in Sweden, at age 62 in Japan, and at age 56 in Taiwan. Among those countries, the span of years during LCS is 33 years in Taiwan and the U.S., 35 years in Canada, 36 years in France, 38 years in Japan, and 42 years in Sweden.

Table 6: Comparison of Economic Lifecycle of Selected Countries

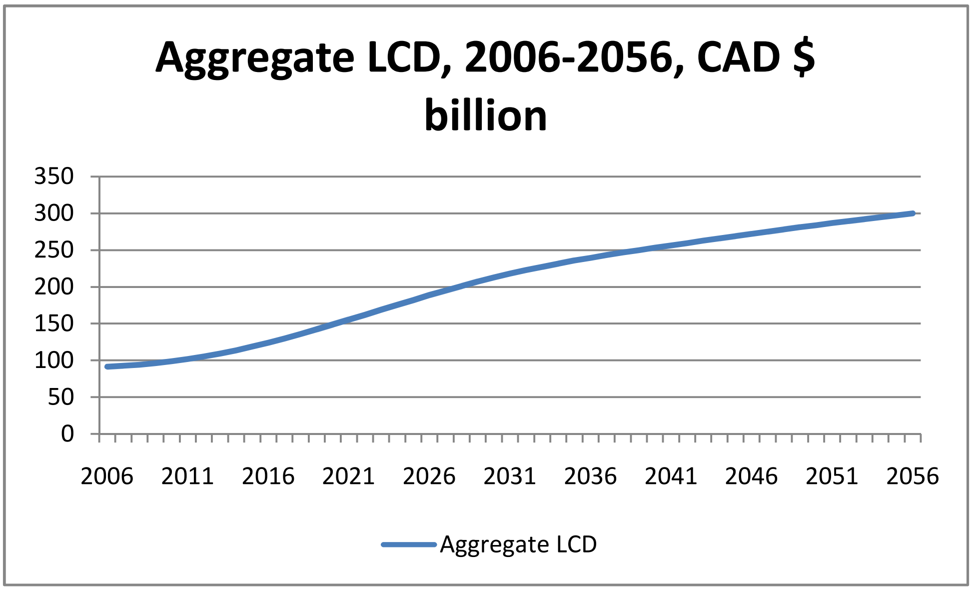
	U.S. (2003)	Canada (2006)	Sweden (2003)	France (2001)	Japan (2004)	Taiwan (2003)
Cross age (LCD to LCS)	26	25	23	23	23	23
Cross age (LCS to LCD)	59	60	65	59	62	56
Span (years)	33	35	42	36	38	33

5. Projection

The papers from Lee (1980) and Mason (1977) provide useful empirical results on transition on the pattern of consumption and labour income. Demographers, such as Keyfitz (1977) and Bourgeois-Pichat (1978) discuss how population growth rate influences profiles of consumption and labour income and hence social security systems by using theoretical models and empirical data. But the data at that time was not part of a consistent framework. The methodology constructed in this paper, which is commonly experienced by 33 countries, builds a more reliable age patterns to show the impact of population aging on consumption and labour income profiles.

The LCD developed in the previous sections can be very useful in running projections into the future. An accounting projection can be relevant to estimate the economic challenge of the upcoming demographic transition. To conduct the projections, assume that per capita total consumption (private and public consumption), and per capita total labour income for years 2007 to 2056 are the same as the ones for year 2006. With constant per capita lifecycle profiles and population projections for years 2007 to 2056, the results indicate how the aggregate LCD will evolve over time if no change in behaviour or government policy occurs.

Figure 15: Results of Projection of Aggregate LCD, CAD $ billion, 2006-2056



Based on the results, the LCD in Canada in 2006 was around $91,546 million. In the long run, an efficient economy is constrained to have zero or positive LCD (Mason et al., 2006). The projections (Figure 1) show that the aggregate LCD keeps growing from 2006 to 2056 given the population projections. The aggregate LCD in 2006 is 6.31% over GDP in 2006, and the aggregate LCD in 2056 increases to 20.68% over

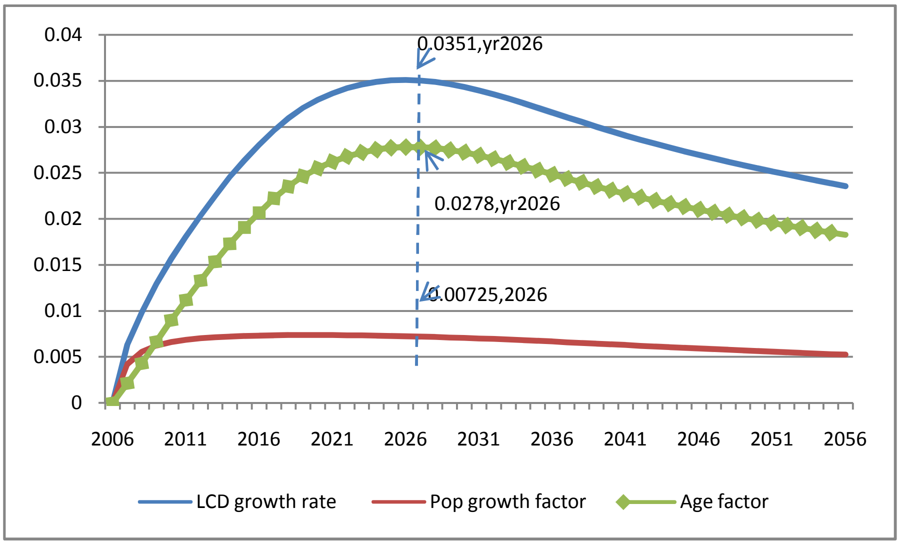
GDP as a result of the demographic projections.

Figure 16 reports the growth rates of the aggregate LCD. Two factors drive this growth rate. The first factor is the increase in total population. As the aggregate LCD is positive in 2006, with constant per capita LCD patterns, the aggregate LCD increases naturally with population. The second factor is aging, or more generally, the change in the age structure. The demographic projections suggest that the working age population will decline, thus imposing downward pressure on labour income. In addition, as the size of elderly increases, private and public spending on health care will augment. Thus, it is expected to face a change in the structure and level of total consumption. After eliminating the impact of the growth rate of total population, the rest of the impact is due to the age factor on the change of aggregate LCD.

The growth rate of LCD is decomposed (Figure 16) into the population growth rate and the age factor. First, the pressure on aggregate LCD occurs mostly between 2006 and 2026 as the growth rates increase rapidly during this period. Second, the result shows clearly that the principal factor behind the rapid rise of the aggregate LCD is the age factor.

The aggregate LCD increases rapidly from 2006 to reach a maximum growth rate of 3.51%, in year 2026. From 2006 to 2026, the average growth rate of aggregate LCD is 2.59%. Although the growth rate declines after 2026, the total amount of LCD will continue to increase. Such a growth rate profile over the next 50 years suggests that aging populations will constitute a real challenge for the Canadian economy.

Figure 16: Projection of Growth Rate of Aggregate Level of LCD, Population, and Age Factor[23]



With respect to the population growth factor, assume that everything (e.g. social and economic policy, economic conditions, market, regulation, and persons' behaviours) remains the same status as the one in 2006, the aggregate level of LCD grows as the same rate of population. The aggregate LCD increases in the range 0.5% to 0.725% from years 2006 to 2056, and reaches the maximum in 2025. After 2025, the contribution of the population growth rate to LCD converges slowly to only 0.5%.

The impact of age factor is much more significant than the population growth factor, except for a short period of time between 2006 and 2008. The impact of age reaches its maximum growth rate at 2.78%, in 2026. The average growth rate of the age factor between 2006 and 2026 is 1.89%. Compared to the average growth rate of aggregate LCD (2.59%) during this period, age factor captures 73% impact of the increase of the

[23] Note that the data of population is from population projections for Canada, provinces and territories, 2006-2056, conducted by Statistics Canada (catalogue no. 91-520-XIE). The data are under assumptions of medium-growth, medium migration trends scenario.

aggregate LCD. From 2027 to 2056, age factor growth rate is 2.29% on average.

The previous analysis concludes that population aging brings a significant economic challenge on Canada, mostly driven by the age factor. The most challenging period is likely to be between 2018 and 2038. The LCD will increase at an average rate of 3% per year. Population aging will contribute for 2.4 percentage points of this increase.

5.1. Scenarios

The above analysis is an accounting exercise. Clearly, behaviours and government policies are likely to change in the upcoming decades. In this section, the rise in LCD is measured in terms of labour income and in terms of consumption, indicating by how much labour productivity need to improve or to what extent consumption and government spending need to be reduced.

The first scenario (Table 7) is to examine by how much labour income needs to rise to keep aggregate LCD constant at 2006 level (scenario 1), and to repeat the exercise for public and aggregate consumption. The first row in Table 7 is the growth rate for each variable in the benchmark projection; the second row is the necessary growth rate to keep the LCD constant. If LCD remains to the 2006 level, and other variables evolve accordingly to their benchmark projections (see Figure 17), labour income needs to increase by an average growth rate rising from 0.23% to 0.65% between 2006 and 2056[24]. Similarly, the growth rate of consumption needs to decline from 0.59% to 0.21%. Labour income needs to increase faster than consumption needs to decline

[24] This result has the same magnitude as the paper by Denton and Spencer (2009).

because of the change in the age composition of population. Indeed, the size of elderly increases while the size of the working-age population declines. Consequently, the relative size of the labour force is declining and hence labour income most change by a larger percentage.

If LCD remains constant as its 2006 level and labour income and private consumption evolve according to their benchmark projections, public consumption growth rate needs to decline from 0.75% to -0.64% that is by 1.39 percentage points. If only public health consumption adjusts while education and other government consumption evolve accordingly to the benchmark projections, then public expenditure on health care will reach zero by 2043. If only public education adjusts, public expenditure on education will reach zero by 2022.

Figure 17: Projection of LCD, Labour Income, Consumption, Public Consumption and its Components from 2006 to 2056, CAD $ billion

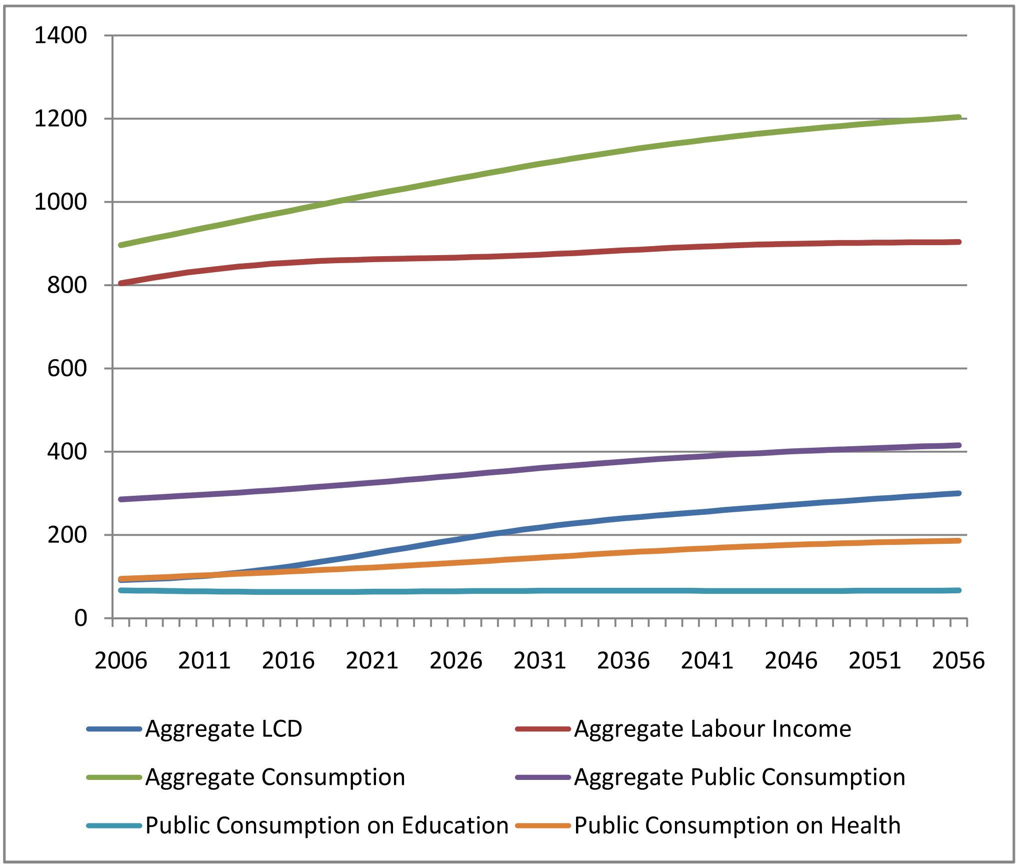


Table 7: Average Growth Rate from 2006 to 2056[25], by Percentage

	YL[26]	CON	CONG	CONGE	CONGH
benchmark average growth rate	0.23%	0.59%	0.75%	-0.01%	1.37%
average growth rate (adjusted)	0.65%	0.21%	-0.64%	2022 zero	2043 zero

Figure 18 a) and b) report that the evolution over time of the growth rate of labour income and consumption necessary to keep LCD at its 2006 level. In Figure 18 a), the growth rate of labour income in benchmark projection is 0.89% in 2007 and reaches the minimum 0.09% in 2024. The growth rate of labour income in the benchmark projection declines rapidly from 2007 to 2024. This result suggests that the Canadian

[25] YL refers to labour income; CON refers to consumption; CONG refers to public consumption; CONGH refers to public health consumption; CONGE refers to public education consumption.
[26] The average growth rate of labour income is calculated as, (YL in 2056/YL in 2006)^(1/50)=1+average growth rate of YL from 2006 to 2056.

economy is already under pressure due to population aging, and that pressure will intensify in the next 15 years. To keep LCD as its 2006 level, the labour income growth rate in scenario 1 starts with a high rate in 2007 and slowly declines till 2056. The difference of growth rate between the benchmark projection and scenario 1 implies that the gap increases from 2007 to reach the maximum in 2023. It proves again that the population aging pressure on LCD will be high for the next two decades. After 2024, the pressure of population aging declines but at a slow pace.

To keep LCD constant, consumption needs to change in the opposite direction to labour income (scenario 2). Figure 18 b) shows that in the benchmark projection, the growth rate of consumption declines as for labour income but with a lower rate. The difference of the growth rate for consumption in scenario 2 declines rapidly between 2007 and 2024. The growth rate between scenario 2 and benchmark consumption becomes more and more negative during the same period. This is mirror image of labour income that demonstrates that the pressure of population aging on LCD will be intense in the next two decades.

Figure 18: a) Growth Rate of Labour Income in Projection if Constant LCD 2006

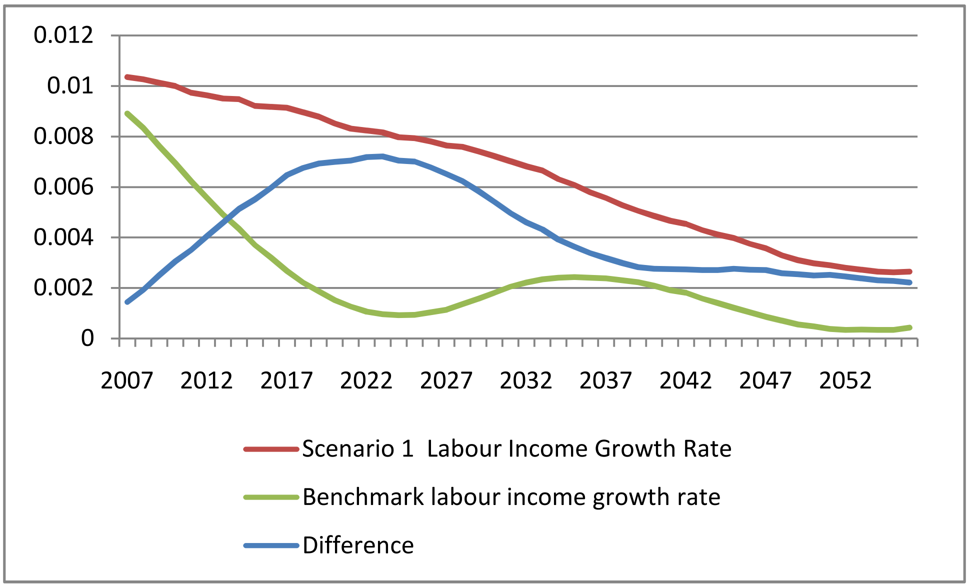
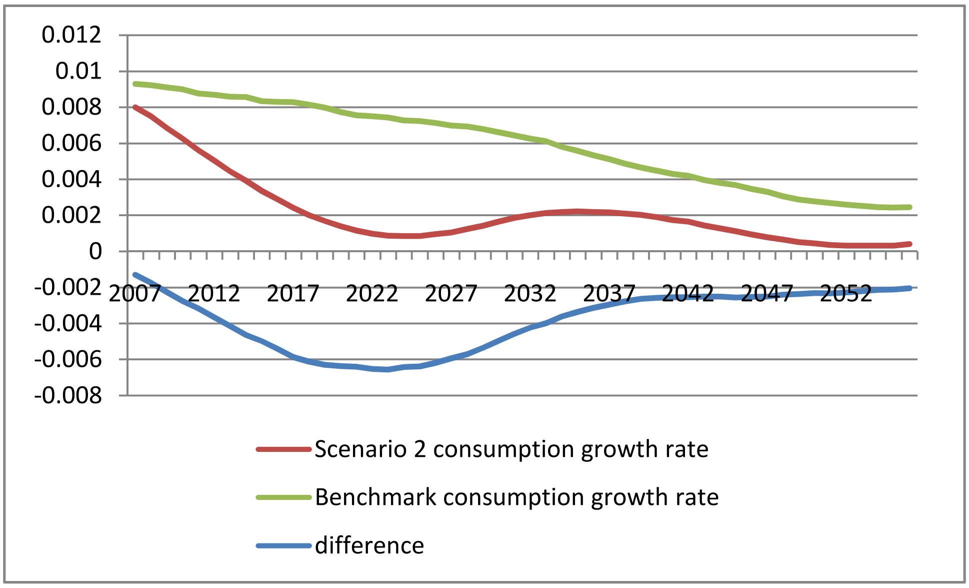


Figure 18: b) Growth Rate of Consumption in Projection if Constant LCD 2006



6. Conclusion

This paper built age profiles for private and public consumption and labour income with a different methodology. The LCD for young and old age group in 2006 equals 39% of total labour income. The net LCD for the Canadian population is 9% of total labour income. Compared to the U.S., the consumption and its components are quite different in Canada. Due to the differences in the health care system, the results show that most health care cost of elderly is provided by public programs in Canada. In the the U.S., the difference of health care cost between private and public sectors is small.

The estimated age profiles for consumption and labour income is to quantify the impact of population aging on the economy. Using population projections from 2006 to 2056, the aggregate LCD in Canada will increase from around 100$ billions to 300$ billions. The share of aggregate LCD over GDP increases from 6.31% to 20.61% from 2006 to 2056. The analysis shows that the impact of age factor captures two thirds of the total growth of aggregate LCD. From 2006 to 2026, age factor represents even a large share of the increase of LCD at 73%.

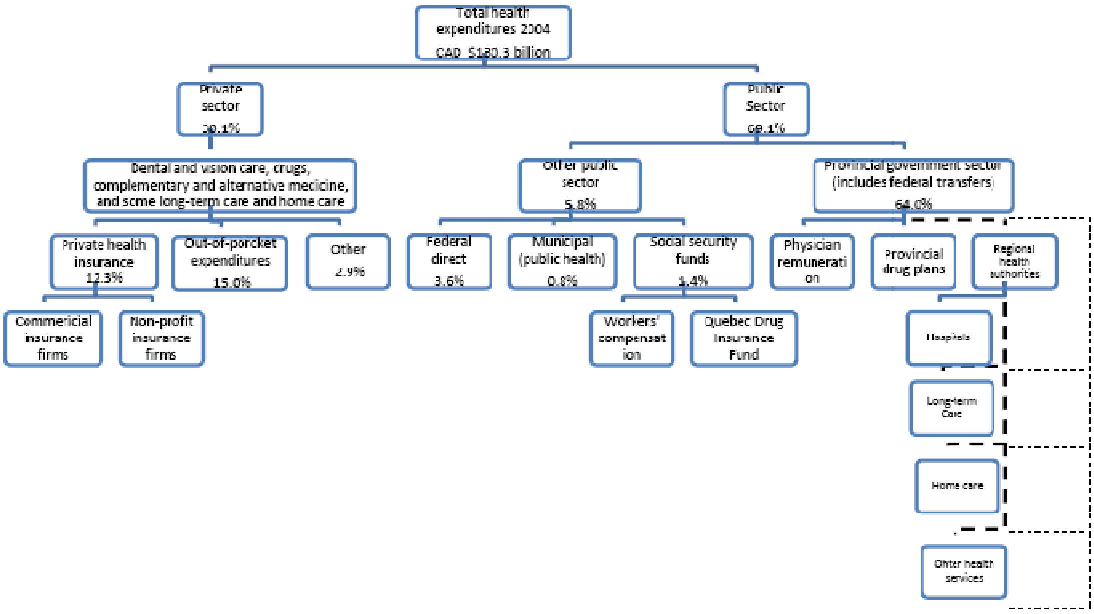
To keep constant the aggregate LCD at its 2006 level, the average growth rate of labour income needs to increase from 0.23% in the benchmark projection to 0.65%, the average growth rate of consumption needs to decline from 0.59% in the benchmark projection to 0.21%. By only controlling public consumption, the average growth rate needs to decrease by 1.39%. Moreover, public consumption on education and health will equal zero in 2022 and 2043 respectively if they are use to maintain LCD constant.

Again, to maintain a constant level of LCD as in 2006, the difference of growth rate of labour income between the benchmark and scenario 1 increases from 0.2% in 2007 and reaches the maximum at 0.7% in 2023. It indicates that the pressure of population aging on the economy is mostly concentrated during 2007 to 2023.

The results suggest that a huge pressure from demographic transition on the overall Canada economy for the next few decades. If Canada government does not plan or did not prepare for, the growth of the economy of Canada may have to slow significantly. The results quantify by how much of labour income or production needs to increase, and by how much of total consumption or public consumption needs to be cut.

Appendix 1

Chart 1: Framework of Financing of Health Care 2004



Data source: http://www.ecosante.org/ocde.htm

Table 1a[27]: Estimate of Total Provincial and Territorial Government Health Expenditures, by Age, Canada, (CAD $'000,000) 2001-2007, Both Sexes

Year	<1	1-4	5-14	15-44	45-64	65-74	75-84	85+
2001	1993.7	1329.7	3082.9	17557.2	14724.8	10756.9	11766.3	7182.8
2002	2146.5	1384.2	3231.8	18410	15849.7	11347.7	13173.9	7680.1
2003	2325	1446.2	3377.9	19591.5	17705.5	12218.7	13915.4	8280.6
2004	2476.9	1484	3479.6	20342.4	19153.4	12994.4	15103.8	9057.4

Year	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90+
2005	2515	1616	1827	1993	2563	3155	3585	3893	3997	4638	4973	5170	5480	5232	6141	7372	8272	7947	6697	3680
2006	2720	1707	1893	2081	2722	3312	3794	4031	4138	4767	5312	5638	6043	5827	6599	7729	8797	8544	7342	4072
2007	2938	1856	2020	2258	3024	3535	4064	4235	4370	4984	5756	6181	6497	6532	7181	8111	9344	8972	7884	4283

Table 1b: Estimate of Total Provincial and Territorial Government Health Expenditures, by Age, Canada, (CAD $' per capita) 2001-2007, Both Sexes

[27] Data source of public health expenditure is National Health Expenditure Trends, 1975-2009.

Year	<1	1-4	5-14	15-44	45-64	65-74	75-84	85+
2001	5998.91	931.94	752.77	1269.27	1986.84	4977.72	8768.45	17095.55
2002	6554.43	986.6	789.2	1326.5	2065.02	5217.52	9524.84	17650.39
2003	7071.15	1046.81	828.87	1411.14	2231.68	5575.99	9763.2	18413.62
2004	7564.76	1078.91	861.57	1463.31	2338.99	5864.88	10342.4	19418.23

Year	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90+
2005	7437	1185	970	945.6	1193	1405	1631	1748	1688	1688	1898	2245	2724	3452	5142	7067	9564	12699	20731	21639
2006	7891	1245	1025	995.8	1254	1464	1697	1810	1755	1762	1984	2380	2897	3676	5369	7382	9987	13331	21209	22802
2007	8239	1323	1122	1098	1351	1557	1822	1936	1890	1881	2127	2516	3080	3809	5589	7732	####	13711	21335	23007

Appendix 2

Optional Methods for Allocating Private Education Consumption

Method 1: NTA method

I use the equation

$$CFE_j^{edu} = \sum_a \alpha(a)E_j(a) + \sum_a \beta(a)NE_j(a)$$

$$CFE_{ij}(x) = CFE_j \frac{\alpha(x)}{\sum_a \alpha(a)E_j(a)} \quad (16)$$

where CFE_j^{edu} is the private consumption on education in household j, $E_j(a)$ is the number of members enrolled with age a in household j, $NE_j(a)$ is the number of members not enrolled with age a in household j, $\alpha(a)$ and $\beta(a)$ is the corresponding coefficients respectively, and $CFE_{ij}(x)$ is the private consumption on education of member i in household j.

I cannot use this method because I do not have information about the student indicators, $E_j(a)$ and $NE_j(a)$, in SHS.

Method 2[28]:

The method requires to combine two surveys together by using the variable "fllprt20" in SLID, and the proxy variable "highest degree received/ever received BA, etc" in SHS. The equation to work with is

$$\hat{\imath}_{j,x} = \frac{SD(a_x)}{SD(i_x)}\left(i_{j,x} - E(i_x)\right) + E(a_x) \tag{17}$$

where $\hat{\imath}_{j,x}$: the adjusted student status proxy variable from SHS. This variable will have age-specific mean and standard deviation equal to $E(a_x)$ and $SD(a_x)$, but at the individual-level of dataset I.

$E(a_x)$: mean of "fllprt20" in SLID.

$SD(a_x)$: standard deviation of "fllprt20" in SLID.

$E(i_x)$: mean of proxy variable in SHS.

$SD(i_x)$: standard deviation of proxy variable in SHS.

Optional Methods for Allocating Private Health Consumption

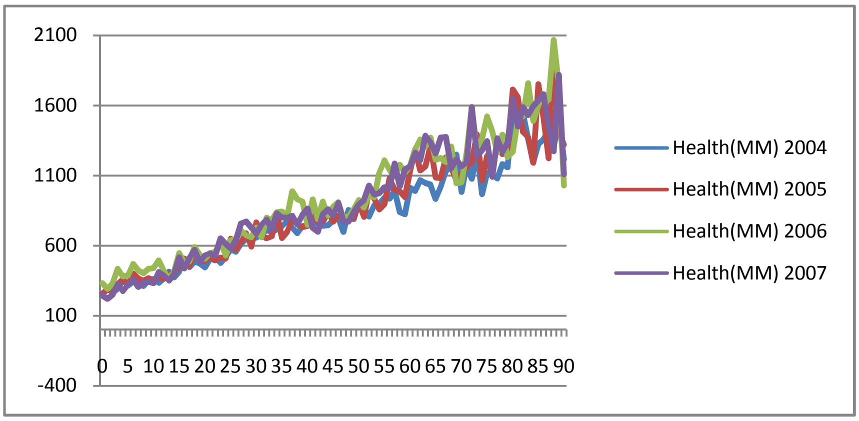
Method 1: Allocation based on health utilization rates

$$CFH_{ij}(x) = \frac{HUR_i(x)}{(\sum_i HUR_i(x))_j} . CFH_j \tag{18}$$

Results are shown in Figure 19.

Figure 19[29]: Private Health Consumption Per Capita, CAD $, SHS 2004-2007

[28] This method is from Gretchen Donehower (University of California, Berkeley, Department of Economics and Demography) of NTA team.



Method 2: Regression Method based on Inpatient and Outpatient

The regression equation is the following.

$$CFH_j = \sum_a \alpha(a).IN_j(a) + \sum_a \beta(a).OUT_j(a) \qquad (19)$$

where $IN_j(a)$ represents the amount of inpatient services (e.g. the number of medical doctor visits) used by the members with age a in household j, $OUT_j(a)$ represents the number of outpatients services (e.g. the number of nights spent in hospital or other health institutions such as clinics) used by the members with age a in household j, $\alpha(a)$ and $\beta(a)$ are the corresponding coefficients, and CFH_j is private consumption on health in household j. Private health consumption is regressed on the number of members using inpatient services (IN), and outpatient services (OUT) in each year of age.

Method 3: Regression Method Based on the number of member

The regression equations are as following:

Equation 1: The linear equation

[29] This method is from Marcel Mérette, University of Ottawa.

$$CFH_j = \sum_a \beta(a).U(a)M_j(a) \tag{20}$$

Equation 2: The non-linear equation

$$CFH_j = \sum_a \beta_0(a).U(a)M_j(a) + \sum_a \beta_1.a.(a).U(a)M_j(a) + \sum_a \beta_2.a^2.(a).U(a)M_j(a) \tag{21}$$

Private health consumption is regressed on the number of members (M) and per capita utilization measure by age (U).

Method 4: "based on non-parametric iterative method" provided by NTA team

In this approach, health expenditure is assigned with equal shares to each household member and then tabulate the per capita profile. The per capita profile is then used as weights to allocate health consumption to household members. This generates a new per capita profile. Here is an example (Example 1) to show how it works. First, let look at column "Iteration 1". The health consumption in household 1 is 70. The equal share to each member is 70/3=23.33. The health consumption in household 2 is 80. The equal share to each member is 80/3=26.67. The health consumption in household 3 is 40. The equal share to each member is 40/2=20. The health consumption in household 4 is 20. The equal share to each member is 20/2=10.

The second step is to calculate the average health consumption for each age group. The average health consumption for age group 5 is (23.33+10+10)/3=14.44; for age group 35 is (23.33+23.33+26.67+26.67)/4=25; for age group 65 is (26.67+20+20)/3=22.22.

Third, let look at column “Iteration 2”. The health consumption of individual 1 in household 1 is 70*[14.44/(14.44+25+25)]=15.69; of individual 2 in household 1 is 70*[25/(14.44+25+25)]=27.16; of individual 3 in household 1 is 70*[25/(14.44+25+25)]=27.16. The same approach is repeated for individuals in other households. Thus, per capita health consumption in iteration 2 is (15.69+10+10)/3=11.90 for age group 5; (27.16+27.16+27.69+27.69)/4=27.42 for age group 35; and (24.62+20+20)/3=21.54. Repeat the procedure in each iteration until iteration 6.

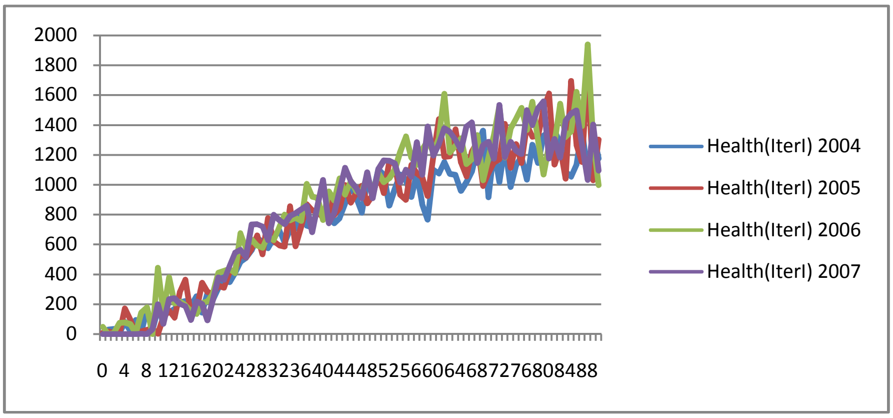
Finally, the estimated health consumption per capita profile is approaching to the real one under the limit of 100 times of iterations.

Example 1: Non-parametric iteration method

IterativeMethod				Estimated C after iteration					
Age	True C			Iteration1	Iteration2	Iteration3	Iteration4	Iteration5	Iteration6
5	10			14.44444	11.89655	10.82563	10.36457	10.16299	10.07359
35	30			25	27.42374	28.7414	29.40266	29.72062	29.87027
65	20			22.22222	21.53846	20.8525	20.43188	20.20952	20.09938
HHNo	Id No	Age	HHC						
1	1	5	70	23.33333	15.68966	12.4769	11.09372	10.48896	10.22077
1	2	35	70	23.33333	27.15517	28.76155	29.45314	29.75552	29.88961
1	3	35	70	23.33333	27.15517	28.76155	29.45314	29.75552	29.88961
2	1	35	80	26.66667	27.69231	28.72124	29.35218	29.68571	29.85093
2	2	35	80	26.66667	27.69231	28.72124	29.35218	29.68571	29.85093
2	3	65	80	26.66667	24.61538	22.55751	21.29564	20.62857	20.29814
3	1	65	40	20	20	20	20	20	20
3	2	65	40	20	20	20	20	20	20
4	1	5	20	10	10	10	10	10	10
4	2	5	20	10	10	10	10	10	10

Results are shown in Figure 20.

Figure 20: Private Health Consumption Per Capita, CAD $, 2004-2007, under Iteration Method



References

Bourgeois-Pichat, Jean (1978) ‘Le financement des retraites par capitalisation’, Population 33, No. 6, 1115-34

Denton, Frank T., Dean C. Mountain and Byron G. Spencer (2002) ‘Age, Retirement and Expenditure Patterns: An Econometric Study of Older Canadian Households’ SEDAP Research Paper, No. 82

Guillemette, Yvan, (2003) ‘Slowing Down With Age: The Ominous Implications of Workforce Aging for Canadian Living Standards’ C.D. Howe Institute, No. 182, ISSN: 0824-8001

Gunderson, Morley (1998) ‘Remove Barriers to Working beyond Age 65, Says C.D. Howe Institute Study,’ C.D. Howe Institute

Hicks, Chantal (1997) ‘The age distribution of the tax / transfer system in Canada,’ presented to the conference on Intergenerational Equity in Canada, Statistics Canada, Ottawa

Kesselman, Jonathan R. (2004) ‘Mandatory Retirement and Older Workers: Encouraging Longer Working Lives,’ C.D. Howe Institute, No. 200, ISSN: 0824-8001

Lee, Ronald (1980) ‘Age Structure Intergenerational Transfers and Economic Growth: An Overview,’ *Revue économicque* 31, No. 6, *Démographie économicque*, 1129-56

Lee, Ronald D. (1994a) ‘The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle,' in *Demography of Aging*, ed. L. G. Martin and S. H. Preston (Washington, D.C.: National Academy Press), 8-49

- (1994b) 'Population, Age Structure, Intergenerational Transfers, and Wealth: A New Approach, with Applications to the US.,' in *The Family and Intergenerational Relations*, *Journal of Human Resources* 29, edited by P. Gertler, 1027-63

Lee, Ronald and Andrew Mason, lead authors and editors (Forthcoming 2011) 'Population aging and the generational economy: A global perspective,' Cheltenham, (UK: Edward Elgar)

Lee, Ronald, Sang-Hyop Lee, and Andrew Mason (2008) 'Charting the Economic Life Cycle,' in *Population Aging, Human Capital Accumulation, and Productivity Growth, a supplement to Population and Development Review 33*, ed. A. Prskawetz, D.E. Bloom, and W. Lutz (New York: Population Council), 208-37

Mason, Andrew (1977) 'The life Cycle Saving Model: A Synthesis of Dependency and Rate of Growth Effects,' Unpublished manuscript of the East-West Population Institute, Hawaii

Mason, Andrew, Ronald Lee, An-Chi Tung, Mun Sim Lai, and Tim Miller (2006) 'Population Aging and Intergenerational Transfers: Introducing Age into National Accounts.' in *Developments in the Economics of Aging*, ed. D. Wise (Chicago: NBER and University of Chicago Press)

Mason, Andrew, Ronald Lee, Gretchen Donehower, Sang-Hyop Lee, Tim Miller, An-Chi Tung, and Amonthep Chawla (2009) '*National Transfer Accounts Manual Draft Version 1.0'*

Nathan, Keyfitz (1977) *Applied Mathematical Demography* (New York: John Wiley and Sons)

Robson, William B. P. (2009) 'Boomer Bulge: Dealing with the Stress of Demographic Change on Government Budgets in Canada,' C.D. Howe Institute