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Population aging in Canada: What the lifecycle deficit profiles are telling us about living standards?

Marcel Mérette[*] and Julien Navaux[†]

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[*] Department of Economics, University of Ottawa; 120 University Private, Ottawa, Ontario, Canada, K1N 6N5; e-mail: mmerette@uottawa.ca
[†] Department of Economics, University of Ottawa; 120 University Private, Ottawa, Ontario, Canada, K1N 6N5; e-mail: jnavaux@uottawa.ca

1. Introduction

The macroeconomic consequences of population aging have been widely investigated throughout the world. Challenges related to labour market, immigration, public pensions or health expenditures have motivated empirical research that inspired new public policies. Given that in Canada, the welfare state supports a significant part of health care costs as well as retirement pension benefits, specific 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 most of the observed health care costs. Population aging may therefore rise public spending considerably as health care expenditures increase rapidly with age (Clavet *et al.* 2013); however, many studies[1] show that other factors such as rapid technical progress in the medical sector, increased inflation rate in the health care sector, increasing physician costs or increased use of drugs explain most of the additional costs in public health care. According to these studies, population aging plays a minor role in the increase in public health care costs so far.

Another concern relates to whether the labour force will decline or not in Canada with population aging (McDaniel *et al.* 2015; Bissonnette *et al.* 2016; Bélanger *et al.* 2016). Evolvement of the labour force is certainly a major issue with respect to future production and economic growth. Although immigration in Canada could reduce the negative impacts of population aging in Canada (Fougère *et al.* 2004), a slower labour force growth rate requires an increase in productivity to maintain the economic growth rates that we have observed over the last few years.

Although the above literature 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 (GAs). GAs have been initiated by Laurence J. Kotlikoff and his co-authors (Auerbach *et al.* 1994), following debates about intergenerational equity (Preston (1984) and Longman (1987)). The GA methodology is a major breakthrough to estimate the value of taxes and public transfers received by current and future generations over their entire lifecycle. In Canada, Kotlikoff and Raffelhüschen (1999) and Oreopoulos and Vaillancourt (1998) report the fiscal burden of population aging on future generations; however, the 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

[1] See for instance Canadian Institute for Health Information (2011), Evans et al. (2010), and Dormont and Huber (2006).

economic transfer data set across ages, it is impossible to assess under which conditions current standards of living (difference between consumption and income) will be sustainable as part of the ongoing demographic change.

In this paper, we develop a new longitudinal data set for Canada based on the National Transfer Account (NTA) methodology. NTA is a more complete picture of economic activity by age than GA. NTA measures the way in which individuals produce, consume, save and share resources at each age on a retrospective basis. This paper introduces for the first time individual age consumption and labour income profiles in Canada for the period between 1998 and 2013.[2] The longitudinal dimension of the study sheds light on how the gap between consumption and labour income, called lifecycle deficit in the NTA methodology, has been changing over that period. We also use the age profiles of consumption and labour income to build an alternative indicator to the demographic support ratio, called the NTA Economic Support Ratio. This will allow us to project the pressure of aging on this new ratio and hence estimate under which conditions consumption in Canada will be sustainable over time.

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. Secondly, we show that the increase in the lifecycle surplus of working-age groups between 1998 and 2013 is lower than the rise in the lifecycle deficit of non-working age groups over the same period. All ages considered, the NTA Economic Support Ratio, corresponding to the share of labour income in total consumption, decreases from 0.93 to 0.88 between 1998 and 2013. Thirdly, the projections of the NTA Economic Support Ratio that we made using the NTA age profiles show a decline of the ratio to 0.75 in 2060. Maintaining the NTA Economic Support Ratio to the 2013 level would require a significant decline in the per capita consumption relative to the per capita labour income.

The article is organized as follows. In Section 2, we introduce the NTA methodology and the data computed to construct the Canadian accounts. Then in Section 3, we analyze the age profiles for consumption, labour income and the difference between the two in 2013, which is the most recent year of construction. In Section 4, we analyse the evolution of the three profiles from 1998 to 2013. Section 5 introduces the NTA Economic Support Ratio (NTA-ESR) between 1998 and 2013. We also calculate the ratio up to 2060 by taking into consideration demographic projections. The NTA-ESR allows us to estimate the economic changes that will be necessary in the upcoming aging years. Section 6 provides concluding remarks.

[2] This work completes the preliminary NTA accounts that were made by Mérette, Georges and Zhang (2011) for the 2004-2007 period.

2. NTA methodology

A brief description of the NTA methodology

The methodology of the National Transfer Accounts originates from the work of Lee (1980) and Mason (1988). NTAs are based on a unified international methodology that consists in introducing age into National Accounts. The theoretical basis of the methodology is available in Lee and Mason (2011a, 2011b), and the detail is described in a reference manual published by the United Nations in 2013.

NTAs 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 lifecycle deficit (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 also results in asset-based reallocations equal to the asset income net of savings $Y_a^K - S_a$.

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

The young and old 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 lifecycle deficit (LCD). In contrast to young and old people, middle-age adults do not consume their labour income entirely and hence generate lifecycle surplus that is used to save money and transfer resources to young and old individuals.

Every variable of the NTA accounts is calculated with the same process:

1. For each component, the per capita age profile f_a is extracted from survey data or an administrative database.
2. The mean age profile is smoothed[3] with a level 2 polynomial. Each profile $\tilde{f}_a$ is then multiplied by the number of people at each age a, N_a, in order to get an aggregate flow $F = \sum_{a=0}^{n} \tilde{f}_a \, N_a$
3. The aggregate age profile is adjusted so that the aggregate flow F fits perfectly with the corresponding aggregate AG from the System of National Accounts (SNAs). The corrective term $c = F/AG$ is then calculated and applied to the aggregate smoothed series. The corrected profiles are $\tilde{F}^c = \tilde{F}/c$ at the aggregate level and $\tilde{f}^c = \tilde{F}^c/N_a$ at the individual level.

Earlier works conducted with this international methodology 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 such a series so far: the United States (Donehower and Miller 2011),

[3] Age profiles calculated from surveys are smoothed but administrative data is not (see the United Nations manual published in 2013).

Taiwan (Lai and Tung 2015), Australia (Temple *et al.* 2017) and France (Navaux 2016; d'Albis *et al.* 2015, 2017a, 2017b). We are adding Canada to that list with this article.

Data

In view of the availability of the various surveys and administrative data introduced in Figure X (see appendix), we build the National Transfer Accounts for Canada for each year between 1998 and 2013 and for each age between 0 and 90. Aggregates are computed with the CANSIM tables of the System of Macroeconomic Accounts produced by Statistics Canada (see appendix). These aggregates are available from 1981, but the number of years is limited by the availability of age profiles. The three components of labour income (labour earnings, employer contributions, self-employment labour income) are calculated from the Survey of Labour and Income Dynamics and from the Canadian Income Survey available from 1993 to 2014. Private consumption age profiles (education, health, imputed rents and other consumption) are calculated using the Survey of Household Spending (SHS), which is only available between 1997 and 2013. Moreover, public health consumption relies on provincial/territorial government expenditure by age and sex from the Canadian Institute for Health Information from 1998 to 2014. Age profiles of public education consumption are even more restricted. They are estimated from the number of students enrolled in public elementary and secondary schools that are available from the 2002/03 to 2014/15 school year, and from the number of students enrolled in postsecondary education that are available from the 1999/00 to 2014/15 school year. We choose to compute NTA age profiles from 1998 to 2013 to get the major part of the actual age profiles from surveys and administrative data. Still, two years for the postsecondary education and five years for elementary and secondary education are missing. Consequently, we assume that the number of students enrolled by age groups remains stable during those years. According to the NTA manual, public consumption other than health and education are allocated to individuals equally by age because it includes sovereign functions such as the police, justice, defense or public administration (UN 2013). The appendix details the calculation of the aggregates and the age profiles for Canada between 1998 and 2013.

1. The lifecycle deficit in Canada 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 lifecycle deficit for 2013. Recall that 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. In order to better understand the shape of age profiles, we report the most important components for consumption and labour income in the figures below. We also comment on the most salient features of the figures.

Consumption

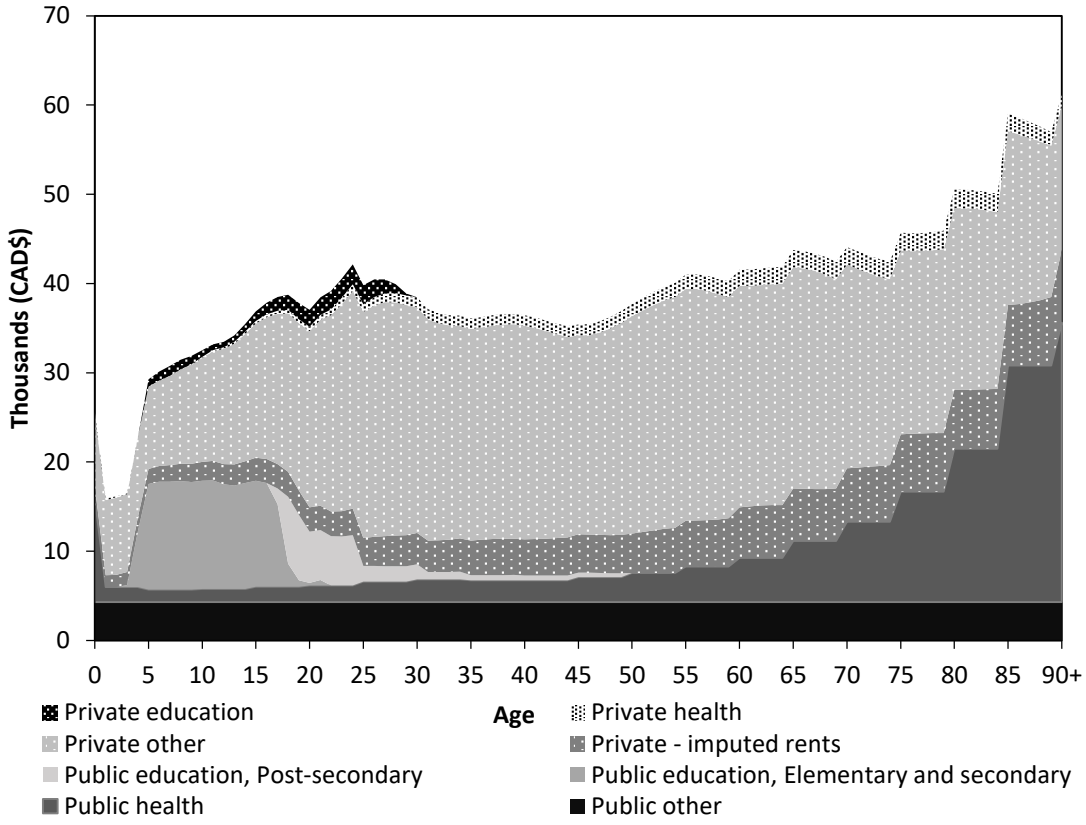
Figure A introduces the per capita age profiles of total (private and public) consumption in Canada, composed of public education (7.1% of total consumption), public health (11.1%) other public consumption (11.3%), private education (1.1%), private health (3%), imputed rents (10.7%) and other private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

Total consumption accounts for $25,656 (Canadian dollars) at age 0 in 2013. This amount is much higher than at age 1 with the 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 to 3 ($16,512). Thereafter, children start to attend daycare and kindergarten, so there is private and public spending on education. Consequently, total consumption increases significantly up to $29,253 at age 5. Total consumption continues to increase linearly between age 5 and 24, reaching a level equal to $42,151. Consumption follows a mild V-shaped age profile between ages 25 and 56. This V-shape is due to private consumption ("private other" in the figure) that follows an M-shaped age profile over ages, with a first mode at 27, a second mode at 56 and a low point at 44. This result is also observed in France (d'Albis *et al.* 2017a) and in several countries taking part in the NTA Project (Tung 2011). It corresponds to the ages at which people have children at home. It results to what is called downward intra-household transfers that is, from adults to young age, in order to fund children's consumption. One of the most astonishing observation in this exercise is that although private consumption declines among older people, total consumption increases significantly in the late part of life. After age 56, total (private and public) consumption follows an exponential trend up to age 90+ ($61,204), driven mostly by health care consumption. Indeed, people aged 60 and over dedicate a significant part of their consumption to public health and this share increases substantially with age: 13.7% for ages 60-69, 23.6% for ages 70-79, 38.9% for ages 80-89 and 51.2% for people aged 90 and over.

The shape of public health consumption is likely to become an issue for total consumption as population aging results in a substantial rise in the elderly population. In Canada, recall that the share of people aged 60 and over almost doubled over the last 45 years: from 11.6% in 1971 to 22.8% in 2016. Although academic literature evidenced that population aging is not the main driver of the past increase in public health expenditure[4], the rise in life expectancy should stimulate the consumption of health services.

[4] See for instance: Canadian Institute for Health Information (2011), Evans et al. (2010), and Dormont and Huber (2006).

Figure A. Total consumption per capita in Canada for 2013



Reading note: In Canada, average public and private consumption was $27,778 at the age of 45 in 2013.

Labour income

In Canada, labour income accounts for 61.9% of the GDP in 2013. Labour income is the sum of labour earnings (74.6%), employer contributions (11.9%) and self-employment labour income (13.5%). Figure B reports the per capita age profile of labour income in Canada for 2013. Labour income follows four distinct periods over ages. In the first one, labour income increases rapidly up to age 38 ($63,324). It remains stable from ages 38 to 41 ($64,376 at age 41) and increases slowly from ages 42 to 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 on 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.* 2017a), but slightly lower than the United States, where half of the income is earned by the 19 highest-income years[5].

[5] Authors' calculations from the US labour income age profiles of ntaccounts.org.

Figure B. Per capita labour income in Canada for 2013

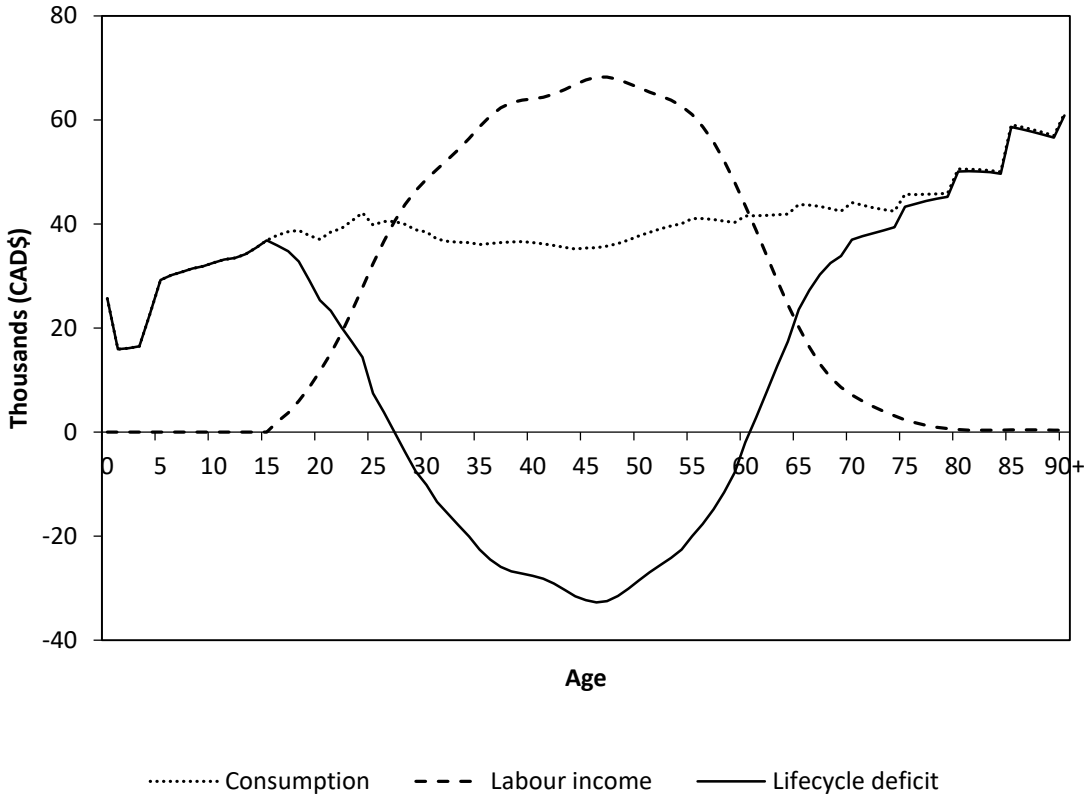
Reading note: In Canada, average labour income was $68,227 at age 47 in 2013.

Lifecycle deficit

Figure C introduced per capita age profiles for total consumption C_a, labour income Y_a^L and the lifecycle deficit, which is defined in NTA terminology by the difference between total consumption and labour income ($C_a - Y_a^L$). In 2013, consumption is larger than labour income (positive lifecycle deficit) between ages 0 and 26; however, starting at age 27, labour income becomes greater than consumption (negative lifecycle deficit in the graph). This excess of labour income over consumption remains until age 60. Therefore, the number of ages in which $C_a < Y_a^L$ (negative lifecycle deficit) is 34 in Canada. Later entry to the labour market (because of a higher participation rate in postsecondary education for instance) would reduce this number, whereas movement toward postponing retirement age would increase it. The number of ages during which consumption is higher than labour income is equal to 27 at young ages (0 to 26) and 22 ages after 60 years old, assuming that the latest age is the life expectancy at birth, established at 82 years old in 2013.[6]

[6] In 2011-2013, the life expectancy at birth is equal to 81.7 years in Canada (Statistics Canada).

Figure C. Per capita lifecycle deficit in Canada for 2013



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

2. Lifecycle deficits between 1998 and 2013

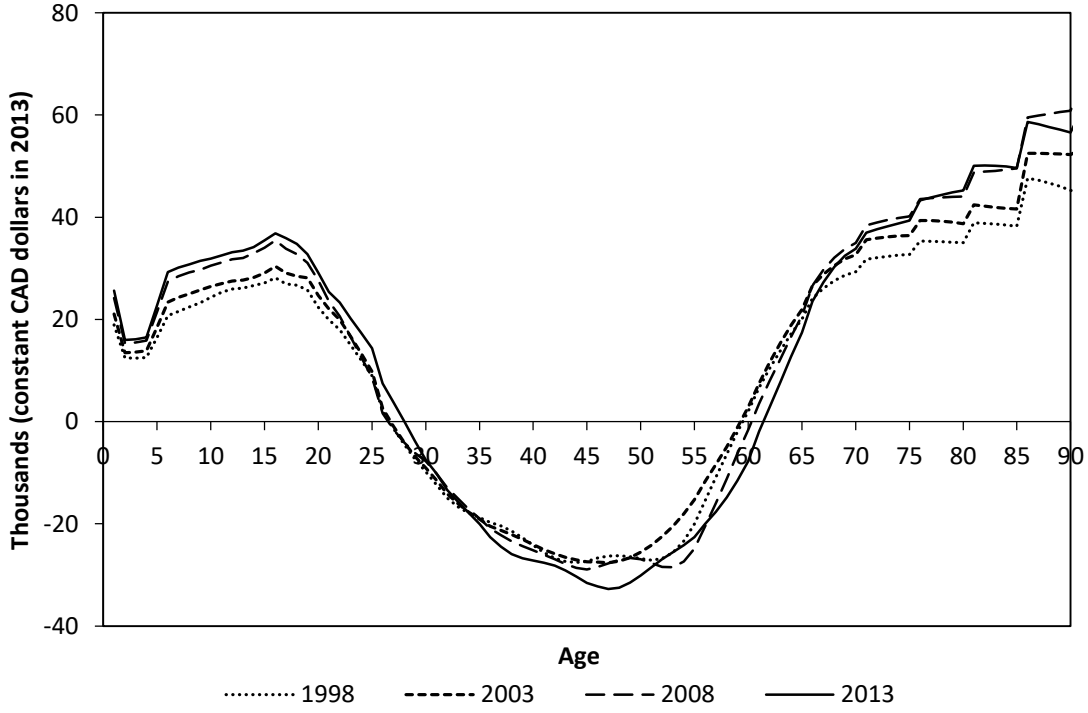
Positive lifecycle deficits are not a problem per se. They can be financed by public transfers, private transfers($T_a^I - T_a^O$) and asset-based reallocation that is, by the difference between asset income and saving($Y_a^K - S_a$). Thus, individuals may be able to finance part of their deficit from their own resources; however, the trend in the lifecycle deficits may be a good indicator of the future quest for transfers and asset reallocations since we know that among older people, consumption is much larger than labour income. In other words, if the pressure on transfers and asset reallocations to finance consumption increase significantly with population aging, one may wonder to what extent lifecycle deficits will be sustainable in the medium run. Aggregate lifecycle deficits in the economy depend on the multiplication of the population per age times the per capita LCD. In algebraic terms, it is equal to N_a (population age structure) times $\tilde{f}^c$ (per capita lifecycle deficit profiles). If the per capita lifecycle deficit ($\tilde{f}^c$) is moving toward old age because of cultural, societal or institutional changes, we must expect larger reallocations of resources toward the elderly even with an identical rate of growth of the

population across ages. Similarly, if the age structure of the population (N_a) is changing rapidly toward those ages generating positive lifecycle deficits (consumption larger than labour income), the living standards of current living and future generations may be at risk if per capita profiles remain consistent. Both possibilities deserve to be further analysed.

Evolution of per capita profiles

Figure D reports constant Canadian dollars per capita lifecycle deficits (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 between 1998 and 2013 in Canada. The first observation is that per capita lifecycle deficit profiles are characterised by a V--shaped curse between 1998 and 2013; however, the figure also illustrates the right shift of the per capita lifecycle deficit profile during that period. In fact, the gap between consumption and labour income has widened increasingly over the recent period. The negative LCD (LCD_{-}^{*}) increases slowly at middle age, but the positive LCD (LCD_{+}^{*}) increases more rapidly due to high consumption levels at old age. We calculate the average growth rates for strictly positive LCD denoted $\overline{LCD_{+}^{*}}$ (such that $\overline{LCD_{+}^{*}}$ = $LCD_{+}^{*}/N_{a_{+}}^{*}$ with $N_{a_{+}}^{*}$ equals 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 \$22,500 in 1998 and \$28,500 in 2013 (values in constant 2013 dollars), which represents an average yearly increase of 1.58%. The average $\overline{LCD_{-}^{*}}$ was \$19,900 in 1998 and \$21,400 in 2013, which represents an average yearly increase of 0.47%. The per capita increase of the surplus of labour income over consumption of the working age groups is insufficient to compensate for the increase of the lifecycle deficits among the young and old.

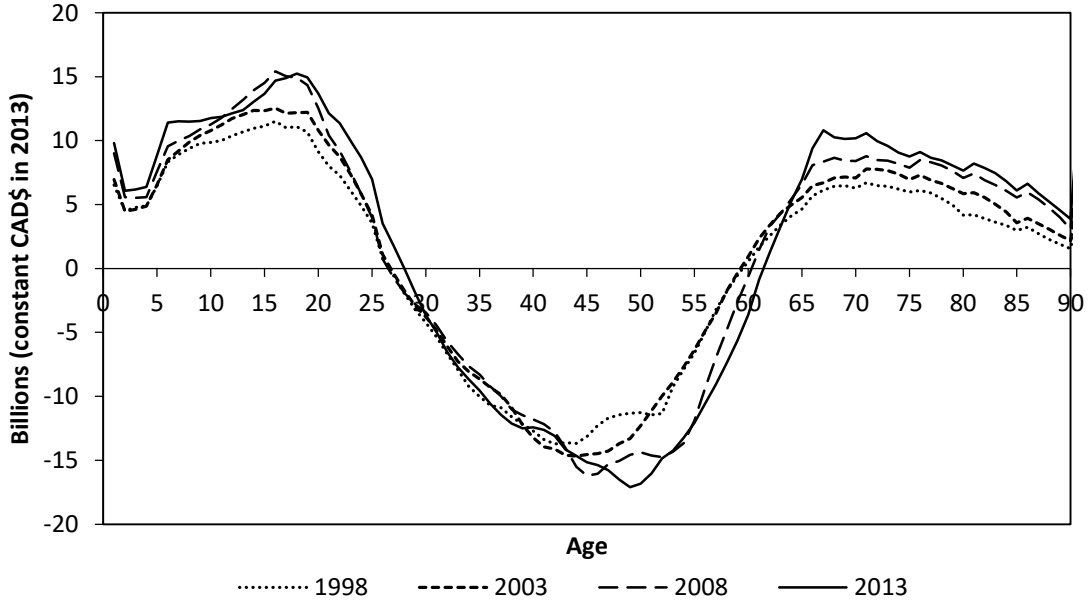
Figure D. Per capita lifecycle deficit profiles in Canada from 1998 to 2013



Aggregate lifecycle deficits

Figure E reports the aggregate lifecycle deficit profiles for 1998, 2003, 2008 and 2013. It is worth noting that the aggregate LCD shapes in Figure E are quite different from the per capita profiles in Figure D. This reflects the impact of the population age structure. In comparison to 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 E shows that the differences in LCDs are larger in 2013 than in previous years. In fact, in 2013, the total lifecycle deficit equals $160.3 billion. That amount is the net difference between the $361 billion of strictly negative lifecycle deficits denoted LCD_{-}^{*} (ages with $C_a < Y_a^L$) and the $521.3 billion of positive lifecycle deficits 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% in constant dollars on average, whereas the LCD_{-}^{*} increases less rapidly than the LCD_{+}^{*} with a 1.47% average growth rate during the same period. Consequently, during this period, positive lifecycle deficits (LCD_{+}^{*}) at young and old ages are decreasingly financed by the negative lifecycle deficits (LCD_{-}^{*}) of working age groups. Public and private transfers and asset-based reallocations are thus increasingly used to finance the consumption of the young and old. Moreover, these dynamics are not homogenous throughout the ages. Note that between 1998 and 2013, the LCD_{-}^{*} increased by 3.37% after age 45, which would have been enough to cover the increase of the LCD_{+}^{*} of inactive age groups that is equal to 2.65% over the period. Yet, this aggregate effect is due to the change of the age structure of the population during that period, and in particular, of the contribution of the baby-boom generations that were in the second half of their professional career during that period. They were aged between 33 and 52 in 1998, but between 48 and 67 in 2013. As this special cohort is moving ahead toward older ages and hence toward higher consumption levels, one can be concerned about the sustainability of living standards in the future. We will examine this question more closely in the next section.

Figure E. Total lifecycle deficit in Canada from 1998 to 2013



3. NTA economic support ratio between 1981 and 2060

Most of the time, demographers and economists refer to the dependency ratio to approximate the pressure of population aging on the economy. A typical dependency ratio divides the number of people aged 0-19 and 65 and over by the number of people aged 20 to 64 : $\frac{Population_{0-19} + Population_{65+}}{Population_{20-64}}$.[7] This ratio has the advantage of being easy to calculate and project over time. Notwithstanding the usefulness of it, one must admit that this ratio only pays attention to the age structure of the population, which makes it a strictly demographic ratio. It does not take into account economic factors such as the age of entry into the working life, retirement age, level and lifecycle profiles of consumption and labour income.

Lee (2014) and Sanderson and Scherbov (2015) propose a better *economic* dependency ratio that we call the NTA economic support ratio (NTA-ESR).[8] This ratio considers demographic changes but also economic factors as it relies on age profiles of consumption $c(a,t)$ and labour income $yl(a,t)$. To estimate the NTA-ESR, age profiles of consumption and labour income are taken from a base year denoted $\bar{t}$ (Lee, 2014). The NTA economic support ratio then equals the population age distribution in a given year times the base year age profile of labour income $\sum_a yl(a,\bar{t}) * N(a,t)$, divided by a similar product for consumption $\sum_a c(a,\bar{t}) * N(a,t)$. Algebraically, NTA-ESR at year *t* with base year $\bar{t}$ equals:

$$NTA - ESR_t = \frac{\sum_a yl(a,\bar{t}) * N(a,t)}{\sum_a c(a,\bar{t}) * N(a,t)} \quad (2)$$

Application of this ratio or its variants can be found in Lee and Mason (2010), Prskawetz and Sambt (2014), Sanderson and Scherbov (2015) and Vaittinen and Vanne (2017). The value added of longitudinal NTA projects is the capacity to report on the evolution of the NTA-ESR in recent years. Table 1 reports the *inverted* dependency ratio (IDR) and the NTA-ESR for past, current and future years in Canada. Calculations into the future are made using demographic projections from Statistics Canada.[9]

[7] Sometimes the *inverted* dependency ratio (IDR) is used to measure the extent at which economically active age groups can support the non-economically active population. IDC simply equals to the 20-64 population /(0-19 population + 65+ population).

[8] The ratio is called "NTA economic support ratio" by Sanderson and Scherbov (2015) and "weighted economic support ratio" by Lee (2014).

[9] We use the M1 projection scenario: medium-growth, 1991/1992 to 2010/2011 trends.

Table 1 NTA Economic Support Ratio and Inverted Dependency Ratio in Canada

NTA data					Projections									
1998	2003	2008	2011	2013	2018	2023	2028	2033	2038	2043	2048	2053	2058	2060
Weighted economic support ratio | YL/C														
0.93	0.89	0.89	0.86	0.88	0.86	0.83	0.80	0.78	0.77	0.76	0.75	0.75	0.75	0.75
Inverted demographic support ratio | Pop20-64/(Pop0-19+Pop65+)														
1.57	1.64	1.68	1.68	1.66	1.57	1.41	1.29	1.23	1.21	1.22	1.21	1.19	1.17	1.16

Reading note: In 2013, in Canada, labour income accounted for 80% of the total consumption aggregate. For the same year, in France, labour income accounted for 84% of total consumption.

This table shows that the story suggested by the NTA-ESR is quite different from that of the IDR. In 1998, the inverted dependency ratio was equal to 1.57 in Canada. This means that for each member of the 'non-working age groups', we find 1.57 member of the 'working age groups'. The IDR improves in Canada until 2011, with a ratio equal to 1.68. The IDR has a value of 1.66 in 2013. Although this ratio is lower than its peak in 2008 and 2011, the difference is slim and hence does not suggest any significant demographic development during that period. As mentioned above, the inverted dependency ratio strictly relies on the number of people in and out of working age groups. It does not take into account the level of consumption and labour income at each age, which are obviously keys to assessing the effects of population aging on the economy. The NTA-ESR includes total consumption and labour income by age. The trend using this ratio in recent years suggests a quite different view. In contrast to the IDR, the NTA-ESR declines from 0.93 to 0.88 over the same period. This represents 5 points of percentage decline over this short 15-year period. This means that labour income covers total consumption by 93% in 1998 but only by 88% in 2013. It is important to note that this decline occurs at the same time that the IDR improves in Canada. The decline of the NTA-ESR is due both to the per capita consumption and labour income profiles and to population aging. The 1998-2013 period is indeed characterized by a significant increase in the number of people aged 60 and over (16.4% of the population in 1998 and 21.3% in 2013). Consequently, the per capita LCD_{+}^{*} at old ages increases more rapidly than the per capita LCD_{-}^{*} at working ages[10]. The decline in the NTA-ESR suggests that other sources of revenue compensate for the relative decline of labour income with respect to consumption. Financing consumption away from labour income requires drawing on assets and transfers. This may not be sustainable in the medium run. It is thus worthwhile to investigate the future projections for IDR and NTA-ESR.

[10] Between 1998 and 2013, the per capita LCD_{+}^{*} at old age increases by 1.37% per year while the per capita LCD_{-}^{*} increases only by 0.47%.

Projections

The projections up to 2060 reported in Table 1 now invert the story of recent years. With respect to the inverted dependency ratio, a rapid decline is expected from 1.66, in 2013, to as low as 1.16, in 2060. This represents a drop of more than 30% of this ratio. This significant drop has inspired some catastrophic scenarios with respect to the economic consequences of population aging. In the case of the NTA-ESR, the decline is much less dramatic, from 0.88 to 0.75, a drop of 15%. The projected decline in the NTA-ESR is certainly less sensational than the one for the IDR, but it is still significant. Further analysis is thus warranted.

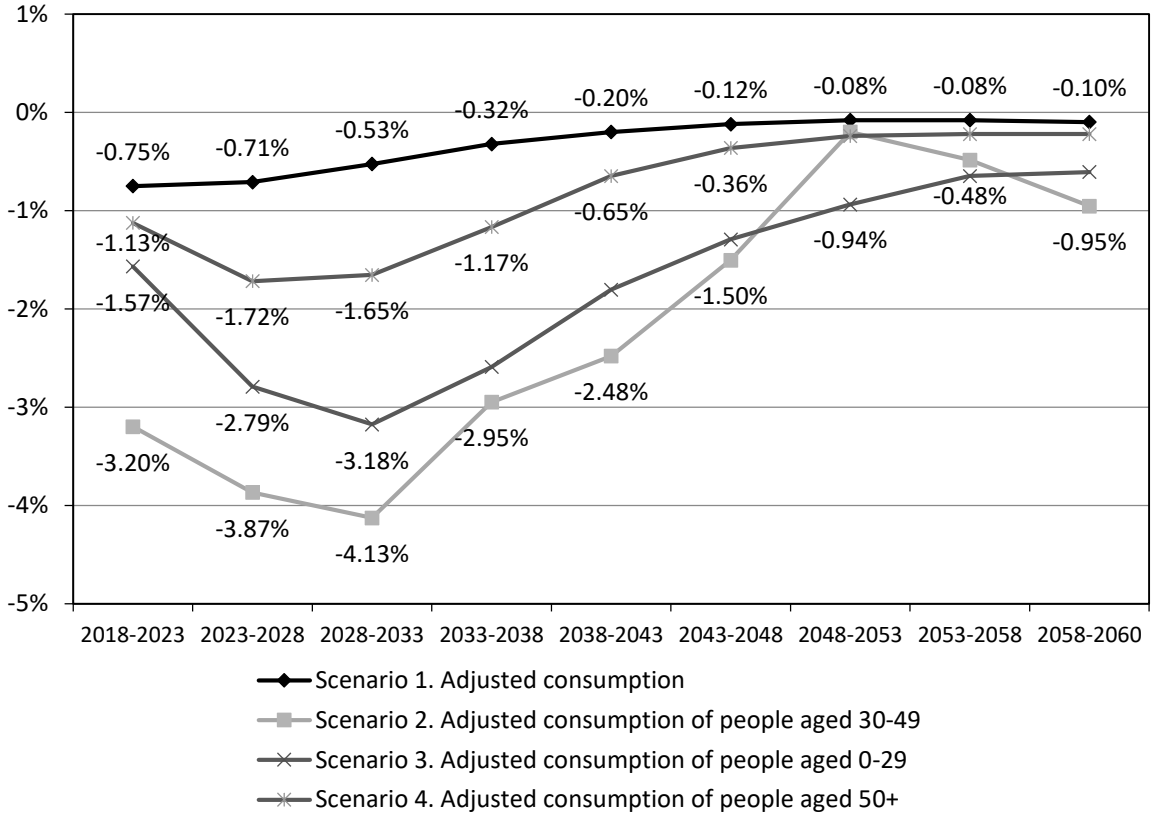
Assuming that other sources of revenue (assets, family and government transfers) are not in a position to compensate for the relative decline of labour income with respect to consumption, we can estimate the significance of the decline in the NTA-ESR using various scenarios. In all scenarios, we calculate the extent to which consumption must decline relatively to labour income to avoid the NTA-ESR's expected 13 percent points decline. The relative decrease of consumption is estimated annually for five-year periods from 2018 to 2058 (2018-2023; 2023-2028…) and for a two-year period from 2058 to 2060. Figure F introduces four scenarios. In the first scenario, consumption takes the cut across all ages. Notice that the percentage cut is constant at each age in this scenario. In the three additional scenarios, we target specific ages that is, the young (0-29), middle-aged (30-49) and old (50+).

Where all ages take the same percentage cut in consumption, Figure F shows that the average annual drop in consumption would be -0.75% from 2018 to 2023 and -0.71% from 2023 to 2028. Thereafter, the decrease in consumption would slow down. Between 2048 and 2058, the decline would be 0.08% annually. The percentage decline of consumption would reach 0.1% after 2058. A cut concentrated on a specific age group could result in a relative but also absolute decline in consumption over the next decades given that the required decrease may exceed the economic growth. The decline could be particularly strong if the target is on middle-age individuals (scenario 2). In fact, the drop in consumption would have to be -3.2% annually between 2018 and 2023 and -3.87% between 2023 and 2028. The drop would be larger between 2028 and 2033 at 4.13%. The trend in the decline should be lower thereafter even if it remains high. In scenario 3, which focuses on young people aged 0 to 29, the drop would be lower than the scenario focusing on middle-age individuals: -1.57% between 2018 and 2023, -2.79% 2023 and 2028, and -3.18% between 2028 and 2033. A target on age 50 and over (scenario 4) implies an even lower decrease in consumption relative to labour income, due to the high level of consumption at old age. Relative consumption would drop by 1.13% between 2018 and 2023 and by 1.72% between 2023 and 2028.

In all four scenarios, the percentage cuts we report are actually the maximum by which consumption would drop as we assumed in these calculations that other sources of revenue besides labour income

would be limited. Nevertheless, the size of percentage cuts is large enough to wonder if current levels of consumption relative to labour income are sustainable.

Figure F. Annual changes in consumption relative to labour income to keep YL/C=0.88



Conclusion

In this article, we introduce time series age profiles of labour income, consumption and lifecycle deficit in Canada for the period between 1998 and 2013. National Transfer Accounts (NTAs) are quite useful to discuss the issue of population aging as it highlights the allocation of economic flow variables across ages, while being consistent with the National Accounts. NTA time series show how lifecycle deficits change over time among the young and old, and the role played by the working-age groups in financing the non-working age groups with the lifecycle surplus they generate.

The age profiles reveal that the increase in lifecycle deficit among the young and old in Canada has not been compensated by the increase in lifecycle surplus of working age groups. The high level of consumption among the old and the concentration of labour income on a small number of ages enhance the pure demographic effect of population aging. Between 1998 and 2013, the ratio of total labour income over total consumption decreased by 5 percentage points. This ratio, which we call the NTA-ESR ratio, gives a more precise estimate of the economic challenges linked to demographic changes. As shown above, the inverted dependency ratio tends to minimize the recent changes on the allocation of resources across ages between 1998 and 2013; however, with respect to the ongoing

challenge of population aging, the inverted dependency ratio presents a more dramatic economic picture than the NTA-ESR.

Still, we show that the NTA-ESR is expected to decline in the coming years, which is an indication that population aging can be a challenge for consumption. From an individual point of view, it means that the share of labour income financing consumption will decline if the employment rate does not increase for working-age groups, especially among older people. A stable ratio would require increasing the relative level of labour income to consumption or decreasing the level of consumption relative to labour income.

In this article, we focus on consumption and labour income. A complete view of the NTA-ESR ratio would require including the net asset income of savings to assess if Canadians produce more than they consume (labour and net asset income of savings > consumption) or if they consume more than they produce (labour and net asset income of savings < consumption). D'Albis et al. (2017b; 2018) show that asset income is highly concentrated among older age groups. A complete view of the NTA-ESR ratio could thus mitigate the increasing gap between consumption and labour income in the following years. Hence, further investigation into NTA data will be welcomed although this study shows that the gap between labour income and consumption will be increasingly difficult to overcome.

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Appendix
Technical manual of NTA in Canada

The technical manual introduces the steps to calculate age profiles of labour income and consumption between 1998 and 2013 for Canada. It completes the United Nations manual published in 2013 that describes the international methodology used for all countries. The technical manual provides the elements necessary to build lifecycle deficit accounts for Canada. The first part describes the calculation of aggregates while the second part details the methodology and the statistical sources to construct per capita age profiles.

Controls for aggregates

NTA aggregates are taken from the National Accounts of Statistics Canada. NTA aggregates are calculated in two steps. First, we calculate aggregates at the most aggregated level of NTA, as introduced in the equation (1) of the article ($C_a - Y_a^L = (T_a^I - T_a^O) + (Y_a^K - S_a)$). The eight steps to calculate these aggregates are detailed in Table X for 2013. Then, we calculate sublevel aggregates for labour income (wages, employer's contribution, labour share of Gross Mixed Income), for private consumption (education, health, imputed rents, other) and public consumption (education in elementary and secondary school, post-secondary education, health; other).

The aggregates of the eight steps in Table X are estimated from different sources of the national accounts published by Statistics Canada. The decomposition of the GDP and the adjustment for statistical discrepancies (Step 1 and 2) are calculated from the GDP expenditure-base table (CANSIM 384-0038) and the current and capital accounts (CANSIM 380-0072) for the left part of the equation and from the GDP income-base table (CANSIM 384-0037) for the right part of the equation. 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 from the arbitrary rule chose in the United Nations Manual (2013) that applies 2/3 to labour income and 1/3 to capital. We consider that the share of labour income is the relative size of the compensation of Employees in the value produced by companies (Compensation of Employees + Gross Operating Surplus). The allocation of Indirect taxes less subsidies (nets 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 CoE + Compensation of Employees + labour share of GMI) and the relative share of capital income (Net Property income + Gross Operating Surplus + capital share of GMI + Capital share of CFC). The aggregates for Step 6 and Step 7 come from the current and capital accounts (CANSIM 380-0072).

The second step to calculate the NTA aggregate consist 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 the National Health Expenditure Trends of the Canadian Institute for Health Information (CIHI). We include public expenses from the federal, provincial, and municipal governments, plus Social Security Funds.

Statistics Canada publishes the aggregate for public education on a school/academic year perspective. Thus, we assume that the aggregate for year n is equal to 60% of the school/academic year $n-1/n$ and 40% of the school/academic year $n/n+1$ (considering a school/academic year from September to June and thus six months in academic year $n-1$/n and four months in the academic year $n/n+1$). Primary and secondary education are calculated from the public and private elementary and secondary education expenditures of table CANSIM 478-0014. Post-secondary education includes college education (CANSIM 478-0004), universities (CANSIM 478-0007) and vocational training education expenditures (CANSIM 478-0005)[11]. As they are only available up to 2004/2005, we consider that the ratio of post-secondary education expenditure on primary and secondary expenditure remains 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.

[11] In 2013, primary and secondary education, Colleges and universities, and vocational training education account respectively for 66.4%, 26.6% and 7% of total education expenditure.

Table X. Aggregates for the equation (1)

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

	Final Consumption Expenditures	+	Gross Capital Formation (Investment)	+	Net Exports	=	Compensation of Employees (CoE)	+	Gross Operating Surplus (GOS)	+	Gross Mixed Income (GMI)	+	Indirect Taxes Less Subsidies (ITLS)
private	1 143 738		396 194				1 025 682		444 265		230 907		
public	417 730		77 084						67 415				
total	1 561 468		473 278		-47 461		1 025 682		511 680		230 907		216 831

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

				LESS Income SD	=	LESS CoE % Expend SD	+	LESS GOS % Expend SD	+	LESS GMI % Expend SD		
private						659,12		285,49		148,39		
public												
total				-1 093		659		285		148		

3. Go from domestic to national basis by including net Rest-of-World (ROW) Amounts

				PLUS net Primary Inc from ROW	=	PLUS net CoE from ROW	+	PLUS net Property Inc from ROW				
private						-1 960		-8 411				
public								-6 118				
total				-16 489		-1 960		-14 529				

4. Reallocate GMI to Labor verus Capital

						PLUS GMI TO LABOR		PLUS GMI TO CAPITAL		LESS GMI		
private						161 689		69 365		-231 053		
public												
total						161 689		69 365		-231 053		

5. Reallocate ITLS to consumption, labor and capital to go from "market" to "basic" prices

	LESS C share of ITLS				=	PLUS L share of ITLS	+	PLUS K share of ITLS	+			LESS ITLS
private	-130 753					71 965		14 114				-216 831
public												
total	-130 753					71 965		14 114				-216 831

6. Go from gross to net by removing Consumption of Fixed Capital (CFC) from capital share of profits.

		LESS CFC			=		LESS CFC
private		-274 785					-274 785
public		-65 894					-65 894
total		-340 679					-340 679

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		-5 522		
public		5 625		
total		103		-103
7b. Net Lending/Borrowing				
private		-61 592		
public		-22 280		
total		-83 872		83 872
7c. Net non-produced non- financial assets (NPNFA)				
private		2 923		
public		-2 923		
total		0		0

8. NTA identity

	Private Consumption (CF) / Public Consumption (CG)	+	Private Saving (SF) / Public Saving (SG)	+	NEGATIVE Transfers (-T)	=	Labor Income (YL)	+	Private Asset Income (YAF) / Public Asset Income (YAG)
private	1 012 985		57 218				1258035		244 834
public	417 730		-8 388						-4 597
total	1 430 715		48 830		18726		1 258 035		240 236

Reading note: Amounts in millions dollars
Source: National Accounts (Statistics Canada), Authors' calculations.

Age profiles for consumption and labour income

Age profiles for labour income are calculated from the Survey of Labour and Income Dynamics (SLID, from 1998 to 2011) and from the Canadian Income Survey (CIS, for 2012 and 2013) as showed by Figure X. They are composed of labour earnings, employer contributions and self-employment labour income (Labour share of Gross Mixed Income). In the SLID and CIS surveys, labour earnings and self-employment income are reported net of income tax for each individual. However, according to the NTA methodology (United Nations, 2013), we need to impute gross labour income that includes income tax. The variable of income tax in SLID and CIS is at the individual level, but it does not separate the taxes due to labour earnings, self-employment income or other sources. To do so, we multiply the individual income tax value by the ratio of individual labour income (resp. labour earnings and self-employment income) on the total income earned by each individual. Employer contributions are not available in the SLID and CIS surveys, but we can rely on the employee's contributions that are available at the individual level from 1999 to 2013. CPP and QPP employer contributions[12] accounts for the share of total contributions by employees and employers. Thus, we use the variable of employee's contributions to calculate employers' contributions. Employee's contributions are not available in 1998. We use the parameters published by Lin (2001) to calculate the contribution of employers in 1998 (Employer's contribution = (Gross wages + Gross Mixed Income – exemptions) x contribution rate). Employment Insurance (EI) premiums of employers are calculated using the parameters published by Lin (2001) (Employer's contribution = (Maximum Insurable Earnings of employees x Premium rate x 1.4).

Age profiles of private consumption are calculated using the Survey of Household Spending (SHS) from 1998 to 2013. Private consumption is composed of education, health and other consumption that are available at the household level, and by imputed rents that are not available in SHS. Private education and health profiles are obtained by regression methods, following the strategy suggested in the United Nations' manual (2013). For education, household consumption is assumed to be a function of the number of household members aged 5 to 29. The regression coefficients obtained at each age are then used to allocate private education within the household. Following the works of d'Albis *et al.* (2015, **2017a**), household health expenditure is assumed to be a function of the number of household

[12] Acronymes for *Canada Pension Plan* and *Quebec Pension Plan*.

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 including characteristics of the household (age of the husband or age of the reference person), the characteristics of the dwelling (type of accommodation, year of construction, number of rooms etc.) and the location (sixteen 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, are allocated across ages within the household with the equivalence scale (see figure Y) suggested by Lee and Mason (2011a). Private consumption other than health and education is assigned to each member according to its weight. The weight is 0.4 for young children up to age 4, then it increases linearly from age 4 to 20, and is equal to 1 for adults aged 20 and older.

Age profiles for public health are calculated from the National Health Expenditure Trends of the Canadian Institute for Health Information (CIHI). Total health expenditures of Provinces and Territories are available by age groups. We assume that within each age group, each individual gets the same amount of public health expenditures.

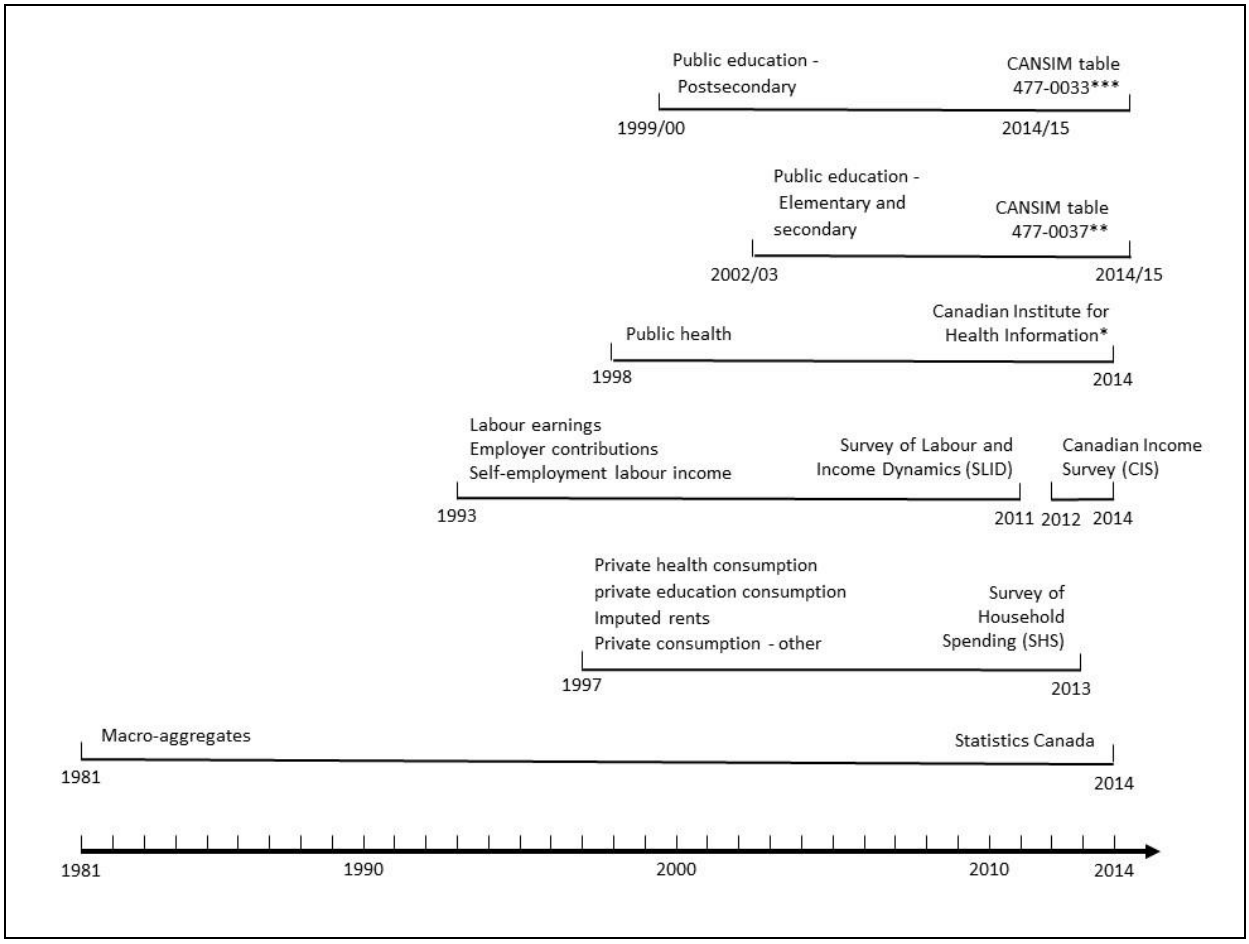
Age profiles of public education is composed by primary and secondary education (CANSIM table 477-0037) and by post-secondary education (CANSIM table 477-0033). Post-secondary education includes college education and universities. The CANSIM tables 477-0033 and 477-0037 provide the number of students enrolled at each age and for school/academic years. We assume that each years n is composed by 60% of the students of the school/academic years $n-1/n$ and by 40% of the students of the school/academic years $n/n+1$. Moreover, we assume for each education degree (primary and secondary, college, universities) that every student gets the same amount of education expenditure. The CANSIM table for 477-0037 primary and secondary education is only available from 2002/2003. Thus, we consider that the number of students by age in 2002 and before is equivalent to the number of students in 2003. Enrollments of primary and secondary education are available for each age up to 20 years old. The last age group includes all students who are 21 years old or more. We attribute all students of this age group to the age 21 category.

The CANSIM table 477-0033 that we use for post-secondary education is only available from 1999/2000. Thus, we apply the hypothesis we use for primary and secondary education: the number of students by age in 1999 and before is equivalent to the number of students in 2000. Moreover, post-secondary education enrolments are available for ages groups : less than 20 years old, 20 to 24 years old, 25 to 30 years old, 31 to 34 years old, 35 to 39 years old and 40 years old or more. For each age group, we consider that the number of enrolled students is distributed equally across ages. The enrollments before 20 years old are equally distributed between age 17 and 19 in Québec (due to the

particularity of the education system in Québec with the CEGEP[13] institutions) and between age 18 and 19 for other provinces. The last age group, age 40 or more, is equally distributed between age 40 and 49 across Canada.

Finally, other public expenditures are equally allocated across each individual, according to the United Nations manual (2013).

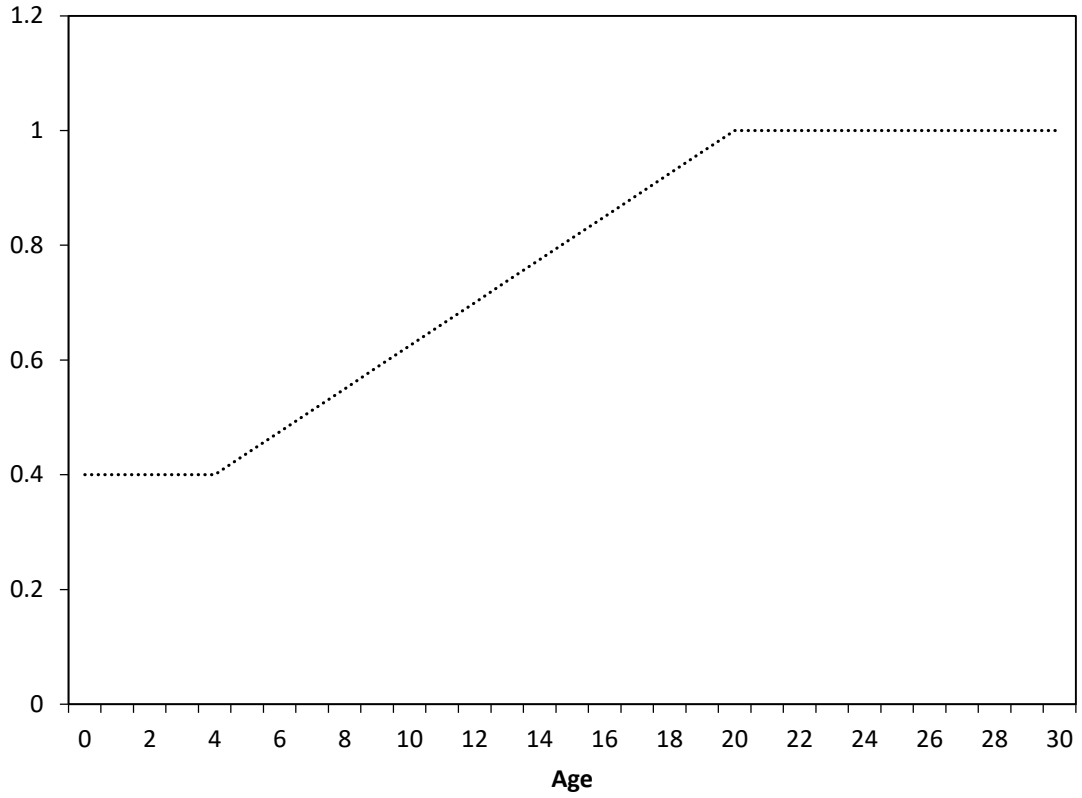
Figure X. Sources of age profiles



* Series E. Provincial/territorial government expenditure by age and sex.
** Number of students in regular programs for youth, public elementary and secondary schools, by age and sex, Canada, provinces and territories.
*** Postsecondary enrolments, by program type, credential type, age groups, registration status and sex.

[13] Collège d'Enseignement Général et Professionnel.

Figure Y. Equivalence scale for allocating private consumption other than education and health



Source: United Nations (2013)

Abstract

In this paper, we develop a new longitudinal data set for Canada based on the National Transfer Account (NTA) methodology. NTA gives 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. This paper introduces 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 been changing over that period. We also use the age profiles of consumption and labour income to construct an alternative indicator to the demographic dependency ratio, called the NTA Economic Support Ratio. This allows us to project the pressure of aging on this new ratio and hence to identify under which conditions private consumption in Canada can be funded over the next few years. The analysis raises concerns about the sustainability of living standards in an aging context.