Population Aging in Canada: What Life Cycle Deficit Age Profiles Are Telling Us about Living Standards

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Les auteurs développent une nouvelle base de données canadienne, reposant sur la méthodologie des comptes de transferts nationaux (CTN). L'approche sous-jacente aux CTN, dite micro-macro, permet d'obtenir un tableau exhaustif des flux économiques et de mesurer rétrospectivement la manière dont les individus produisent, consomment, épargnent et partagent les ressources selon l'âge. Les auteurs présentent d'abord la méthode des CTN et la comparent à d'autres approches micro-macro. Ils appliquent ensuite cette méthode afin d'obtenir, pour la première fois, la répartition des revenus du travail et de la consommation selon l'âge au Canada, pour la période s'échelonnant de 1998 à 2013. L'analyse temporelle nous renseigne sur l'évolution du déficit de cycle de vie, soit la différence entre la consommation et les revenus du travail selon l'âge, et soulève plusieurs questions quant aux niveaux de vies futurs au Canada.

Mots clés : consommation, revenus du travail, déficit de cycle de vie, profils selon l'âge, comptes de transferts nationaux

In this article, we develop a new longitudinal dataset for Canada based on the National Transfer Accounts (NTA) methodology. The NTA constitute a micro–macro linkage methodology that provides a complete picture of economic flows by age and measures the way in which individuals produce, consume, save, and share resources at each age on a retrospective basis. In this article, we introduce the NTA and evidence their link with micro–macro methodologies. Then, we provide for the first time individual age consumption and labour income profiles in Canada for the period between 1998 and 2013. The longitudinal dimension of the study sheds light on how the gap between consumption and labour income has changed over that period and raises questions about the future of living standards in Canada.

Keywords: consumption, labour income, life cycle deficit, age profiles, National Transfer Accounts

Introduction

The macroeconomic consequences of population aging have been widely investigated throughout the world. Challenges related to the labour market, immigration, public pensions, and health expenditures have motivated empirical research that led to new public policies. Because the welfare state in Canada supports a significant part of health care costs and retirement pension benefits, many research studies have been conducted on aging and health care and on aging and the participation of older workers in the labour market.

Canada's public health care system covers 4/5 of the observed health care expenditures.[1] Population aging may therefore raise public spending considerably because health care expenditures increase rapidly with age (Clavet et al. 2013), but many studies show that other factors such as rapid technical progress in the medical sector, increasing physician costs and other inflationary costs specific to the health care sector, and increased use of drugs explain most of the additional costs in public health care (see, e.g., CIHI 2011, Dormont and Huber 2006, Evans et al. 2001). According to these studies, population aging has played a minor role in the rise of public health care costs.

Another concern relates to whether the labour force in Canada will decline with population aging (Bélanger, Carrière, and Sabourin 2016; Bissonnette et al. 2016; McDaniel, Wong, and Watt 2015). Evolution of the labour force is certainly a major issue with respect to future production and economic growth. Although immigration (Fougère et al. 2004) and older workers' higher participation rates (Denton and Spencer 2009) could reduce the negative impact on the labour force, perspectives on future labour force growth still require an increase

in productivity to maintain the economic growth rates observed over the past few decades.

Although the literature cited thus far addresses major topics related to population aging in Canada, a complete analysis of its consequences requires a full data set of the economic flows between ages and generations. A first attempt to investigate the burden of population aging on current and future generations has been developed through what is called *generational accounts* (GA). GA were initiated by Laurence J. Kotlikoff and his co-authors (Auerbach, Gokhale, and Kotlikoff 1994) after debates about intergenerational equity (Longman 1987; Preston 1984). The GA methodology is a major breakthrough in estimating the value of taxes and public transfers received by current and future generations over their entire life cycle. In Canada, Oreopoulos and Vaillancourt (1998); Oreopoulos, Kotlikoff, and Leibfritz (1999); and Kotlikoff and Raffelhüschen (1999) report the fiscal burden of population aging on future generations; however, GA methodology focuses on net public transfers and does not include any measure of private transfers, even though supports within the family can play a major role in living standards and intergenerational solidarity (Masson 1998). In addition, its forward-looking nature is very sensitive to the assumptions used to build the accounts (Bonnet 2002). Hence, without a full public and private economic transfer data set across ages, it is not possible to assess under which conditions current standards of living will be sustainable as part of ongoing demographic change.

In this article, we develop a new longitudinal data set for Canada based on the National Transfer Accounts (NTA) methodology. NTA provide a more complete picture of economic activity by age than do GA. NTA measure the way in which individuals produce, consume, save, and share resources at each age on a retrospective basis and follow a micro–macro linkage approach. In view of the availability of the various surveys and administrative data, we build for the first time individual consumption and labour income age profiles in Canada for each year between 1998 and 2013 and for each age between 0 and 90 years and older.[2] The longitudinal dimension of the study sheds light on how the gap between consumption and labour income, called *life cycle deficit* (LCD) in the NTA methodology, has been changing over that period. The recent trend in LCD raises questions about the future of living standards in Canada.

Using the new NTA data set, we start by demonstrating that for 2013, consumption increases with age, and labour income is highly concentrated over the lifetime. Second, we show that the increase in the life cycle surplus of working-age groups between 1998 and 2013 does not compensate for the rise in the LCD of non-working-age groups over the same period. Third, we evidence that older workers significantly increase the life cycle surplus they generate between 1998 and 2013. Fourth, we show that younger workers were particularly affected by and after the 2008 economic crisis because their LCD deteriorated significantly.

The article is organized as follows. In the next section, we introduce the NTA methodology. Then we show how this methodology links micro and macro data. In the "Life Cycle Deficit for 2013" section, we analyze the age profiles for consumption and labour income and the difference between the two in 2013, which is the most recent year of construction. We next analyse the evolution of the three profiles from 1998 to 2013. We then provide concluding remarks.

National Transfer Accounts methodology

The NTA methodology originates from the work of Lee (1980) and Mason (1988). NTA are based on a unified international methodology that consists of introducing age into the National Economic Accounts. The theoretical basis of the methodology is available in Lee and Mason (2011a, 2011b), and the technical details are described in a reference manual published by the UN (2013). NTA are generating interest from governments around the world. For instance, NTA became part of the official statistics of South Korea in January 2019.

NTA are based on an accounting identity, introduced in Equation (1), such that the difference between consumption (C_a) and labour income (Y_a^L) at each age a corresponds to the LCD (Lee 1994). The gap between consumption and labour income results in net public or private transfers T_a^N equal to transfer inflows T_a^I and transfer outflows T_a^O, and it also results in asset-based reallocations equal to the asset income net of savings $Y_a^K - S_a$.

$$C_a - Y_a^L = \left(T_a^I - T_a^O\right) + \left(Y_a^K - S_a\right). \quad (1)$$

Young and old people are expected to consume more than their income from their participation in the labour market. They must thus rely on public transfers, private transfers, and asset-based reallocations to cover their positive LCD. In contrast to young and old people, middle-aged adults do not entirely consume their labour income and hence generate life cycle surplus that is used to save money and transfer resources to young and old individuals.

The NTA include flows from and to three institutions: the private sector (including households, household enterprises, non-profit institutions serving households, and corporations), the public sector (federal, regional, and local governments), and the rest of the world. As defined in the UN (2013) manual, the institutions are considered intermediaries between individuals, who are the basic unit of analysis. At each age, individuals generate flows for themselves (wages, self-employment income, and other asset income) that they consume, save, or transfer to other age

groups through the state or through the family. The NTA methodology assumes that flows from and to institutions (corporations, non-profit institutions serving households [NPISH], and governments) are treated as flows to and from individuals. Flows from and to firms are assigned to the individuals who own them. For instance, asset income from and to firms is allocated across ages according to the profile of private asset income owned by individuals. Governments' mediate public transfers that they levy from individuals (taxes) and transfer to individuals (public cash transfers and public consumption). Governments also generate public asset-based reallocations that are the difference between public asset income and public saving. Public asset-based reallocations do not flow from and to governments. Public asset-based reallocations are assigned to individuals on whose behalf the government is acting as intermediary (UN 2013). The age pattern used to assign public asset-based reallocations corresponds to the public transfer outflows.

Earlier works conducted with this international methodology have helped to make static comparisons across 70 countries. The most recent developments using NTA include a time-series perspective, but only a few countries have completed NTA over a horizon of several years: the United States (Lee, Donehower, and Miller 2011), Taiwan (Lai and Tung 2015), Australia (Temple, Rice, and McDonald 2017), and France (d'Albis et al. 2015, 2017, 2018; Navaux 2016). With this article, we add Canada to that list.

Links Between Micro and Macro Data

Micro–Macro Procedure

NTA are an example of micro–macro linkage methodologies that add new dimensions to macroeconomic accounts. In particular, NTA provide age perspectives on the allocation of resources by extracting original indicators from micro-data that are consistent with macroeconomic accounts. The Expert Group on Disparities in a National Accounts Framework of the Organisation for Economic Co-operation and Development (OECD) provides an international framework to apply micro–macro linkage methodologies. In this section, we describe how the NTA methodology fits with the five-step approach provided by the Expert Group and described in Zwijnenburg, Bournot, and Giovannelli (2017). We also compare our application with another micro–macro application for Canada by Statistics Canada (2017) that produces household wealth accounts according to several dimensions: provinces, age groups, household type, and household disposable income quintiles.

Step 1: Adjustment of National Accounts Totals

NTA constitute a complete picture of the economic flows from and to individuals. Consequently, individuals are considered the beginning and the end of economic flows, whereas other economic agents such as private and public sectors or the rest of the world are regarded as intermediaries through which economic flows pass. The individual focus in NTA differs from the Statistics Canada (2017) approach in which the central point of attention is the household.

The aggregates used in NTA are the result of a two-step process. First, we take from national accounts eight macro control variables: private consumption, public consumption, labour income, net transfers with the rest of the world, private asset income, public asset income, private saving, and public saving (see Table A.1 in online Appendix A that introduces calculations for 2013). Note that private consumption is composed of final private-sector consumption expenditures, that is, final consumption of households and NPISHs from which taxes less subsidies on products are deducted. Public consumption equals government's final consumption expenditure made up of common and individual consumption expenditure. Common public expenditures belong equally to the entire community (e.g., police, justice, defense, or public administration), whereas individual public expenditures benefit individuals directly (public health, public education).[3] Second, we divide macro control variables into subgroups. For instance, we have three subgroups for labour income: wages, employer's contribution, and labour share of gross mixed income. With respect to private consumption, the subgroups are education, health, imputed rents, and other consumption. Public consumption is subdivided into elementary and secondary school education, post-secondary education, health, and other. Appendix A details the methodology used to determine NTA aggregates and their subgroups.

Step 2: Identifying the Relevant Micro Variables

Most micro–macro linkage methodologies use a survey database for labour income and private consumption because the focus is usually the household sector (see, e.g., Statistics Canada 2017 and Vermeulen 2016 on household assets). Because the coverage of economic flows is large (private and public sectors, the rest of the world) and the focus is on individuals, NTA must take into consideration a large number of data sources, including administrative data in addition to a survey database.[4]

We calculate the three components of labour income (labour earnings, employer contributions, self-employment labour income) using Survey of Labour and Income Dynamics (SLID) and Canadian Income Survey (CIS) data available from 1993 to 2014. We estimate private consumption age profiles (education, health, imputed rents, and other consumption) using the Survey of Household Spending (SHS) data, which are only available between 1997 and 2013.

Public consumption is distributed among individuals from the administrative database. Our calculations of

public health consumption relies on provincial and territorial government expenditure by age and sex from the CIHI for 1998–2014. Age profiles for public education consumption are more restricted. We estimate these age profiles from the number of students enrolled in public elementary and secondary schools, which is available from the 2002–2003 to 2014–2015 school years, and from the number of students enrolled in post-secondary education, which is available from the 1999–2000 to 2014–15 school years. We chose to compute NTA age profiles from 1998 to 2013 because the major part of the age profiles are available for these years. Still, two years for post-secondary education and five years for elementary and secondary education are missing. Consequently, we assume that the number of students enrolled by age group remains on the same trends during those years (see details in Appendix B). According to the UN (2013) manual, an equal amount of common public consumption expenditure (police, justice, defense, or public administration) is allocated to each individual. Appendix B details the method for calculating per capita age profiles.

Step 3: Imputation

Some of the variables necessary to build NTA are not directly available in surveys. This is the case for imputed rent, employer's contribution, and income tax, which are related to labour income. We thus have to estimate them, as detailed in Appendix B. Moreover, the NTA methodology requires an allocation of resources at the basic unit of analysis, which is the individual. This is not always readily obtainable. For instance, labour income is available at the individual level, but private consumption is available only at the household level. We thus use regression methods to allocate households' expenses in education and health across individual members. For private consumption other than health and education, we use an equivalence scale for the allocations among individuals of the household. Appendix B provides descriptions of the methodologies we use to individualize variables that are only available at the household level.

Step 4: Cluster Individuals

Many micro–macro linkage methodologies resort to clustering households. For instance, Statistics Canada (2017) clusters households with respect to several dimensions: provinces, age groups (younger than 35, 35–44, 45–54, 55–64, and 65 and older), household type, and household disposable income quintiles. NTA cluster only on the age dimension, but at a more granular level (yearly age) than for Statistics Canada (2017), which uses age groups.

Step 5: Scaling the Relevant Indicators

The last step of the procedure consists of readjusting values of indicators extracted from surveys with a scaling factor, to ensure that the values of aggregates calculated from surveys and from macroeconomic accounts are comparable. Statistics Canada (2017) conducts a ranking, balancing, and reconciliation process to ensure that the sum over specific categories (provinces, household disposable income quintiles, age groups, and household types) are equal to the macro-aggregates while minimizing the change in each cell estimated from surveys. According to the UN (2013) manual, NTA calculate the scaling factor by extracting per capita age profiles at the lowest level of the indicators (for private consumption, e.g., private education, private health, imputed rents, other private consumption) to adjust the age pattern up or down by the same factor at each age. From an algebraic perspective, we have the following: the per capita age profile f_a is extracted from survey data or an administrative database. The mean age profile is smoothed with a Level 2 polynomial.[5] Each profile $\tilde{f}_a$ is then multiplied by the number of people at each age, N_a, to get an aggregate flow $F = \sum_{a=0}^{n} \tilde{f}_a N_a$. The aggregate age profile may need to be adjusted so that the aggregate flow F fits perfectly with the corresponding aggregate AG from the System of National Accounts (SNA). To do so, the scaling factor $s = F/AG$ is calculated and applied to the aggregate smoothed series. Once s is determined, the corrected profiles in NTA are $\tilde{F}^S = \tilde{F}/s$ at the aggregate level and $\tilde{f}^s = \tilde{F}^S/N_a$ at the individual level.

Scaling Factor

Because $s = F/AG$, one can consider the scaling factor as indicating the extent to which the aggregate age profile constructed by NTA covers the corresponding SNA number. Table 1 introduces the scaling factor that we use to readjust age profiles for various aggregates of our study. An $s = 1$ means that $F = AG$, and hence the constructed aggregate NTA number corresponds exactly to the SNA statistics. The constructed aggregate NTA number underestimates the corresponding SNA statistics when $s < 1$ and overestimates them when $s > 1$.

Looking at Table 1, the scaling factor for private consumption with SHS was around 0.86 between 1998 and 2009. Hence, micro-data from the survey cover around 86 percent of the macro-aggregates during that period. The coverage of SHS improves drastically from 2010 to 2013, with an average scaling factor of 0.92. The last year for which data are available, 2013, evidences an improvement in coverage with a scaling factor of 0.94. Canadian micro-data have better coverage than the average of OECD countries (Fesseau, Wolff, and Mattonetti 2013). In 2009,[6] OECD countries have a scaling factor of 0.76, on average, whereas for the same year in Canada this factor equals 0.84 for SHS. Private consumption includes four components: education, health, imputed rents, and the rest of private consumption (other). Although micro-data for health, imputed rents, and the rest of private consumption cover their macro-aggregates relatively well (87 percent, 84

Table 1: Scaling Factor $s = F / AG$

NTA Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Labour income[a]	1.00	1.00	1.02	1.00	1.00	1.00	0.99	0.99	0.98	0.98	0.99	0.97	0.97	0.97	0.95	0.95
Wages	1.09	1.08	1.09	1.07	1.07	1.07	1.06	1.06	1.06	1.05	1.06	1.05	1.05	1.05	1.03	1.03
Self-employment labour income	0.47	0.57	0.57	0.57	0.63	0.58	0.59	0.56	0.50	0.51	0.54	0.50	0.51	0.49	0.38	0.40
Private consumption[b]	0.88	0.88	0.87	0.87	0.89	0.86	0.87	0.87	0.87	0.84	0.83	0.84	0.91	0.93	0.91	0.94
Education	1.92	1.96	2.08	2.01	1.98	1.88	1.97	2.03	1.99	2.01	2.15	2.23	1.90	1.86	1.78	1.84
Health	0.89	0.90	0.91	0.88	0.93	0.88	0.89	0.88	0.88	0.85	0.83	0.80	0.84	0.84	0.84	0.81
Imputed rents	0.85	0.88	0.82	0.79	0.82	0.81	0.83	0.88	0.81	0.81	0.79	0.76	0.84	0.95	0.83	0.97
Other	0.87	0.87	0.86	0.86	0.88	0.85	0.85	0.85	0.86	0.83	0.82	0.84	0.91	0.92	0.92	0.93
Public consumption[c]	0.97	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Elementary and secondary education	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Post-secondary education	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Health	0.92	0.92	0.92	0.91	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.93
Other (collective expenditures)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[a] Aggregate of wages and self-employment labour income.

[b] Aggregate of education, health, imputed rents, and other.

[c] Aggregate of elementary and secondary education, post-secondary education, health, and other.

Sources: Survey of Household Spending, Survey of Labour and Income Dynamics, Canadian Income Survey, national health expenditure trends (Canadian Institute for Health Information), number of students in public elementary and secondary schools, post-secondary enrolments (Statistics Canada), national accounts, and authors' calculations.

percent, and 87 percent on average, respectively, between 1998 and 2013), micro-data for private education overestimate its macro-aggregate by 92 percent in 1998 and by 84 percent in 2013. Fortunately, because education in Canada is mostly public, private education expenditure is a small consumption item in our analysis (only 1.1 percent of total consumption in 2013).

By design, scaling factors for public education and for other public consumption are equal to 1. In fact, education age profiles result from the allocation of aggregates across ages according to the number of students (see Appendix B for a description of the methodology to calculate per capita age profiles of education at each level). Moreover, other public consumption is composed of collective expenditures that have the same value for each individual regardless of age. The age profile for public health captures between 91 percent and 93 percent of the corresponding macro-aggregates. In comparison, Bruil's (2018) micro-data for the Netherlands cover only 85 percent of health care expenditures.

The scaling factor that we obtain for labour income is on average equal to 0.99. It is very close to 1 from 1998 to 2008, it equals 0.97 for the three last waves of SLID, and it then decreases down to 0.95 for the CIS waves in 2012 and 2013. A more detailed analysis of the components for labour income shows that wages are estimated with a scaling factor of 1.06 on average. The scaling factors for wages even improve over time. The survey age profiles overestimate the macro-aggregate by 9 percent in 1998 and 2000, but only by 3 percent in 2012 and 2013. However, self-employment labour income is underestimated, as is usually the case in this kind of micro–macro linkage exercise. The scaling factor for self-employment labour is 0.54 on average for the SLID survey waves from 1998 to 2011. The coverage rate of micro-data is heterogeneous during this period, with a minimum of 0.47 in 1998 and a maximum of 0.63 in 2002. The 2012 and 2013 CIS waves have lower coverage than the SLID with a factor of 0.38 in 2012 and of 0.40 in 2013. Data calculated by Fesseau et al. (2013) show a large variation in coverage for OECD countries. Micro-data from 12 countries cover 67 percent of the macro-aggregates on average. However, OECD data report a high degree of variation among countries, with a minimum of 14 percent and a maximum of 127 percent.

According to Fesseau et al. (2013), micro-data differ from the national accounts aggregates when the two sources use different definitions of self-employment income. In our case, underestimation of self-employment income is partly due to the NTA calculation method. In fact, we know from Step 2 of the NTA process that we extract average age profiles from surveys. To do so, it is sometimes necessary to extreme observations that could result in high peaks for per capita age profiles. The main issues for the NTA methodology are private asset income and self-employment labour income, which are highly concentrated in top percentiles. For Canada, we tried several alternatives to reject individuals who own the top 0.5 percent of self-employment income. It resulted in an

underestimation of self-employment labour and capital income from surveys. For 2013, we estimate that the top 0.5 percent of self-employment income represents 17.3 percent of total self-employment income.

Life Cycle Deficit for 2013

In this section, we apply the NTA methodology to Canadian data and report the per capita age profiles of consumption, labour income, and LCD for 2013. Recall that, by construction, these profiles are consistent with the aggregates reported by national accounts. In other words, age profiles are not only compatible with sectoral (or micro-level) data but are also congruous to the macroeconomic view of the Canadian economy. To better understand the shape of age profiles, we report the most important components for consumption and labour income in the figures presented in this section. We also comment on their most salient features.

Consumption

Figure 1 introduces the per capita age profiles of total (private and public) consumption in Canada, composed of public education (7.1 percent of total consumption), public health (11.1 percent), other public consumption (11.3 percent), private education (1.1 percent), private health (3 percent), imputed rents (10.7 percent), and other private consumption (55.7 percent) for 2013.

Total consumption accounts for $25,656 at age 0 in 2013. This amount is much higher than at age 1 year, with total consumption accounting for $15,962. The peak at age 0 is due to health expenditures dedicated to newborns. Total consumption remains relatively stable from age 1 year to age 3 years ($16,512). Thereafter, children start to attend daycare and kindergarten, so private and public spending on education occurs. Consequently, total consumption increases significantly up to $29,253 at age 5 years. Total consumption continues to increase linearly between ages 5 and 24 years, reaching a level equal to $42,151. Consumption follows a mild v-shaped age profile between ages 25 and 56 years. This v shape is due to private consumption ("private other" in the figure), which follows an M-shaped age profile over ages, with a first mode at 27, a second mode at 56, and a low point at 45.

This result is also observed in France (d'Albis et al. 2017) and in other countries taking part in the NTA project (Tung 2011). It corresponds to the ages at which people have children at home, and it results in what are called *downward intra-household transfers* from adults to children. One of the most interesting observations in this exercise is that although private consumption declines among

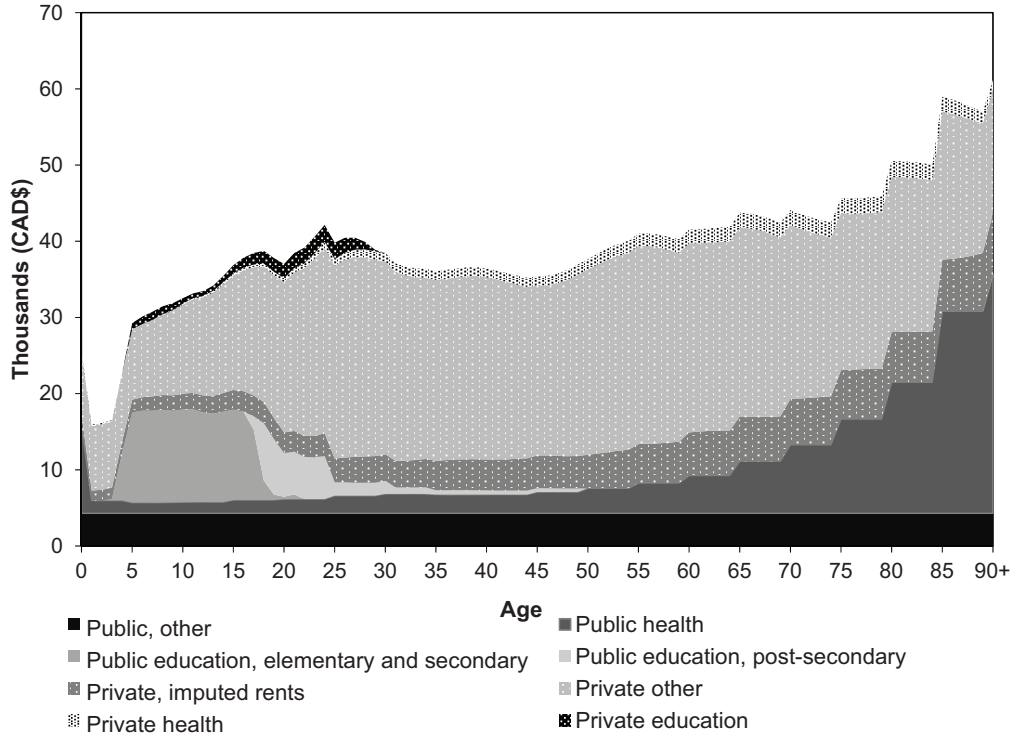

Figure 1: Total Consumption per Capita in Canada for 2013

Note: In Canada, average public and private consumption in 2013 was $35,390 at age 45 years.

Sources: 2013 Survey of Household Spending, 2013 Canadian Institute for Health Information, number of students in public elementary and secondary schools, post-secondary enrolments (Statistics Canada), national accounts, and authors' calculations.

older people, total consumption increases significantly in the late part of life. After age 56 years, total (private and public) consumption follows an exponential trend up to age 90 years and older ($61,204), driven mostly by health care consumption. Indeed, people aged 60 years and older dedicate a significant part of their consumption to public health, and this share increases substantially with age: 13.7 percent for ages 60–69, 23.6 percent for ages 70–79, 38.9 percent for ages 80–89, and 51.2 percent for people age 90 and older.

Internationally, the strong increase in total consumption at later ages resulting from public health expenditure is observed in a few countries. Among 68 countries that publish consumption profiles on ntaccounts.org, only six evidence a strong increase in total consumption at old ages: Northern European countries (Finland and Sweden), developed Anglo-Saxon countries (Australia, United Kingdom, United States), and Japan.[7] In five of these countries (Finland, Sweden, Australia, the United Kingdom, and Japan), the increase in total consumption results only from public health expenditure. Private consumption decreases by around 20 percent in these countries from age 60 years to age 85 years. The rise in total consumption in the United States results from an increase in public health expenditure (from US$2,959 at age 60 to US$24,854 at age 85 for 2011) and in private consumption after age 80 (private consumption decreases from US$40,678 at age 60 to US$35,426 at age 80 and increases to US$43,910 at age 90 and older). The high level of private consumption in old age in the United States is also due to private health expenditure, as evidenced by Lee et al. (2011).

In Canada, the shape of public health consumption is likely to become an issue for total consumption because population aging involves a substantial rise in the elderly population. Recall that the share of people aged 60 years and older in Canada almost doubled over the past 45 years, from 11.6 percent in 1971 to 22.8 percent in 2016. As mentioned in the Introduction, the academic literature demonstrates that recent demographic changes are not the main driver of the past increase in public health expenditure. One may expect, however, to see the rise in life expectancy stimulating the consumption of health services at old ages.

Labour Income

In Canada, labour income accounts for 61.9 percent of the gross domestic product (GDP) in 2013. Labour income is the sum of labour earnings (74.6 percent), employer contributions (11.9 percent), and self-employment labour income (13.5 percent). Figure 2 reports the per capita age profile of labour income in Canada for 2013. Labour income follows four distinct periods over ages. Labour

Figure 2: Per Capita Labour Income in Canada for 2013

Note: In Canada, the average labour income in 2013was $68,227 at age 47 years.

Source: 2013 Canadian Income Survey, national accounts, and authors' calculations.

income increases rapidly up to age 38 years ($63,324). It remains stable from age 38 to age 41 ($64,376 at age 41) and increases slowly from age 42 to age 47 ($68,227 at age 47). After age 47, labour income declines to reach near zero after age 70.

In contrast to consumption, labour income is highly concentrated in a small number of ages. Indeed, the 18 highest income years account for one-half of the labour income in the economy, which is similar to France for 2011, as evidenced by d'Albis et al. (2017), but slightly lower than the United States, in which half of the income is earned in the 19 highest income years.[8]

Life Cycle Deficit

Figure 3 introduces per capita age profiles for total consumption C_a, labour income Y_a^L, and the LCD, which is defined in NTA terminology as the difference between total consumption and labour income ($C_a - Y_a^L$). In 2013, consumption is larger than labour income (positive LCD) between ages 0 and 26 years; however, starting at age 27, labour income becomes greater than consumption (negative LCD). This excess of labour income over consumption remains until age 60. Therefore, the number of years in which $C_a < Y_a^L$ (negative LCD) is 34 in Canada. Later entry into the labour market (because of a higher rate of participation in post-secondary education, e.g.) would reduce this number, whereas movement toward postponing retirement age would increase it. The number of years during which consumption is larger than labour income is equal to 27 at young ages (0–26 years) and to 22 after age 60 years, assuming that the latest age is the life expectancy at birth, established at 82 years old in 2013.[9] The number of years with a (positive) LCD at young ages is particularly high in Canada compared with other developed countries. Among a group of nine OECD countries analyzed by d'Albis et al. (2017), only two countries (Germany and Italy) report LCDs for the first 27 years of life (i.e., between age 0 and age 26 years). The LCD at the beginning of life occurs during the first 26 years in Finland, Japan, Spain, Sweden, and the United States and during the first 25 years in France and the United Kingdom. Moreover, the number of years at the end of life with LCD in Canada is in the middle of the pack. Canada's number of years is similar to that of the United Kingdom (22 years); higher than those of Finland, Germany, Spain, Sweden, and the United States; but lower than those of France, Italy, and Japan. To sum up, the total number of years with a positive LCD equals 49 in Canada, which is among the highest in our group of OECD countries: smaller than Italy (51), equal to Japan (49), and larger than in seven other countries (48 in France

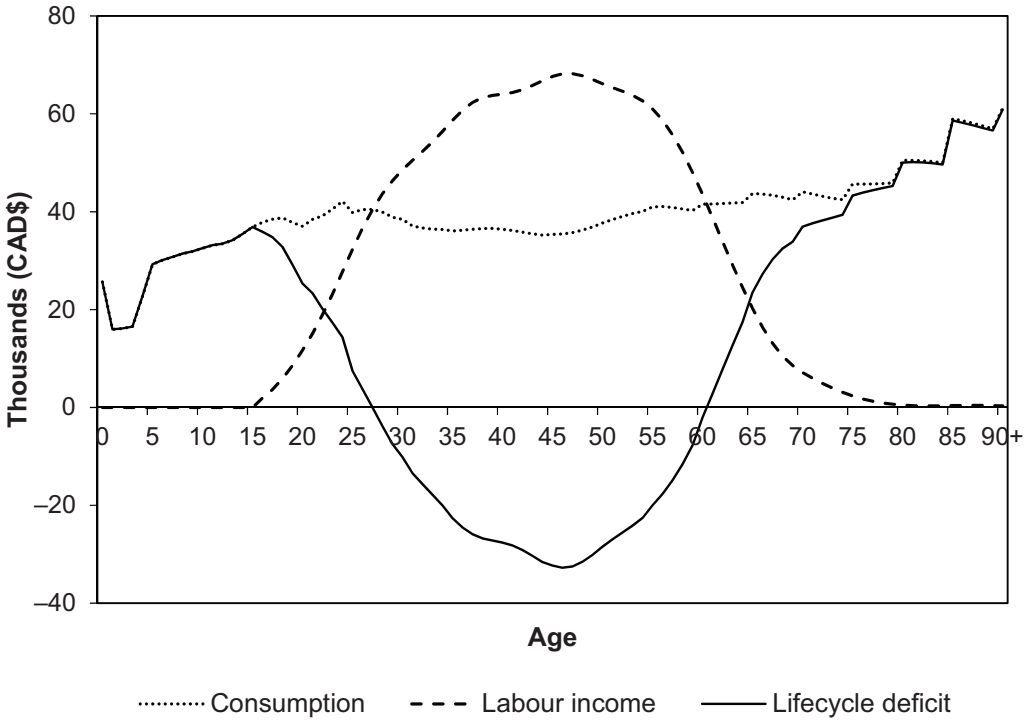

Figure 3: Per Capita Life Cycle Deficit in Canada for 2013

Sources: 2013 Canadian Income Survey, 2013 Survey of Household Spending, 2013 Canadian Institute for Health Information, number of students in public elementary and secondary schools, post-secondary enrollments (Statistics Canada), national accounts, and authors' calculations.

and Germany, 47 in Spain and the United Kingdom, 46 in Finland, and 44 in Sweden and the United States).

Such a difference in the number of years with positive and negative LCDs raises the question of the impact of age structure on these profiles and total LCDs. Static NTA profiles cannot address this question. Thus, we now turn to the analysis of the evolution of consumption, labour income, and LCD between 1998 and 2013.

Life cycle deficits between 1998 and 2013

Positive LCDs are not a problem per se. They can be financed by public transfers, private transfers ($T_a^I - T_a^O$), and asset-based reallocation—that is, by the difference between asset income and savings ($Y_a^K - S_a$). Thus, individuals may be able to finance part of their deficit from their own resources; however, the trend in LCDs may be a good indicator of the future quest for transfers and asset reallocations because, among older people, consumption is much larger than labour income. In other words, if the pressure on transfers and asset reallocations to finance consumption increases significantly with population aging, one may wonder to what extent LCDs will be sustainable in the future. Aggregate LCDs in the economy depend on the multiplication of the population per age by the per capita LCD. In algebraic terms, it is equal to N_a (population age structure) × $\tilde{f}^c$ (per capita LCD profiles). If the per capita LCD ($\tilde{f}^s$) is moving toward old age because of cultural, societal, or institutional changes, we must expect larger reallocations of resources to elderly people even with an identical rate of population growth across ages. Similarly, if the age structure of the population (N_a) is changing rapidly toward those ages generating positive LCDs (consumption larger than labour income), the living standards of current and future generations may be at risk if per capita profiles remain stable. Both possibilities deserve to be further analysed.

Evolution of Per Capita Profiles

Figure 4 reports constant Canadian dollars per capita LCDs, by age, in Canada for 1998, 2003, 2008, and 2013. Comparing these profiles over time highlights to what extent transfers across ages have changed in Canada between 1998 and 2013. The first observation is that per capita LCD profiles are characterised by a v shape during this period; however, the figure also illustrates the right shift of the per capita LCD profile during that period. In fact, the gap between consumption and labour income has increasingly widened over the recent period. The negative LCD (LCD_-^*) increases slowly at middle age, but the positive LCD (LCD_+^*) increases more rapidly as a result of high consumption levels in old age. We calculate the average growth rates for strictly positive LCD, denoted

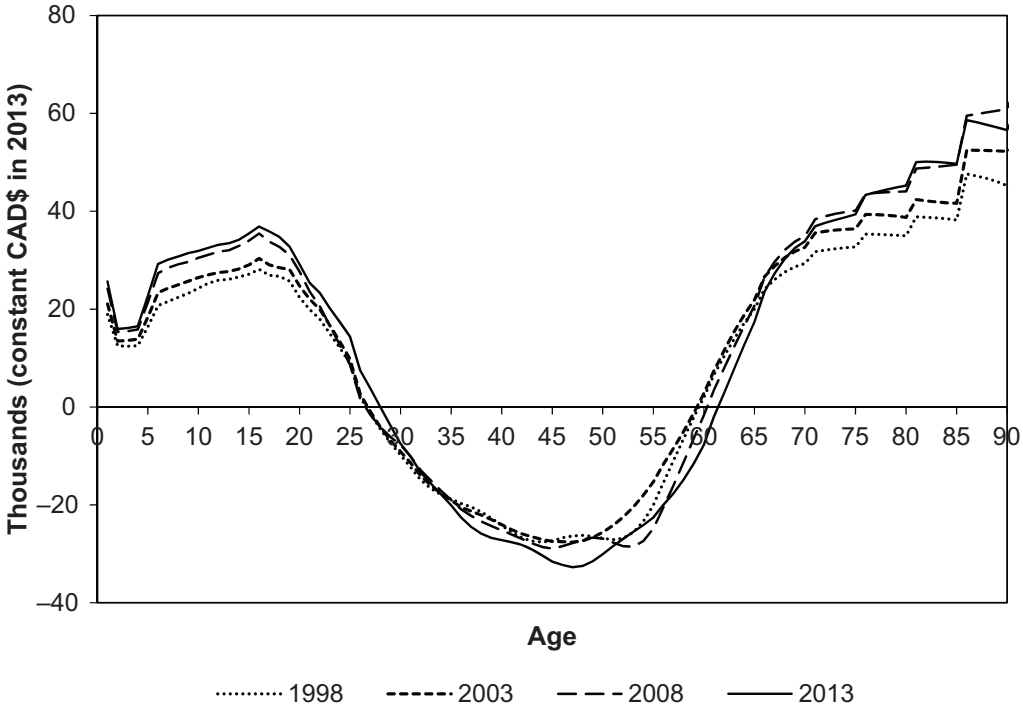

Figure 4: Per Capita Life Cycle Deficit Profiles in Canada from 1998 to 2013

Sources: Survey of Household Spending, Survey of Labour and Income Dynamics, Canadian Income Survey, national health expenditure trends (Canadian Institute for Health Information), number of students in public elementary and secondary schools, post-secondary enrolments (Statistics Canada), national accounts, and authors' calculations.

$\overline{LCD_+^*}$ (such that $\overline{LCD_+^*} = LCD_+^* / N_{a+}^*$, with N_{a+}^* equal to the number of people for which $C_a > Y_a^L$), and for strictly negative LCD per capita, denoted $\overline{LCD_-^*}$. The $\overline{LCD_+^*}$ was $22,533 in 1998 and $28,502 in 2013 (values in constant 2013 dollars), which represents an average yearly increase of 1.58 percent. The average $\overline{LCD_-^*}$ was $19,941 in 1998 and $21,401 in 2013, which represents a yearly increase of 0.47 percent. The per capita increase in the surplus of labour income over consumption of the working-age groups does not offset the increase in the LCDs among the young and old individuals.

Moreover, we can identify from Figure 4 two different sub-periods: before and after the 2008 crisis. In that figure, we see relatively similar life cycle profiles in 1998 and 2008, whereas we observe larger deficits and larger surpluses at various ages for 2013. To be more precise, note, for instance, that between 1998 and 2008, the average life cycle surplus remains relatively stable from age 26 years to age 49 years. However the life cycle surplus increases strongly for ages 50–60 during the same decade. The average life cycle surplus rose from $20,261 in 1998 to $20,751 in 2008 for the 26–49 age group, which represents a 2 percent increase. For the 50–60 age group, it rose from $15,396 to $18,128 (+18 percent) for the same period.

Of course, the evolution of the life cycle profiles must come from consumption changes, labour income changes, or both. Over the decade 1998–2008, our data show that the rise in consumption was slightly higher between ages 26 and 49 years (an increase of 22 percent, from $29,127 to $35,677) than between ages 50 and 60 years (an increase of 20 percent, from $31,897 to $38,312). The main difference between the two age groups lies mainly in labour income. Indeed, between 1998 and 2008, per capita labour income increases by only 14 percent for the 26–49 age group ($49,389 in 1998, $56,428 in 2008) but by as much as 19 percent for the 50–60 age group ($47,293 in 1998, $56,440 in 2008). To sum up, over 1998 to 2008, the increase in per capita labour income was not strong enough to generate an additional surplus over consumption for ages 26–49, whereas for ages 50–60, the increase in labour income seemed to cover larger total consumption at a later age in life.

The 2008 crisis breaks this pattern. Younger individuals seem to suffer the most from the consequences of the economic crisis between 2008 and 2013. For instance, the life cycle surplus of the 26–29 age group experiences a decline of 61 percent ($4,875 in 2008, $1,924 in 2013), and the per capita deficit of the 20–25 age group increases significantly.[10] In contrast, the per capita life cycle surplus increases by 7 percent for ages 35–60.[11] Overall, the LCD ($C > YL$) of the 20–29 age group was equal to $6,361 on average in 2008 and rose to as much as $10,081 in 2013. This represents an increase of 58 percent over five years. After 2008, the increase in the LCD for the 20–29 age group is probably the consequence of the rapid decline in the employment rate. Indeed, for the 20–24 age group, the employment rate declines from 71.6 percent in 2008 to 68.1 percent in 2009 and has not recovered since then (68.2 percent in 2018; Statistics Canada, CANSIM Table 282-0002, "Labour Force Characteristics by Sex and Detailed Age Group"). The decline between 2008 and 2009 was even stronger for ages 15–19: from 47.4 percent to 42.4 percent. In contrast, the employment rate for ages 45 and older declines only slightly from 51.7 percent in 2008 to 51 percent in 2009.

Aggregate Life Cycle Deficits

Figure 5 reports the aggregate LCD profiles for 1998, 2003, 2008, and 2013. It is worth noting that the aggregate LCD shapes in Figure 5 are quite different from the per capita profiles in Figure 4. This reflects the impact of the population age structure. In comparison with per capita profiles, a younger population raises the aggregate LCD at a young age and reduces the aggregate LCD at an old age. Also, Figure 5 shows that the differences in LCDs are larger in 2013 than in previous years. In fact, in 2013 the total LCD equals $160.3 billion. That amount is the net difference between the $361 billion of strictly negative LCDs, denoted LCD_-^* (ages with $C_a < Y_a^L$), and the $521.3 billion of positive LCDs, denoted LCD_+^* (young and old ages with $C_a > Y_a^L$).

We calculate that between 1998 and 2013, the LCD_+^* increases by 2.65 percent in constant dollars on a yearly basis, whereas the LCD_-^* increases less rapidly than the LCD_+^*, with a 1.47 percent yearly growth rate during the same period. Consequently, during this period, positive LCDs (LCD_+^*) at young and old ages are decreasingly financed by the negative LCDs (LCD_-^*) of working-age groups. Public and private transfers and asset-based reallocations are thus increasingly used to finance the consumption of young and old people. Moreover, these dynamics are not homogeneous throughout the ages. Between 1998 and 2013, aggregate LCD_-^* decreases by 0.12 percent each year before age 45, which means that this age group generates smaller and smaller surplus over time. The life cycle surplus relies only on people aged 45 years and older, for which the aggregate LCD_-^* increased by 3.37 percent each year. This aggregate effect is partly due to the change in the age structure of the population during that period and, in particular, to the contribution of the baby-boom generation, who were in the second half of their professional career during that period. Baby boomers were between 33 and 52 years old in 1998 but between 48 and 67 years old in 2013. Because the baby-boom cohort is moving toward older ages and hence toward higher consumption levels, one can be concerned about the future sustainability of living standards.

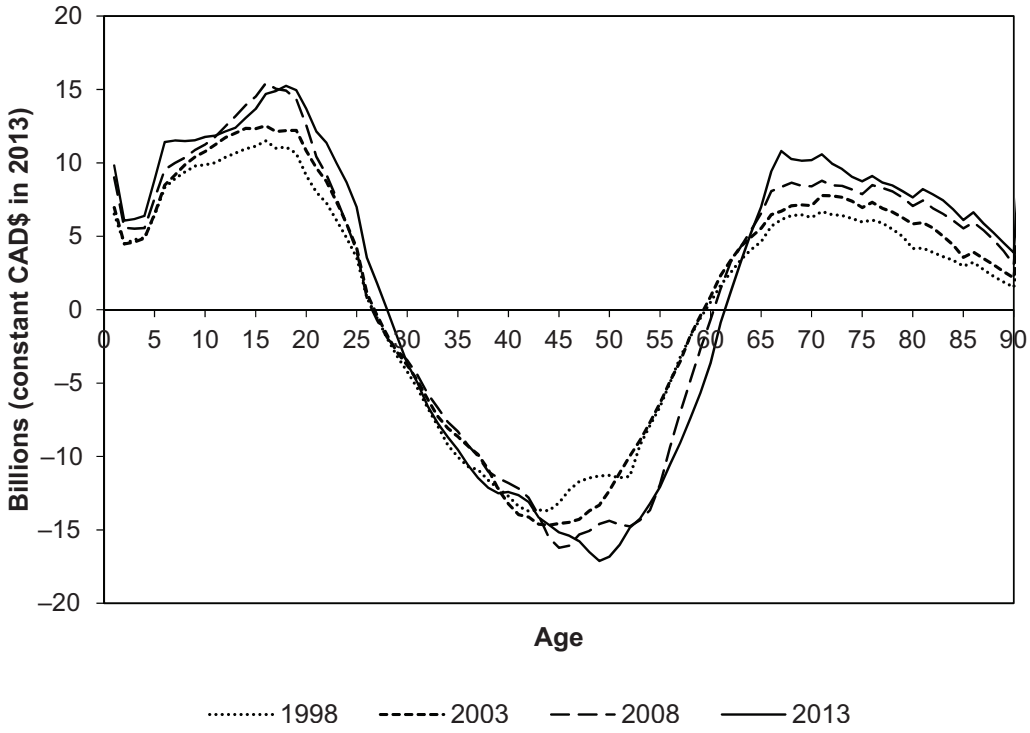

Figure 5: Total Life Cycle Deficit in Canada from 1998 to 2013

Sources: Survey of Household Spending, Survey of Labour and Income Dynamics, Canadian Income Survey, national health expenditure trends (Canadian Institute for Health Information), number of students in public elementary and secondary schools, post-secondary enrolments (Statistics Canada), national accounts, and authors' calculations.

Conclusion

NTA provide a new perspective on population aging because they highlight a complete allocation of economic flow variables across ages while being consistent with the national accounts by following a micro–macro linkage procedure. In this article, we introduce the first assessment of age profiles for labour income, consumption, and LCD in Canada for the period between 1998 and 2013.

We start by analysing age profiles of consumption and labour income for the last year for which data are available, 2013. We evidence that labour income is highly concentrated in a small number of ages, especially because of late entry into the labour market, whereas consumption increases strongly at old ages because of health care consumption. As a result, we do find a large number of ages at which consumption level is higher than labour income.

We then analyse the LCD, that is, the difference between consumption and labour income at each age, using a time-series perspective. We first demonstrate that the increase in per capita LCD at young and old ages is not entirely compensated by the increase in life cycle surplus of working-age groups during this period. The LCD increased by an average yearly rate of 1.58 percent between 1998 and 2013, whereas the life cycle surplus increased by only 0.47 percent. We then show that this statement remains true from an aggregate perspective. Total LCD at young and old ages grows by 2.65 percent on average between 1998 and 2013, whereas the total surplus increased by only 1.47 percent over that period.

A more precise look at working-age groups demonstrates huge differences between young and older workers in the evolution of LCDs. Despite a yearly GDP increase of 3.5 percent over 1998–2008, the per capita life cycle surplus generated by younger workers remains stable, whereas it increases significantly for workers aged 50 years and older. After 2008, the situation for the young deteriorates even more as employment rates decline. Older workers continue to improve their life cycle surplus. No doubt, the 2008 economic crisis affected mostly young people and younger workers.

Our results shed a light on how Canada managed the turning point in its demographic dividend. Indeed, the number of people aged 20–64 years increased over the number of people aged 0–19 and 65 years and older during the period covered. The ratio of the former to the latter was 1.120 in 1971, which indicates that the number of workers was 12 percent higher than the number of dependents. The ratio then increased to 1.570 in 1998 and 1.684 in 2010.

After the turning point of 2010, with 1,684 working-age individuals per 1,000 non-working-age individuals, the ratio begins a downhill slope. It declines to 1.657 in 2013 and is projected to reach 1.152 in 2063. Consequently, the first decade of the 2000s was the best opportunity to value the abundance of workers in Canada and especially the abundance of baby-boomers.

According to the literature on the demographic dividend, workers aged 40–65 years expect to save more than other age groups (Bloom, Canning, and Sevilla 2003) because they no longer bear the burden of supporting their children and hence can devote a higher share of their disposable income to saving. Consequently, it was reasonable to anticipate that the large cohort of baby-boomers would contribute to national saving starting at age 40 years until their retirement. However, Canadian household saving rates fell continuously from the beginning of the 1980s (17.6 percent in 1981)[12] to the pre-2008 crisis (2.2 percent in 2007). The saving rate recovered slightly after the crisis, up to 5.3 percent in 2013, and then went down to 3.8 percent in 2017. The saving rate remains low in comparison to the United States, where it was equal to 6.9 percent in 2017.

To summarize, we do not observe a substantial change in the total saving rate despite the presence of baby-boomers in the labour market. In other words, our LCD analysis suggests that the baby-boomers' surplus is not growing fast enough to generate additional savings as a result of their low saving rate, but maybe also because employment at older ages has not kept pace with improvements in life expectancy (Milligan and Schirle 2018). The needs of the young and old are growing faster than the surplus of baby-boomers; in addition, post-baby-boom generations have slightly decreased their surplus, which could have exerted pressure on the total saving rate. Whether post-baby-boom generations will follow baby-boomers' behaviour after 2013 remains unclear, but if they do, future living standards may be at stake. On the optimistic side, there is always the possibility of a strong cohort–age composition effect that we cannot disentangle here.

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Notes

1 The author's calculations for the year 2013 are from the National Transfer Accounts database.
2 This work completes the preliminary NTA that were made by Mérette, Georges, and Zhang (2011) for 2004–2007.
3 In 2004, individual public consumption expenditures calculated from OECD data equals $157,811 million. In our study, public education consumption equals $66,118 million and public health consumption equals $92,040 million, which sum to $158,158 million. The difference of $347 million may be due to different definitions and measurement errors between Canadian statistics and the OECD.
4 Fesseau et al. (2013) and Bruil (2018) also use administrative data to estimate social transfers in kind.
5 Age profiles calculated from surveys are smoothed, but administrative data are not (see the UN 2013 manual).
6 Calculations for OECD countries are realized for 11 countries and from different survey years, but all around 2009.
7 See also d'Albis et al. (2017), who compare the growth in consumption at old ages in ten countries from the NTA project. They report a strong increase in consumption at old ages in the same countries: Finland, Sweden, United Kingdom, United States, and Japan. They do not include Australia in their international comparison.
8 Authors' calculations from the US labour income age profiles at ntaccounts.org.
9 In 2011–2013, the life expectancy at birth was 81.7 years in Canada (Statistics Canada, CANSIM Table 102-4308).
10 For instance, at age 23 years, the LCD rises from $12,620 in 2008 to $17,343 in 2013.
11 Despite a slight decrease in the life cycle surplus from age 51 to age 55.
12 Net household saving (OECD 2018).
13 In 2013, primary and secondary education, colleges and universities, and vocational training education account, respectively, for 66.4 percent, 26.6 percent, and 7 percent of total education expenditure.

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Appendices

National Transfer Accounts Technical Manual for Canada

The technical manual presents the steps of the age profile calculations of labour income and consumption in Canada. It completes the UN (2013) manual that describes the international methodology used for all countries. The technical manual provides the elements to build life cycle deficit accounts for Canada for 1998–2013. Appendix A describes the calculation of aggregates used as control variables in National Transfer Accounts, and Appendix B details the methodology and the statistical sources to construct per capita age profiles.

Appendix A

Macro Control Variables

The national accounts of Statistics Canada are the principal sources for determining National Transfer Account (NTA) macro control variables. We proceed in two phases. First, we calculate macro control variables at the most aggregated level of NTA, as introduced in Equation (1) in the text, $(C_a - Y_a^L = (T_a^I - T_a^O) + (Y_a^K - S_a))$. The eight macro control variables to calculate these aggregates are detailed in Table A.1 for 2013. Second, we calculate aggregates for sub-groups of labour income (wages, employer's contribution, labour share of gross mixed income), private consumption (education, health, imputed rents, other), and public consumption (education in elementary and secondary school, post-secondary education, health, other).

In Table A.1, we report the eight steps to estimate the eight macro control variables. The values are taken from different sources of the national accounts published by Statistics Canada. The decomposition of the gross domestic product (GDP) and the adjustment for statistical discrepancies (Steps 1 and 2) are taken from the GDP expenditure-base table (CANSIM 384-0038). The left side of the equation uses the current and capital accounts (CANSIM 380-0072), and the right side of the equation uses the GDP income-base table (CANSIM 384-0037). Going from domestic to national basis (Step 3) requires the use of the balance of international payments (CANSIM 376-0101). The allocation of gross mixed income to labour and capital differs (Step 4) from the arbitrary rule chosen by the UN (2013) that applies two-thirds to labour income and one-third to capital. The manual's hypothesis is consistent with past evidence, but time-series NTA require a more accurate hypothesis to capture the dynamics of the labour to capital ratio. For instance, d'Albis et al. (2017a) found that the labour to capital ratio in France was equal to 82.1 percent in 1979, 64.3 percent in 1998, and 65.7 percent in 2011.

In this article, we consider that the share of labour income in total mixed income equals the relative size of the compensation of employees in the total value produced by firms (compensation of employees + gross operating surplus). As a result, the labour–capital ratio for mixed income is 71.3 percent in 1998 and 68.7 percent in 2013 (see Table A.1 for 2013). The allocation in Step 5 of indirect taxes less subsidies (net taxes on products and net taxes on production) to consumption, labour income, and capital income is calculated from the GDP income-base table (CANSIM 384-0037). The allocation of net taxes on production to labour and capital is estimated by using the relative share of labour income (net compensation of employees + compensation of employees + labour share of gross mixed income [GMI]) and the relative share of capital income (net property income + gross operating surplus + capital share of GMI + capital share of consumption of fixed capital [CFC]). The aggregates in Steps 6 and 7 of the table come from the current and capital accounts (CANSIM 380-0072).

The second phase in calculating the NTA aggregates consists of subdividing private consumption (CF), public consumption (CG), and labour income (YL). The shares of private education, health, imputed rents, and other consumption in private consumption are estimated using the detailed household final consumption expenditure table of the national accounts (CANSIM 384-0041).

The aggregate for public health is from CIHI's National Health Expenditure Trends. We include public expenses from the federal, provincial, and municipal governments as well as social security funds.

Statistics Canada publishes the aggregate for public education from a school–academic year perspective. Thus, we assume that the aggregate for year n is equal to 60 percent of the school–academic year $n-1/n$ and 40 percent of the school–academic year $n/n+1$ (considering a school–academic year as running from September to June; thus, six months in academic year $n-1/n$ and four months in academic year $n/n+1$). Primary and secondary education are calculated from the public and private elementary and secondary education expenditures of CANSIM Table 478-0014. Post-secondary education includes college education (CANSIM Table 478-0004), universities (CANSIM Table 478-0007), and vocational training education expenditures (CANSIM Table 478-0005).[12] Because CANSIM tables for post-secondary education are only available up to 2004–2005, we consider the ratio of post-secondary education expenditure on primary and secondary expenditure to remain stable after the school academic year 2004–2005. To calculate the aggregate for public consumption other than health and education, we subtract health expenditure and education expenditure from total public expenditure.

Table A.1: Aggregates of Equation (1) for 2013

1. Start with GDP by expenditure and income approaches, identifying private and public components.

	Final Consumption Expenditures	+	Gross Capital Formation (Investment)	+	Net Exports	=	CoE	+	GOS	+	GMI	+	ITLS
Private	1,061,233		399,931				961,179		455,417		216,355		
Public	393,848		73,875						62,850				
Total	1,455,081		473,806		−31,248		961,179		518,267		216,355		201,620

2. Adjust for SD in GDP by approach. Note that this step does not balance.

					Less Income SD	=	Less CoE % Expenditure SD	+	Less GOS % Expenditure SD	+	Less GMI % Expenditure SD		
Private							65		31		15		
Public													
Total					−109		65		31		15		

3. Go from domestic to national basis by including net ROW amounts.

					Plus Net Primary Income from Row	=	Plus Net CoE from Row	+	Plus Net Property Income from Row				
Private							−1,998		−15,406				
Public									−8,422				
Total					−25,826		−1,998		−23,828				

4. Reallocate GMI to labour versus capital.

							Add GMI to Labor		Plus GMI to Capital		Less GMI		
Private							148,755		67,615		−216,370		
Public													
Total							148,755		67,615		−216,370		

5. Reallocate ITLS to consumption; labour and capital go from market to basic prices.

	Less Consumption Share of ITLS					=	Plus Labour Share of ITLS	+	Plus Capital share of ITLS	+			Less ITLS
Private	−120,319						66,479		14,822				−201,620
Public													
Total	−120,319						66,479		14,822				−201,620

6. Go from gross to net by removing CFC from capital share of profits.

			Less CFC			=			Less CFC				
Private			−247,482						−247,482				
Public			−61,494						−61,494				
Total			−308,976						−308,976				

(*Continued*)

Table A.1: Aggregates of Equation (1) for 2013 (continued)

7. Take saving-related amounts out of net exports and add to investment column to separate saving from transfers.

	Plus Saving-Related Amounts	=	Less Saving-Related Amounts
7a. Net capital transfers			
Private	−5,913		
Public	6,018		
Total	105		−105
7b. Net lending and borrowing			
Private	−36,156		
Public	−28,433		
Total	−64,589		64,589
7c. Net NPNFA			
Private	0		
Public	0		
Total	0		0

8. NTA identity

	CF / CG	+	SF / SG	+	−T	=	YL	+	YAF / YAG
Private	940,914		110,380				1,174,480		274,996
Public	393,848		−10,034						−7,066
Total	1,334,762		100,346		7,301		1,174,480		267,930

Notes: Amounts in C$ millions. CFC = consumption of fixed capital; CF = private consumption; CG = public consumption; CoE = compensation of employees; GDP = gross domestic product; GMI = gross mixed income; GOS = gross operating surplus; ITLS = indirect taxes less subsidies; –T = negative transfer; NPNFA = non-produced non-financial assets; NTA = National Transfer Accounts; ROW = rest of world; SD = statistical discrepancies; SF = private saving; SG = public saving; YAF = private asset income; YAG = public asset income; YL = labor income.

Source: National accounts (Statistics Canada), authors' calculations.

Appendix B

Age Profiles for Consumption and Labour Income

As showed in Figure B.1, the Survey of Labour and Income Dynamics (SLID; from 1998 to 2011) and the Canadian Income Survey (CIS; for 2012 and 2013) are used to estimate age profiles for labour income. Labour income is composed of labour earnings, employer contributions, and self-employment labour income (labour share of gross mixed income). The SLID and CIS surveys report for each individual labour earnings and self-employment income net of income tax. However, according to the NTA methodology (UN 2013), imputed gross labour income must include income tax. Although the income tax in SLID and CIS is available at the individual level, it does not distinguish among labour earnings, self-employment income, or other. To estimate the size of each source, we multiply the individual income tax value by the ratio of individual labour income (labour earnings and self-employment income, respectively) to the total income earned by each individual. Employer contributions are not available in the SLID and CIS surveys, but employee contributions that are available at the individual level from 1999 to 2013 serve as a good approximation. In fact, Canada Pension Plan and Quebec Pension Plan employer contributions account for the same share of total contributions. Thus, we use the variable of employee contributions to calculate employer contributions. Employee contributions are not available for 1998. We use the parameters published by Lin (2001) to calculate the contribution of employers in 1998 (employer contributions = [gross wages + gross mixed income – exemptions] × contribution rate). We also use the parameters published by Lin (2001) to estimate Employment Insurance premiums of employers (employer contributions = maximum insurable earnings of employees × premium rate × 1.4).

The SHS from 1998 to 2013 is used to calculate age profiles of private consumption. Recall that private consumption is composed of education, health, and other consumption. SHS still poses challenges because consumption is reported at the household level but not at the individual level. Moreover, SHS does not report imputed rents. Consequently, we use regression methods to estimate private education and health age profiles, following the strategy suggested in the UN (2013) manual. According to the manual, household consumption of education is a function of the number of household members aged 5–29 years. The regression coefficients obtained at each age are then used to allocate private education at the individual level. Following the works of d'Albis et al. (2015, 2017a), household health expenditure is assumed to be a function of the number of household members in each five-year age group, except for the first year of life (age 0), which is treated separately.

Imputed rents are calculated from the SHS in two steps. First, we regress the value of rents paid by tenants on a set of variables that include characteristics of the household (age of the husband or age of the reference person), the dwelling (type of accommodation, year of construction, number of rooms, etc.), and the location (16 metropolitan areas and a subdivision of non-metropolitan areas with respect to the urban size). Then, we estimate the imputed rents of owner households according to the coefficients obtained in the first regression. Other consumption, including imputed rents, is allocated across ages within the household with the equivalence scale (see Figure B.2) suggested by Lee and Mason (2011a). We assign private consumption other than health and education to each member according to its weight. The weight is 0.4 for young children up to age 4; it then increases linearly from age 4 to age 20 and is equal to 1 for adults aged 20 and older.

CIHI's National Health Expenditure Trends serve to determine public health age profiles. The CIHI reports total health expenditures of provinces and territories by age group. We assume an equal amount of public health expenditures for each individual member of the same age group.

For public education age profiles, we want to distinguish primary and secondary education (CANSIM Table 477-0037) and post-secondary education (CANSIM Table 477-0033). Post-secondary education includes college education and universities. CANSIM Tables 477-0033 and 477-0037 provide the number of students enrolled at each age and for school–academic years. We assume that each year n is composed of 60 percent of the students of the school–academic years $n-1/n$ and 40 percent of the students of the school–academic years $n/n+1$. Moreover, we assume that for each education degree (primary and secondary, college, universities), each student gets the same amount of education expenditure. Because CANSIM Table 477-0037 for primary and secondary education is only available from 2002–2003, we consider the allocation of the number of students by age in 2002 and before equivalents to the allocation of the number of students in 2003. Enrollments in primary and secondary education are available for each age up to 20. Without better information and because the numbers are small, we attribute all primary and secondary students older than age 20 to age 21.

CANSIM Table 477-0033, which we use for post-secondary education, is only available from 1999–2000. Thus, we apply the same hypothesis we use for primary and secondary education: the allocation of the number of students by age in 1999 and earlier is equivalent to the allocation of the number of students in 2000. Moreover, post-secondary education enrollments are only available for the following age groups: younger than 20, 20–24, 25–30, 31–34, 35–39, and 40 or older. For each age group, we assume an equal number of enrolled students across ages. Enrollments before age 20 are assumed to be equally distributed between age 17 and age 19 in Québec (because of the particularity of the education system in Québec with its Collège d'enseignement général et professionnel

institutions) and between age 18 and age 19 for other provinces. With respect to the last age group, age 40 or older, we redistribute the total number equally between ages 40 and 49 across Canada.

Finally, for other public expenditures, we follow the UN (2013) manual and allocate equally across each individual.

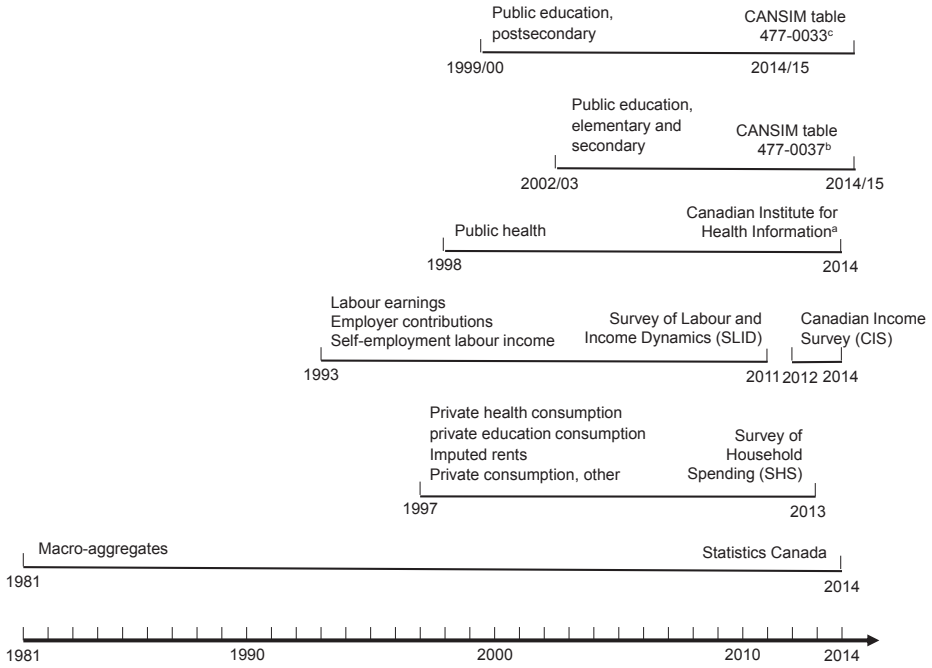

Figure B.1: Sources of Age Profiles

[a] Series E, provincial and territorial government expenditure by age and sex.

[b] Number of students in regular programs for youth, public elementary and secondary schools, by age and sex, Canada, and provinces and territories.

[c] Post-secondary enrollments, by program type, credential type, age groups, registration status, and sex.

Source: Author's compilation of the available sources from household surveys, administrative data, and national economic accounts.

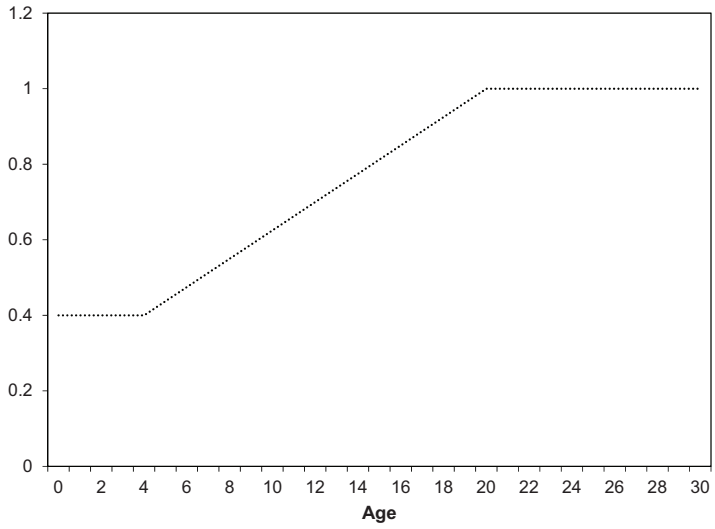

Figure B.2: Equivalence Scale for Allocating Private Consumption Other than Education and Health

Source: UN (2013).