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Population Aging and Work Life Duration in Canada

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Le vieillissement de la population suscite des préoccupations quant au fait que les années de vie supplémentaires sont principalement consacrées à la retraite, ce qui augmenterait la pénurie de main-d'œuvre et la pression sur les finances publiques. Toutefois, ces préoccupations omettent habituellement de rendre compte de façon appropriée des changements dans la participation au marché du travail et les heures travaillées (composantes comportementales), facteurs susceptibles d'amplifier ou de contrer les mouvements du vieillissement de la population (composantes structurelles) tout au long du cycle de vie. Cet article estime la durée de vie active, soit une estimation de la main-d'œuvre disponible qui tient compte de la mortalité, de la participation au marché du travail et de la charge de travail (heures travaillées) à chaque âge, et analyse le ratio de vie active, soit la part de l'espérance de vie consacrée au travail. Il décompose également les changements dans la durée de vie active en composantes démographiques et comportementales, isolant ainsi la contribution du vieillissement de la population au changement observé entre 1981 et 2016. Les résultats suggèrent que la durée de vie active n'a pas diminué avec le vieillissement de la population. Nous constatons plutôt qu'entre 1981 et 2016, la durée de vie active a augmenté de 4,96 ans, tandis que son rapport à l'espérance de vie a augmenté de 3,55 points de pourcentage. La participation au marché du travail est le principal moteur de ces changements, auxquels elle contribue par 3,57 ans, contre 0,73 et 0,65 an pour la charge de travail et la mortalité, respectivement. Ces résultats fournissent des contrarguments au débat en cours au Canada au sujet de l'augmentation de l'âge de la retraite, qui présuppose à tort une réduction de la durée de vie active entrainant la nécessité de financer l'accroissement de l'espérance de vie.

Mots clés: vieillissement démographique, durée de vie au travail, comportement individuel, âge de la retraite, cycle de vie, offre de travail

Population aging has brought concerns that the added years of life are predominantly being spent in retirement, contributing to a labour shortage and pressure on public finances. These concerns, however, usually omit an appropriate account of the changes in labour force participation and hours worked (behavioural components), factors that could be playing toward or against the tides of population aging (structural components) throughout the life cycle. This article estimates work life duration, an expected labour supply that incorporates mortality, labour participation, and workload (hours worked) at each age, and analyzes the work life ratio, the share of life expectancy devoted to working. It also decomposes the changes in work life duration into demographic

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and behavioural components, thus isolating the contribution of population aging to the change between 1981 and 2016. The results suggest that work life duration has not declined as the population has aged. Instead, we find that between 1981 and 2016, work life duration increased by 4.96 years, whereas its ratio to life expectancy increased by 3.55 percentage points. Labour force participation has been the main driver of these changes, contributing 3.57 years compared with 0.73 and 0.65 years for workload and mortality, respectively.

These results bring counterarguments into the ongoing debate in Canada to increase the retirement age in the name of shrinking work life duration to finance increasing life expectancy.

Keywords: population aging, work life duration, individual behaviours, retirement age, life cycle, labour supply

Introduction

Population aging raises concerns about labour shortages and the sustainability of public finances in most Organisation for Economic Co-Operation and Development (OECD) countries. To many, a "one stone, two birds" policy would be to increase the age at which individuals collect a full public pension (hereinafter referred to as *normal retirement age*). Such a policy would, on the one hand, induce workers to stay in the labour market longer and, on the other hand, enhance public finance sustainability by delaying or reducing pension payments. Over the past two decades, many countries have used this reasoning to pass legislation to increase the normal retirement age or the number of contribution years required to collect a full pension. In Canada, however, although most scholars and politicians agree on measures to promote the labour involvement of older adults, increasing the age requirement for a full public pension benefit is often a source of heated debates and discord.

Debates on Increasing the Retirement Age

In Canada, although there has been no policy to increase the normal retirement age since the inception of the Canada Pension Plan/Quebec Pension Plan (CPP/QPP; Chawla and Wannell 2004), recent studies have had contradictory results and policy recommendations. On the one hand, studies analyzing some variants of dependency ratio tend to recommend an increase in the normal retirement age as the share of the dependent population increases (Canadian Institute of Actuaries 2019; D'Amours et al. 2013; Hering and Klassen 2010). For example, Hering and Klassen (2010) suggest that increasing the normal retirement age would significantly improve the fiscal sustainability of the CPP and essentially solve the financing problems of the QPP. On the other hand, studies focusing on the number of years spent in retirement see no reason for such policy, given that individuals are already delaying their retirement (Carrière and Galarneau 2011; Carrière et al. 2015; Gomez and Gunderson 2009; Lefebvre, Merrigan, and Michaud 2012). For example, Carrière et al. (2020) demonstrate that working life expectancy at age 50 years is increasing much faster than life expectancy and, therefore, see no evidence of significant intergenerational inequity that increasing the normal retirement age would solve.

Although these studies may diverge in their recommendations on increasing the normal retirement age, they have in common little to no inclusion of changes in individual behaviour toward the labour market over the entire life cycle. This study contributes to the debates on policy responses to population aging by accounting for labour participation and workload (hours worked) in estimating work life duration (WLD)—that is, the expected labour supply at age 15 years—from the individual perspective.

The article brings three primary contributions to the debates. First, it estimates WLD as an expected labour supply that incorporates mortality, labour participation, and worked hours at each age. Second, it analyzes the changes in WLD and work life ratio (WLR; the share of life expectancy devoted to working) between 1981 and 2016. Finally, it decomposes the changes in WLD into demographic and behavioural components, thus isolating the contribution of population aging to the change between 1981 and 2016. These contributions not only recognize the importance of the changes in individual behaviour over the past few decades but also provide a more precise estimate of the individual labour supply, a gap in the literature that contributes to discord in debates on policy responses to population aging.

Changes in Individual Behaviours

Individual behaviours in the labour market have been changing along with the population age structure. Therefore, they could aggravate or mitigate the effect of population aging on the labour supply. Furnkranz-Prskawetz et al. (2005) illustrate the influence of behavioural components using data on five selected OECD countries from 1983 through 2000. They found that a change in age-specific labour force participation rather than a shift in age structure dominated the crude labour force rate changes. Individual behaviours in the labour market cover entry patterns at a young age, exit schedules at an old age, and prime-age participation for men and

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women. Over the past few decades, these behaviours have changed significantly, especially among women, and so have their impacts on the life cycle labour supply.

Today, young Canadians are staying in school longer and thus postponing their entry into the labour market until later than their parents did (Clark 2007; Fleury 2009). For instance, Clark (2007) found that in 1971, three-quarters of young adults had left school by age 22 years, whereas only half had left by that age in 2001. During roughly the same period, full-time employment among young men and women aged 17–24 years and not in school for the full year changed from 76 percent to 59 percent for men and from 58 percent to 49 percent for women (Statistics Canada 2019).

At the other end of the life cycle, life expectancy and health improvement have enabled people to delay retirement to a greater extent than predicted (Carrière and Galarneau 2011; Gomez and Gunderson 2009; Lefebvre et al. 2012; Leinonen, Martikainen, and Myrskyla 2015). For instance, the expected retirement age for all Canadian workers aged 45 years and older increased from 59.2 years in 1994 to 62.9 years in 2002 (Gomez and Gunderson 2009). That is a four-year increase in eight years,[1] leading to a decline in the proportion of years in retirement (to life expectancy) from 55 percent to 48 percent.

The past four decades have also seen significant changes in labour participation among prime-age adults (Black, Schanzenbach, and Breitwieser 2017; Ketcheson, Kyui, and Vincent 2017; Moyser 2017; Ruggles 2015; Wilson and Jones 2018).[2] In Canada, labour participation among men aged 25–54 years began decreasing in the 1950s (from 97.1 percent in 1950), a trend that continued steadily until the 2010s (to 90.9 percent in 2015). In contrast, participation among women increased by 60.4 percentage points during the same period, from 21.6 percent to 82.0 percent, narrowing the gender gap from 60 percentage points in 1950 to 9 percentage points in 2015 (Moyser 2017).

Although many studies have highlighted the changes in individual behaviours in the context of population aging, they have primarily focused on labour force participation and rarely included worked hours over the life cycle. However, the changes in workload could be as significant to policy response to population aging as changes in labour participation. In the early 1900s, the workweek lasted 60 hours over six days before declining to 37–40 hours over five days in the 1960s (Sunter and Morissette 1994). The decline continued through the 1980s, partially resulting from the increase in part-time employment (Dolton 2017). Nowadays, part time is the preferred work arrangement among students (Galarneau, Morissette, and Usalcas 2013) and workers aged 50 years and older (Carrière and Galarneau 2011), and it is a way for many women to reconcile work and family. In Canada, weekly hours changed from 42.3 hours for full-timers and 16.0 hours for part-timers in 1976 to 40.8 hours and 18.3 hours, respectively, in 2018 (Statistics Canada 2023a).

Following the changes in individual behaviour over the past four decades, defining *working age* is no longer as simple as delimiting age groups (Carrière et al. 2020; Carrière and Galarneau 2011). Therefore, estimating the effect of population aging on the labour supply must include as much of the life cycle as possible. This article aims to contribute to this task for Canada. It measures WLD as the labour supply from the individual perspective and isolates the contributions of mortality, participation, and workload to the changes in WLD between 1981 and 2016.

Work Life Duration in the Literature

Several terms are used in the literature to refer to WLD: labour force expectancy, work life expectancy, labour market life expectancy, duration of working life, the average length of working life, active life expectancy, and so forth (Loichinger and Weber 2016).

Some studies have focused on WLD at older ages, attempting to answer policy concerns by analyzing the share of life expectancy at older ages (often age 50 y) spent working rather than retired (Carrière and Galarneau 2011; Denton, Feaver, and Spencer 2009; Loichinger and Weber 2016). For example, Denton et al. (2009) published cohort work life tables for Canadian men and women aged 50 years and older, considering variation in mortality and participation by age. Loichinger and Weber (2016) accounted for variation in mortality and participation by age and education level in analyzing the ratio of working life expectancy at age 50 years to life expectancy and healthy life expectancy for European countries.

Although these studies provide insights into time allocation at older ages, they are limited in guiding policy response to population aging because they leave out essential parts of the life cycle. In contrast, Eurostat has developed the duration-of-working-life indicator covering most of the life cycle to monitor the European Union 2020 strategy on employment. As used by Eurostat, the duration of working life refers to the number of years a person aged 15 years would expect to be in the labour market (employed or unemployed) throughout their life (Eurostat 2022).

Another branch of the literature, perhaps the most common, provides work life tables as the basis for life insurers in tort compensation after an injury (Gilbert 2018; Skoog, Ciecka, and Krueger 2011). These tables integrate non-market labour in estimating WLD, which nearly equalizes men's and women's estimated lifetime total working years (Krueger and Slesnick 2014). Like the Eurostat indicator, the measures of WLD from these tables account for most of the life cycle. However, they are both limited to including labour participation, leaving aside workload.

In summary, estimations of WLD in the literature have to some extent accounted for behavioural components. However, they are primarily limited to including labour participation, leaving out workload. In other words, they merely measure the spread of labour attachment, leaving out the depth of the attachment, a dimension that would be accounted for by including workload. This research attempts to improve our understanding of the changes in working life span and the role of population aging and individual behaviours over the past four decades. The article uses an adaptation of Sullivan's (1971) method to estimate WLD and the model of continuous change (Horiuchi, Wilmoth, and Pletcher 2008) to decompose its changes between 1981 and 2016. The following section describes these methods in detail.

Methods and Data Sources

WLD measures the number of years a person can expect to devote to paid labour while accounting for mortality (life expectancy), labour participation, and workload (hours worked). WLR is the share of life expectancy that an individual will devote to paid work. By relating WLD to life expectancy over time, the trend in WLR provides valuable insights into the trend in the dependency ratio at the individual level. In these definitions, life expectancy reflects the mortality schedule derived from the traditional life table. *Participation* refers to the individual probability of participation in the labour market, which is the ratio of those employed and unemployed over the population aged 15 years and older, and *workload* refers to the average workload annually.

Building on period life tables, WLD and WLR for a given year describe working patterns of a synthetic or hypothetical cohort with the same mortality, participation, and workload as those observed in that year. In other words, a WLD of 25 years at age 20 for the year 2000 means that an individual could expect to work an additional 25 years if patterns of mortality, participation, and workload by age over the remaining life cycle follow the same distribution observed in the year 2000.

Including workload brings an additional level of precision to estimating the labour supply. We use the term WLD to account for this additional precision. WLD is life expectancy (at work) that accounts for participation and workload on top of survival rates. As with Eurostat's indicator, it looks at the entire life cycle of active persons, rather than specific states or periods in the life cycle, such as youth unemployment or early withdrawal from the labour force (Eurostat 2022). However, it goes beyond the life cycle by integrating the depth of participation captured by the average workload at each age. Thus, it provides a better approximation of the labour supply at the individual level and a better basis for policies that involve individual work lives, such as increasing the retirement age.

Life and Work Life Tables

In the literature, two methods are commonly used to measure WLD. The simplest method has been to assume some reference age at which individuals exit from the labour market. For example, assuming workers qualify for a full public pension at age 65 years, WLD at age 25 would be 40 (65 − 25) years. This approach has been common since the 1970s, even though it vastly overestimates WLD. Since then, more sophisticated methods such as the Markov Process Worklife Expectancy (MPWE) tables have appeared. These approaches account for mortality and participation that, in the case of the MPWE tables, allows individuals to transit through various states (active to non-active and vice versa) from one age to the next. A particular type of MPWE table is the LPE table, which estimates WLD in terms of the probabilities of being alive (L), participating in the labour market (P), and being employed (E) as opposed to unemployed (Ireland 2010). LPE tables are built following Sullivan's (1971) method for accounting for health status and mortality in estimating healthy life expectancy. The same method is used in this study to include labour participation rates and workload on top of mortality rates in estimating WLD.

WLD at age a is estimated by dividing the remaining hours to work (wTa) from age a, by the number of persons surviving at age a (Sa).

$$WLD\alpha = \frac{w\tau\alpha}{S\alpha} = \frac{\sum_{i=\alpha}^{70+} wLi}{S\alpha}, \tag{1}$$

where wLa is the number of person-hours worked between age a and age a+1. Following Sullivan's (1971) approach, wLa is computed by multiplying the number of persons who lived (La) by the participation rate (wpa) and the workload (wha).

Eq. (1) is therefore re-written as

$$WLD_0 = \frac{\sum_{\alpha=0}^{70+} \left(L\alpha \times w\rho\alpha \times wh\alpha \right)}{S\alpha}. \tag{2}$$

Data Sources and Series

The La series are readily available in the life tables data from the Human Mortality Database (HMD 2020), and the wpa are extracted from Table 14-10-0327-01 (Statistics Canada 2023b). The wha series are the averages of the annual workload by age group during a given year. Annual workloads come from three series of annual surveys complementary to the Labour Force Survey of Statistics Canada. The surveys include the Survey of Consumer Finances from 1981 to 1997, the Survey of Labour and Income Dynamics from 1996 to 2011, and the Canadian Income Survey from 2011 to 2016.

Over the years, these surveys have improved in various ways. However, they remain consistent in their central theme, thus providing a long and deep view of the

Canadian labour market throughout its aging process. The annual workload variable is unavailable for some years. In that case, the estimation multiplies the number of weeks worked and the number of hours usually worked per week for that year. The questions used in the three surveys to capture the number of weeks worked come in a few variants. A common one is "During 2013, how many weeks did you work at a job or business? Include vacation, maternity or parental leave, illness, strikes, and lock-outs." For the number of hours usually worked per week, the question is some variant of "During those weeks, how many hours did you usually work per week at all jobs?"

The input data and resulting series have undergone several other operations, including synchronizing the age groups and converting WLD into work year. For instance, the *wpa* series are available by five-year age groups from ages 15 to 69 years and as a single group for those aged 70 years and older. Therefore, the age groups for *La* and *wha* are combined accordingly. Also, because workload *wha* is the total number of hours worked annually, WLD is ultimately measured in hours. Therefore, to allow convenient conversion to years, a full year at work is assumed to be equivalent to 2,000 hours,[3] at 40 hours per week for 50 weeks.

The three series of survey data cover only persons aged 15 years and older. Therefore, individuals are assumed to have no participation or workload in the labour market before age 15. However, although not crucial in magnitude, WLD at later ages is still affected by mortality before age 15. It may be worth noting that the study uses public use microdata files hosted in the Odesi Scholar Portal (Odesi 2020). Although confidential files hosted by Research Data Centres would have provided more granular data, we do not expect the results to change significantly.

Decomposition of Change

The model of continuous change (Horiuchi et al. 2008) is used to decompose the difference in WLD at age 15 years between 1981 and 2016 (the dependent summary measure) into additive effects resulting from the changes in the demographic and behavioural components (the covariates). The model assumes that changes in the covariates happen continuously or gradually, along an actual or hypothetical dimension rather than discretely. This assumption makes sense, particularly for demographic phenomena in which change occurs naturally over time. It, therefore, provides a reasonable justification for the additivity of covariate effects and the elimination of interaction terms, even if the measure in question is a non-additive function of the covariates (Horiuchi et al. 2008, 786)

In Equation (2), the *La* represents the demographic component of WLD and results from two factors. On the one hand, the vector *qa* contains the probabilities of dying between ages *a* and *a*+1. On the other hand, the vector *ma* contains the average number of years lived by those who died between ages *a* and *a*+1. Starting the work life table at *So* = 100,000 individuals, the *Sa* series are generated with the formula *Sa*+1 = *Si*(1 – *qa*), and because the ages *a* do not vary from one year to another, Eq. (2) can be written as

$$WLD_0(t) = f\left(q\alpha, m\alpha, w\rho\alpha, wh\alpha\right)(t) \tag{3}$$

or, in more generalized form, as

$$WLD(t) = f\left(W(t)\right), \tag{4}$$

where *W* is the matrix of *P* components (*qa*, *ma*, *wpa*, *wha*) over *L* ages, and *f* represents the work life table function that transforms *W* into WLD.

On the basis of Horiuchi et al. (2008, 792) the contribution to life expectancy at birth $e_0(t)$, for example, of death rate change in the *i*th age group from the period t_1 to the next period t_2 can be calculated as

$$C_i = \int_{M_i(t_1)}^{M_i(t_2)} \frac{\partial e_0(t)}{\partial M_i(t)} dM_i(t), \tag{5}$$

where *Mi*(*t*) is the death rate for the *i*th age group at time *t*. Extending this formula to include the additional behavioural components included in Equation (4), we can write

$$c_i = \int_{W_i(t_1)}^{W_i(t_2)} \frac{\partial e_0(t)}{\partial W_i(t)} dW_i(t), \tag{6}$$

where *Wi*(*t*) represents the age-specific components for the *i*th age group at time *t*. To conveniently integrate it with the preceding equation, *W* from Eq. (4) needs to be reshaped into a single vector of length *N* (*N* = *P*×L), with *WLDi* (*i* = 1,2,…,*N*) representing the age-specific components. The partial derivative in Eq. (6) is therefore obtained numerically from

$$WLD(t) = f\left(W_i(t)\right) = g\left(W_1(t), W_2(t) \ldots W_N(t)\right), \tag{7}$$

where *g* represents the work life table function that transforms the covariates' values, the vector *Wi*(*t*) of length *N* = P×L, into the vector *WLD*(*t*) of length *L*, the summary values at a given time *t*. The function *g* is different from *f* only in the formats of its inputs but is equivalent in its output series.

Computationally, the right side of Eq. (6) is estimated by numeric integration, that is, approximating $\int_{W_i(t_1)}^{W_i(t_2)} d(t)$ with $\sum_{W_i(t_1)}^{W_i(t_2)} \delta(t)$, and assuming that covariates change incrementally in *T* interval between t_1 and t_2 and proportionally to one another. Setting *T* to 12 to denote monthly changes from one year to another has been sufficient to reduce the overall approximation error to 6 decimal points, essentially zero.

The method is applied to each pair of consecutive years between 1981 and 2017, resulting in a total of 27,648 life tables (for 12 intervals, 16 age groups, four components, and 36 pairs of years). Each work life table provides a new WLD series resulting from the change from one month to another of a single component while holding all other covariates at their previous levels. Incremental decomposition between 1981 and 2016 provides the contribution of each age-specific component to the total change. It also enables us to follow the trends in contributions over the entire period, giving us a glimpse of the next few years or decades.

Changes in Individual Behaviours

As we aim to integrate personal behaviours into estimating WLD, it may be helpful to review the changes in personal behaviours that make their inclusion necessary. Figure 1 and Figure 2 show how participation and workload have changed over the past four decades.

Trends in Participation and Workload

In 1981, participation among young adults was very close to that of mid-age adults. However, the two trends diverged as participation increased for mid-age adults but stagnated for young adults. For instance, the labour participation rate increased by about 9 percentage points between 1981 (77.3 percent) and 2016 (86.6 percent) for mid-age adults, whereas the change was only 1 percentage point for young adults (from 74.6 percent to 75.7 percent). For those aged 55 years and older, participation decreased slightly until the mid-1990s but has increased consistently since then to reach 37.7 percent in 2016, an 8 percentage point increase compared with 1981 (29.8 percent).

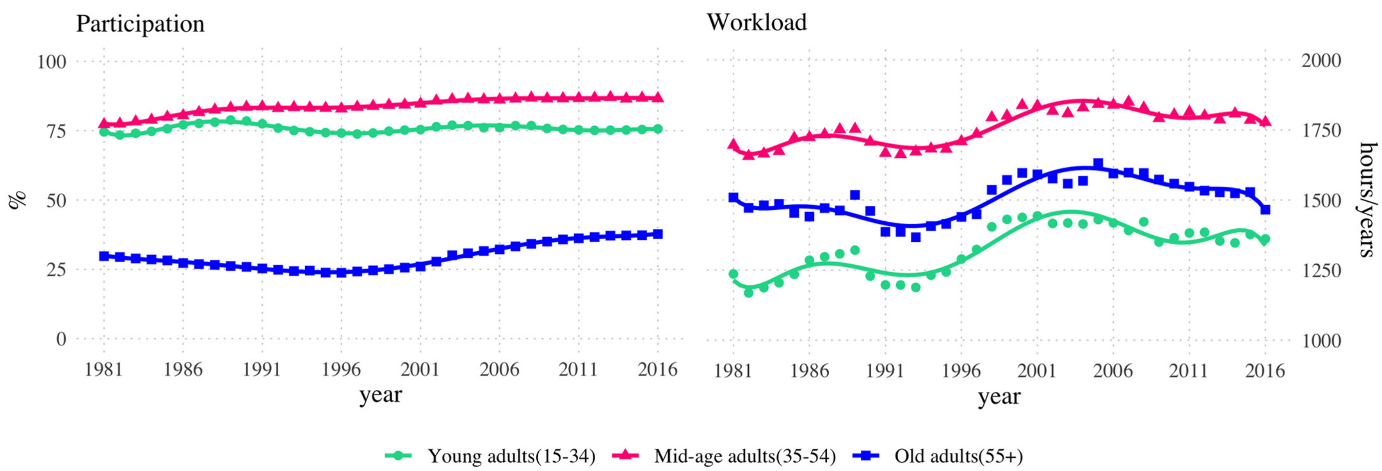

Figure 1: Labour Participation Rate and Average Workload by Age Group for Both Sexes Combined, Canada 1981–2016
Source: Authors' calculations.

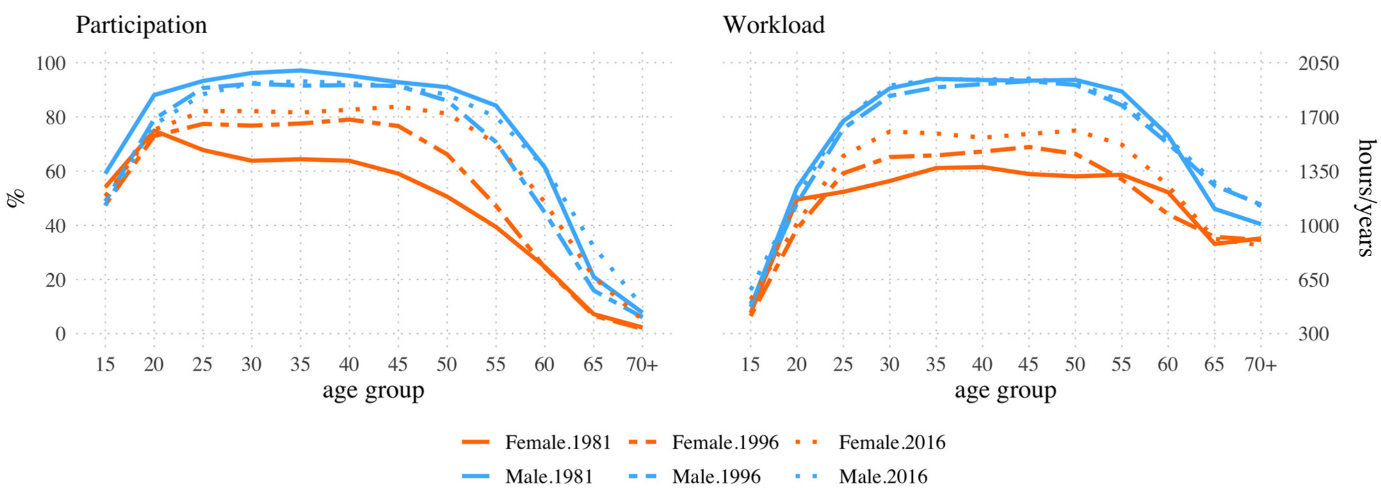

Figure 2: Labour Participation Rate and Average Workload by Age for Men and Women, Canada 1981–2016
Source: Authors' calculations.

The decrease in labour participation experienced during the 1990s could be the result of the recession that affected most of the Western world at that time. Despite this economic downturn, trends in participation have been quite linear over the years, whereas the trends in workload have followed a more agitated pattern, showing three distinct periods for all age groups. Between 1981 and 1990, workload has been relatively stable for mid-age adults while increasing slightly for young and older adults. During this period, workload averaged 1,235 hours for young adults, 1,699 hours for mid-age adults, and 1,454 hours for old adults. However, when the recession hit, it decreased remarkably for all age groups, with young and old adults being the most affected. After the recession, workloads increased rapidly, and by early 2000, the annual workload was about 1,423 hours for young adults, 1,829 hours for mid-age adults, and 1,587 hours for old adults. Since then, workloads have dropped noticeably for young and old adults while stagnating for mid-age adults. In 2016, workload was about 1,361.5 hours for young adults, 1,777.5 hours for mid-age adults, and 1,465.6 hours for old adults.

As can be seen from these results, individual behaviours have changed so much that not accounting for these changes in estimating individual or aggregate supply would lead to significant bias. Among others, three highlights arise from the changes in individual behaviours over the past four decades. First, although their labour participation remained about the same between 1981 and 2016, young adults have had the most significant increase in workload during that period—125 additional hours compared with 81 additional hours for mid-age adults and a decrease of 44 hours for old adults. Second, the labour participation of young adults was closer to that of mid-age adults than that of old adults. However, the opposite is true for their workload, which was closer to that of the old adults than the mid-age adults. These trends suggest that although schooling has remained their main activity, increased availability of part-time jobs has improved employability for young adults. Finally, although the labour participation rate increased among old adults by about the same number of percentage points as for mid-age adults, more and more old adults are opting for part-time jobs in retirement or pre-retirement years, leading to a decrease in average workload. Nevertheless, as Carrière and Galarneau (2011) point out, the decrease in average workload was insufficient to offset the more significant effect of labour participation, leading to an increase in aggregated labour supply.

As one could have expected, given the transformation of the labour market over the 1970s, both labour participation and workload have increased visibly only among mid-age adults, mainly as a result of the increased involvement of women in the labour market. Therefore, these trends may be hiding significant differences between sexes and by age, which we examine in the next section.

Participation and Workload by Age and Gender

Previous studies have described the tremendous change in women's involvement in the labour market over the past half-century quite well. However, the life cycle profile of these changes is less common in the literature. Figure 2 shows the labour participation rate and workload by age for a synthetic cohort in 1981 1996, and 2016 for men and women. The year 1996 is included here because it marked the end of the recession in the early 1990s, a period in which unemployment and early retirement were exceptionally high in Canada (Amirault and Lafleur 2000; Patrick 2001). Comparing the profiles, we can see that the age profile of participation and workload has changed quite differently for men and women.

For women aged 15–24 years, labour participation in 2016 was about the same as that in 1981. From age 25, however, participation in 2016 vastly surpassed 1981 levels, with the most significant gap (32.1 percentage points) observed for the 55–59-year age group. For instance, although 71.0 percent of women aged 55–59 years were in the labour market in 2016, only 38.9 percent were in the labour market in 1981. In 2016, the maximum participation rate was observed among those aged 45–49 years (83.6 percent), whereas in 1981, the maximum rate was among those aged 20–24 years (74.9 percent). It is also worth noting that before 1996, labour participation increased significantly among women aged younger than 45. Since 1996, however, the bulk of the increase has happened after ages 45–49. This is probably due to a cohort effect rather than an age effect. As a large cohort of women enters the labour market, it increases the participation rate of the following age groups as the cohort ages. Therefore, lower age groups that do not receive a similar inflow of new entrants will see a decrease in the participation rate.

Although the increase in participation among women was roughly linear throughout the studied period, the stagnation observed among men was less straightforward, as decreases in some periods and age groups absorbed increases from other periods and age groups. For instance, although labour participation among men decreased between 1981 and 2016, Figure 2 suggests that the decrease happened mainly before age 60. For instance, labour force participation in 2016 is lower than that in 1981 for men at all ages younger than 60, with the sharpest drop (12 percentage points) occurring at ages 15–19, from 59.2 percent in 1981 to 47.3 percent in 2016. However, from ages 60 and older, the trend reversed, and labour participation in 2016 increased significantly, reaching 31.9 percent from 19.1 percent for those aged 65–69. Compared with the profile in 1996, the increase in participation at older ages is much more significant and started much sooner. In fact, labour participation decreased for men of all ages between 1981 and 1996, and much of the decrease happened among those aged 45–49 and older. In 1996, however, labour participation began to increase from age 50, surpassing its levels in 1996 and 1981 for ages 55 and 65, respectively.

Interestingly, compared with 1981, the participation rate in 2016 decreased for those aged 15–19 years by about the same amount as it increased for those aged 65–69 years, suggesting that the increased schooling among young adults is being compensated by delayed retirement among old adults. Although such compensation may not have happened within actual cohorts, it is nevertheless relevant from an intergenerational perspective of time allocation. Also, the maximum labour force participation rate was reached in 2016 in the 40–44-year age group (92.9 percent). In 1981, however, it was reached in the 30–34-year age group (96.1 percent).

Not only has the age profile in participation among women changed between 1981 and 2016, but their age profile in workload has also increased steadily and significantly. Women's workload in 2016 vastly surpassed its level in 1981 for those aged 25–59, with the highest increase (365hours per year) occurring in the 50–54-year age group. However, a drop (146hours) occurred for those aged 20–24, and workload stagnated after age 60. The profile in 1996 shows a drop from age 55, which has been regained at age 60 in 2016, resulting in stagnation. The stagnation of workload is even more prolonged for men, resulting in about the same age profile in 1981, 1996, and 2016. However, the drop mainly occurred around age 55, whereas those aged 60 and older experienced an increase. These trends suggest that pre-retirement marked by a reduction in workload is happening earlier than before. At the same time, they confirm the pattern of delaying retirement suggested by the higher labour participation of those aged 60 and older. This pattern could also be observed in the workload profile for 1996, suggesting that no noticeable change in workload has happened since then.

Changes in the Gender Gap

Overall, participation and workload followed different patterns for men and women between 1981 and 2016. In general, trends were increasing for women and decreasing or stagnating for men. Nevertheless, men have had greater participation and workload than women at any given age and period, even though the gap has narrowed considerably. For example, in 1981, the gap in participation rates between adult (aged 35–54) men and women was 34 percentage points (94 percent − 60 percent). By 2016, it reduced to only 9 percentage points (91 percent − 82 percent). Although less dramatic, the change in the workload gap was also significant. From 588 hours in 1981 (1,936 − 1,348 hr), the gap in workload among men and women aged 35–54 decreased to 349 hours by 2016 (1,945 − 1,596hours).

These trends suggest that including workload on top of labour participation would add significant precision and thus is valuable for estimating labour supply and its changes over time. In the next section, we look at the trend in WLD, a measure of individual labour supply over the life cycle resulting from the interaction among mortality, participation, and workload.

Work Life Duration and Ratio

Trends in Work Life Duration and Ratio

WLD results from the interaction among mortality, participation, and workload (hours worked). Because participation and workload by age have been changing in parallel with mortality, the result of their interaction in the labour market is less obvious. Figure 3 presents trends in WLD and WLR between 1981 and 2016.

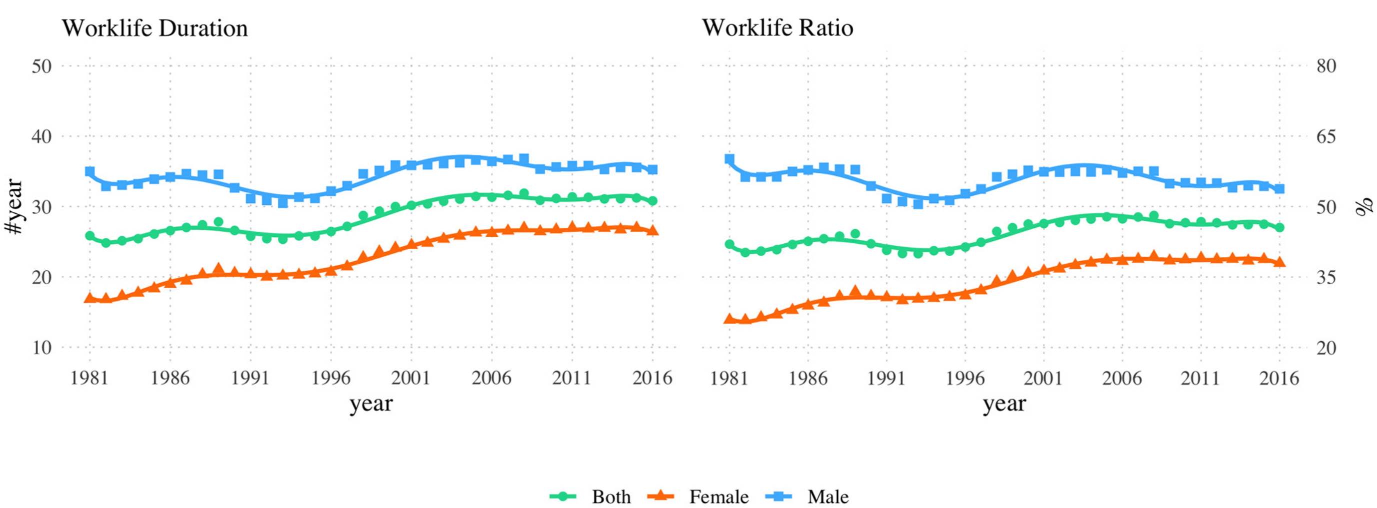

Figure 3: Trend in Work life Duration and Ratio at Age 15 Years for Men, Women, and Both Sexes, Canada 1981–2016
Source: Authors' calculations.

doi:10.3138/cpp.2022-048

Over the past four decades, WLD increased for women by 9.6 years, from 16.8 years in 1981 to 26.4 years in 2016. For men, WLD in 2016 just recovered about the same level in 1981, with only a 0.25-year increase. As a result, WLD for both sexes combined increased by 4.96 years, from 25.9 years in 1981 to 30.8 years in 2016. However, the changes were not monotonic throughout the period, and the trends highlight four sub-periods. First, the period between 1981 and 1988 saw a rapid change in WLD for women, from 16.8 to about 20.3 years, whereas it fluctuated slightly around 33.9 years for men. For the eight years that followed, WLD stagnated for women but decreased remarkably for men to about 31.2 years, the lowest throughout the entire period. During the decade 1996–2006, WLD increased for both sexes to reach 36.4 years for men and 26.2 years for women in 2006. Since then, WLD has stabilized for both sexes.

Although total WLD has increased over the past four decades, life expectancy has also increased. Therefore, how changes in WLD compare with life expectancy has been a source of much debate.

In 1981, men aged 15 years would expect to devote about 60.1 percent of their lives to paid work. By 2016, that proportion fell to about 53.8 percent, a decrease of 6.38 percentage points. Women on the other hand, have increased their WLR by 12.08 points, from 25.9 percent in 1981 to 37.9 percent in 2016. This increase, although very much related to the higher participation and workload, is partially due to a lesser gain in mortality for women. For instance, between 1981 and 2016, life expectancy at age 15 increased by 7.29 years for men (from 58.19 years to 65.48 years) but only 3.83 years for women (from 65.85 years to 69.68 years; HMD 2020). Therefore, despite a decreasing WLR among men, the increasing trend among women resulted in an increased total WLR of 3.55 points, from 42.0 percent to 45.5 percent. However, this overall improvement hides significant variations across ages, as shown in the next section.

Work Life Duration and Ratio by Age and Sex

Figure 4 compares WLD and WLR of a synthetic cohort in 1981 and 1996 to one in 2016 by age for men and women. Although WLD by age among men in 2016 was about the same as that in 1981, it has increased remarkably compared with 1996. For women at all ages of the life cycle, WLD increased steadily between 1981 and 2016. The only exception is for women aged 50 and older, for whom an increase is apparent only after 1996. Throughout the studied period, the highest increase (10 years) happened at ages 25–29, from 14 years in 1981 to 24 years in 2016. These patterns are also reflected in their WLR, because the changes in the labour market dominated those in life expectancy for both sexes.

Comparing WLR profiles for men in 1981 and 2016, it appears that the decrease happened mainly before age 60 years. From age 60, however, the WLR in 2016 surpassed that of 1981. For example, men aged 65–69 in 2016 could expect to work 3 percentage points more of their remaining lives than in 1981, because their WLR increased from 6 percent in 1981 to 9 percent in 2016. The trend suggests that the increase in WLD at age 65 between the two years was more significant than that in life expectancy. Also, this pattern appeared much sooner (at ages 45–49) in the life cycle if we compare WLR in 2016 and 1996. For women, the increase in WLR at age 15 resulted from an upward trend at all ages. However, the highest increase of 14 percentage points is observed among those aged 25–29 years, increasing from 28 percent in 1981 to 42 percent in 2016.

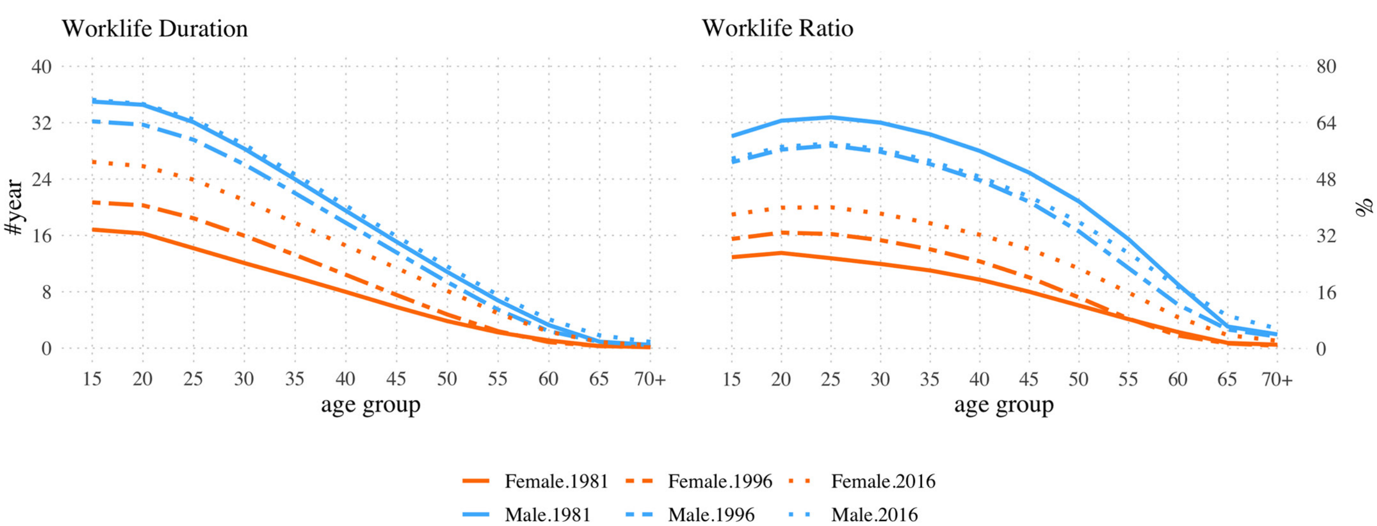

Figure 4: Work Life Duration and Ratio by Age for Men and Women, Canada 1981–2016
Source: Authors' calculations.

In summary, the decrease or stagnation among men was primarily due to young and mid-age adults. In contrast, there was a noticeable increase among older men and women at all ages of the life cycle. As a result, between 1981 and 2016 total WLD has increased by 4.96 years and WLR has increase by 3.55 percentage points. These results suggest that increased engagement in the labour market among women and old adults has compensated for the decrease among men and young adults. However, these changes have also compensated for improved mortality, contrary to what is often believed.

Furthermore, although women have historically had a higher life expectancy, men have had a higher WLD and ratio because of their higher labour participation and workload. However, as trends in WLD and WLR increased for women but stagnated or decreased for men, the gap between men and women decreased considerably over the past four decades. The gap in WLD at age 15 in favour of men decreased from 18.17 years in 1981 to 8.81 years in 2016, and the gap in WLR decreased from 34.28 percentage points in 1981 to only 15.82 percentage points in 2016.

Importance of Including Hours Worked

In previous sections, we emphasized the need to include working hours in estimating the labour supply. Although this inclusion is reasonable in principle, we have yet to compare empirical results with and without workload. Figure 5 describes the trends in WLD and the associated WLR with and without the workload.

Looking at the trend in WLD with and without workload, three observations stand out. First, not including workload results in higher estimates in WLD and WLR. For example, WLD in 2016 would be 42.0 (instead of 35.2) for men and 38.0 (instead of 26.4) for women. Although slightly higher, these results are comparable with those from other countries that rely on similar methods. For instance, recent reports from Eurostat (2019) show that the expected duration of working life in the European Union (EU) in 2016 was 35.7 years (compared with 40 years in Canada) for both sexes. In 2018, the expected average duration of working life among the EU member states ranged from 31.8 years in Italy to 41.9 years in Sweden.

Second, by assuming that men and women work about the same number of hours, the gap between men and women is reduced considerably. For instance, the gap in WLD for 2016 is reduced to less than half, with 3.9 years, if hours are excluded, instead of 8.81 years, if hours are included. In Europe, excluding working hours results in a five-year gap (EuroStat 2020) for the same year, with men at 38.1 years (42.0 years in Canada), and women at 33.1 years (38.0 in Canada).

Third, including workload affects not only the values of WLD and WLR but also their trends. For instance, with and without workload, trends were similar in the 1980s. Slowly, however, they diverge from each other, especially since 2004 for men, leading to significantly different levels of WLD as workload variability increases.

Although workload in Canada has increased over the past four decades, the trends suggest that workload is likely to decrease in the following decades or stagnate at best as a result of an increasing proportion of part-time workers. A decreasing workload is mainly expected as a result of young adults still in school and old adults in or near retirement. However, it could also come from prime-age workers, for whom reducing working hours is becoming a lifestyle. As the proportion of part-timers increases, so too will the bias of WLD based solely on participation. Therefore, not accounting for working hours will increase bias in labour supply estimates and

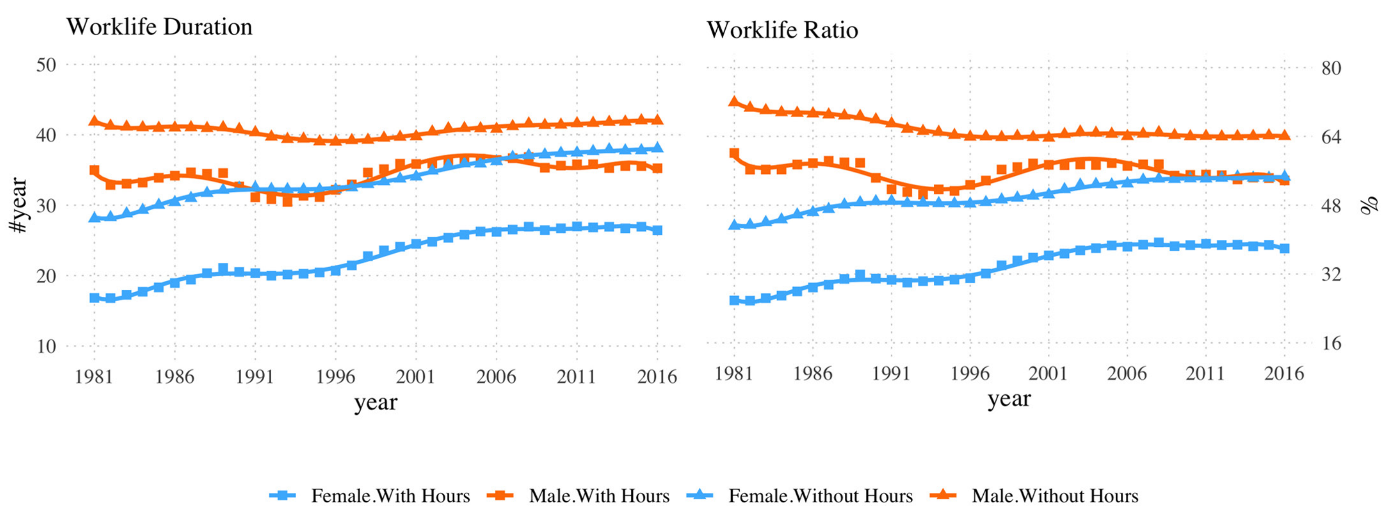

Figure 5: Trends in Work Life Duration With and Without Workload, Canada 1981–2016

Source: Authors' calculations.

doi:10.3138/cpp.2022-048

gender and intergenerational differences. Workloads have at least had a mitigating effect on the labour supply, as we show in greater detail in the next section, where we analyze the contributions of mortality, participation, and workload to the changes in WLD over the past four decades.

Components of Increased Work Life Duration

Figure 6 shows the results of decomposing the total change in WLD into contributions made by each age-specific component of life expectancy (mortality), labour participation (participation), and workload (hours worked). Overall, between 1981 and 2016, WLD increased by 4.96 years, whereas its ratio to life expectancy increased by 3.55 percentage points. Participation has been the main driver of these changes, contributing 3.57 years compared with 0.73 and 0.65 years for workload and mortality, respectively. From an age perspective, contributions (all components and both sexes combined) come mainly from adults aged 35–54 years followed by adults aged 55 years and older (2.51 years and 1.68 years, respectively, with only 0.77 year from those aged 15–34 years).

Looking at contributions to WLD by each component for men and women, it appears that mortality improvements have benefited men at all ages, contributing 1.25 years to their additional WLD. This positive contribution, however, was just enough to compensate for the downward effect of their participation (−0.75 year) and workload (−0.25 year). As a result, WLD among men increased only by 0.25 year in four decades. Compared with men, women have benefited much less from mortality improvement. For this reason, mortality contributed almost nothing to the 9.6 years of change in their WLD, whereas participation has been by far the most significant contributor, with 6.72 years compared with 2.64 years for workload.

Perhaps an easier way of seeing component contributions and how much behavioural components compensated for mortality improvement would be to switch the placement of components and the age groups. In Figure 7, the bars are re-arranged so that each reports the total contribution for a given age group split by components. A new bar (titled Total) is added to report the total contribution for all age groups split by components. Although the information presented remains the same, some results may stand out more clearly. For example, it may be more straightforward to see that contributions from all components almost cancelled each other out for men, participation made the major contribution for

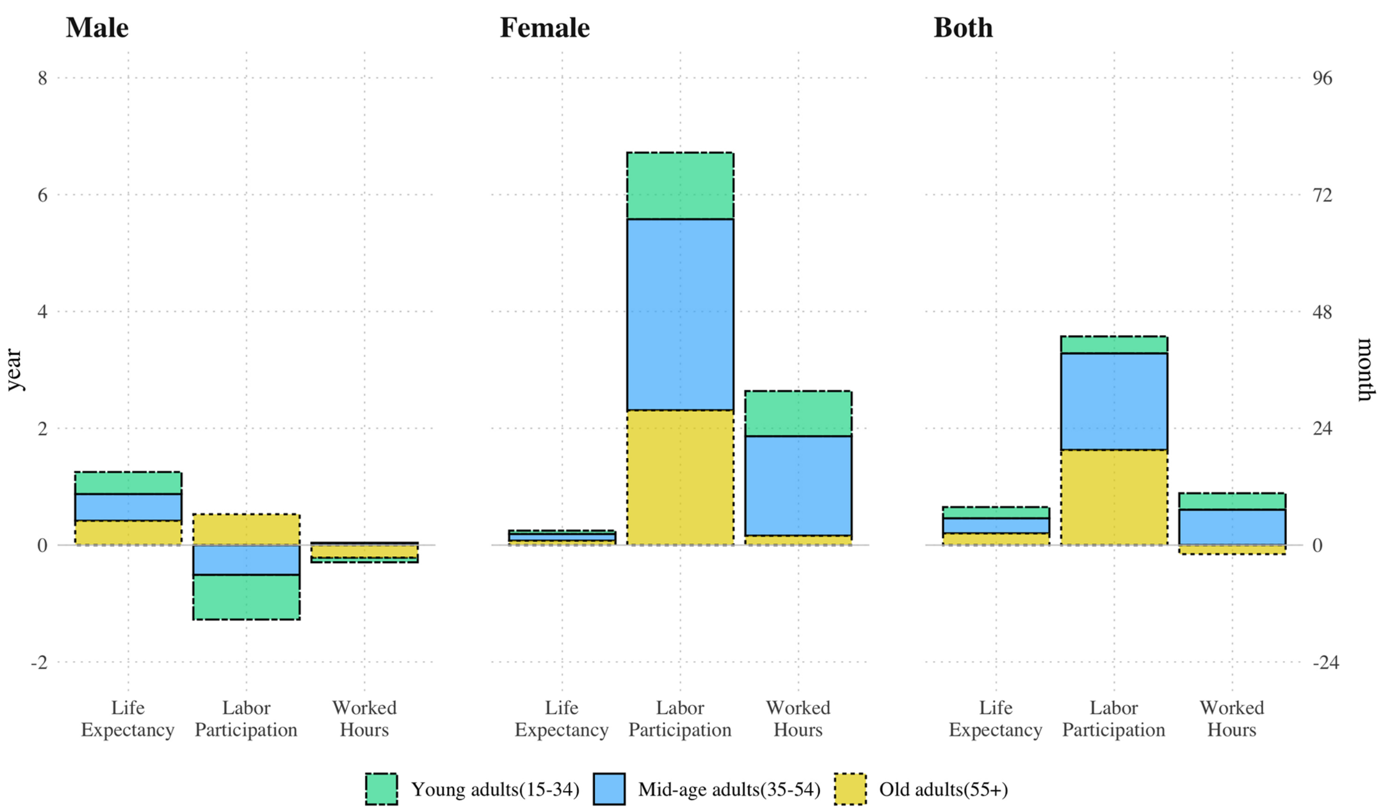

Figure 6: Number of Years Contributed by Components to Changes in Work Life Duration by Sex, Canada 1981–2016
Source: Authors' calculations.

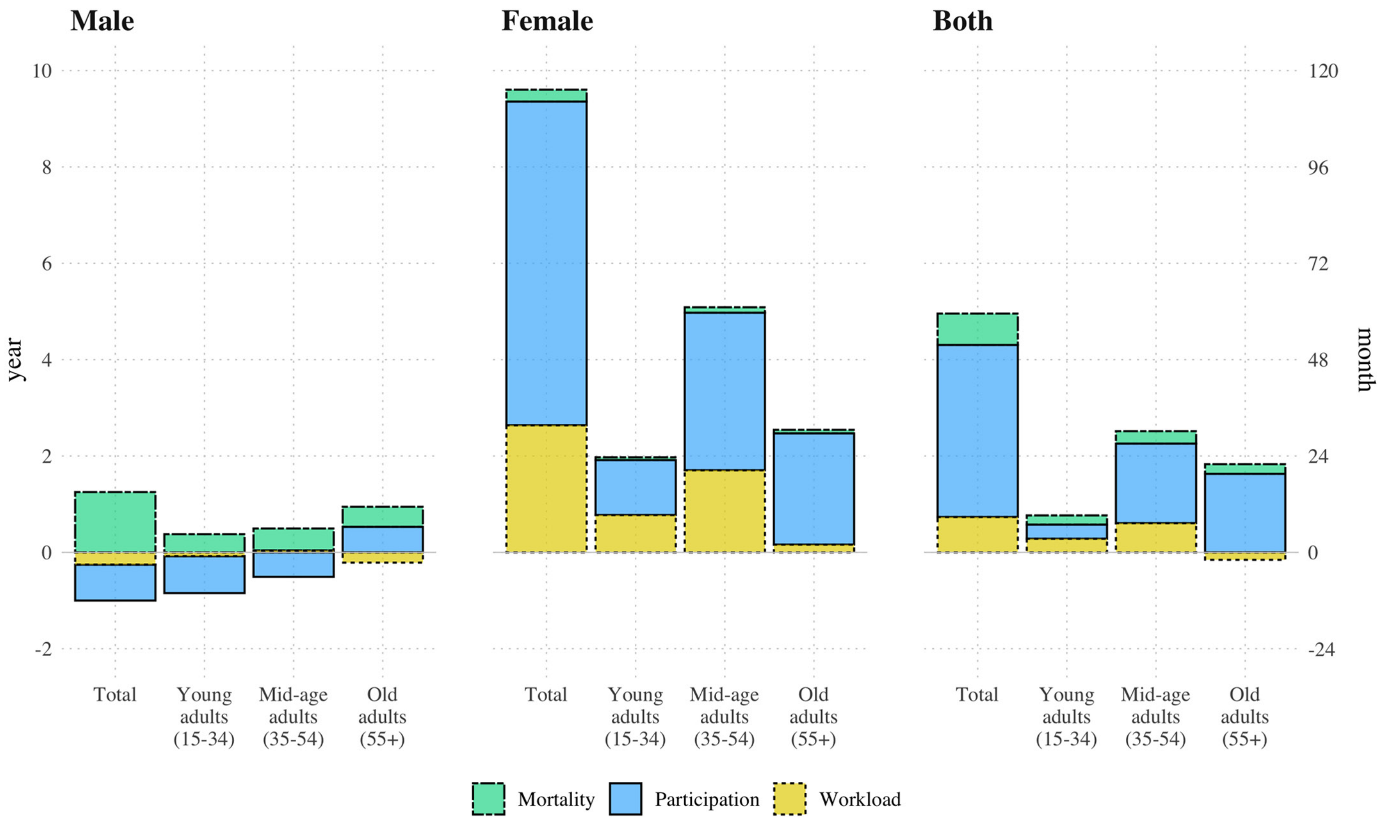

Figure 7: Number of Years Contributed by Components to Changes in Work Life Duration by Sex, Canada 1981–2016
Source: Authors' calculations.

women and both sexes, and mortality contributed almost nothing for women.

As we discussed earlier, the change in WLD did not happen steadily or incrementally but rather through successive sub-periods of increases and decreases. Table 1 and Table 2 split the total change between 1981 and 2016 into sub-periods of 5 years. Looking at the sub-periods, it appears that during the first two periods, WLD decreased for men by about the same amount as it increased for women, resulting in stagnation in WLD for both sexes. In other words, WLD stagnated between 1981 and 1990, as improvements in mortality and participation were entirely offset by degradation in workload. For men, about half of the decrease happened among young adults. The other half is split equally among mid-age adults and old adults. For women, the increase mainly happened among the adult population. These results suggest a structural change in the labour supply: young adults (mainly men) withdrew from the labour market to pursue higher educational attainment, and a more significant engagement among adult women compensated for the hole created.

Building on the increases in human capital investment and women's participation over the decade 1981-1990, the following three periods (1991–2005) show a significant increase in WLD for both sexes. On the one hand, the increase more than overwrote the decrease in the previous decade for men. On the other hand, about two-thirds of their total increase in WLD happened during those 15 years for women. Interestingly, the three age groups contributed about the same toward the increase, suggesting that the 15-year period has seen a society-wide change or a macroeconomic transformation that affects all generations and sexes equally. In particular, the period 1996–2000 appears to be a turning point at which WLD increased the most and about the same amount for both sexes. The increase during these five years accounts for about 3.7 years, most of which comes from workload (about 2.8 years) out of the 4.96-year increase for the entire studied period.

These results illustrate the booming economy of the late 1990s as opposed to the early 1990s. Compared with 1992, the gross domestic product increased by 20 percent in 1998, whereas the population increased by only 6.6 percent. Furthermore, the unemployment rate, which had reached 11 percent in 1992, fell to less than 7 percent in 2000, its lowest level in more than 25 years (Amirault and Lafleur 2000). This decrease is partially due to incentives for early retirement put in place by employers, both public and private, in the 1990s (Maxime, Simon, and Lu 2009). Such incentives have increased the proportion of

Table 1: Increase in Work Life Duration by Age Group and Period for Men, Women, and Both Sexes, Canada 1981–2016

	Young Adults (Aged 15–34 y)			Mid-Age Adults (Aged 35–54 y)			Old Adults (Aged ≥55 y)			Total		
Period	B	F	M	B	F	M	B	F	M	B	F	M
1981–1985	0.3	0.8	−0.3	0.8	1.4	0.1	−0.4	−0.1	−0.7	0.7	2.1	−0.9
1986–1990	−0.8	−0.1	−1.6	0.1	1.3	−1.0	−0.1	0.2	−0.5	−0.8	1.4	−3.1
1991–1995	0.5	0.0	0.9	0.2	0.4	0.1	0.0	0.0	0.0	0.7	0.4	1.0
1996–2000	1.7	1.6	1.7	1.4	1.5	1.3	0.6	0.7	0.6	3.7	3.8	3.6
2001–2005	0.0	0.1	−0.1	0.3	0.7	−0.1	0.8	0.8	0.8	1.1	1.6	0.6
2006–2010	−0.5	−0.2	−0.7	−0.1	0.2	−0.3	0.6	0.8	0.5	0.0	0.8	−0.5
2011–2016	−0.4	−0.4	−0.4	−0.3	−0.4	−0.2	0.1	0.2	0.1	−0.6	−0.6	−0.5
Total	0.8	1.8	−0.5	2.4	5.1	−0.1	1.6	2.6	0.8	4.8	9.5	0.2

Notes: Contributions are in year. B = both sexes, F = female, M = male.
Source: Authors' calculations.

Table 2: Increase in Work Life Duration by Component and Period for Men, Women, and Both Sexes, Canada 1981–2016

	Mortality			Participation			Workload			Total		
Period	B	F	M	B	F	M	B	F	M	B	F	M
1981–1985	0.2	0.1	0.3	0.5	1.5	−0.9	0.1	0.5	−0.2	0.8	2.1	−0.8
1986–1990	0.1	0.0	0.2	0.5	1.4	−0.7	−1.4	−0.1	−2.5	−0.8	1.3	−3.0
1991–1995	0.1	0.0	0.2	−0.4	0.0	−1.0	1.0	0.3	1.9	0.7	0.3	1.1
1996–2000	0.1	0.0	0.3	0.8	1.2	0.3	2.8	2.6	3.1	3.7	3.8	3.7
2001–2005	0.1	0.0	0.2	1.1	1.4	0.7	−0.1	0.3	−0.3	1.1	1.7	0.6
2006–2010	0.1	0.0	0.2	0.6	0.8	0.4	−0.7	−0.1	−1.2	0.0	0.7	−0.6
2011–2016	0.0	0.0	0.0	0.4	0.4	0.3	−0.9	−0.9	−0.9	−0.5	−0.5	−0.6
Total	0.7	0.1	1.4	3.5	6.7	−0.9	0.8	2.6	−0.1	5.0	9.4	0.4

Notes: Contributions are in year. B = both sexes; F = female; M = male.
Source: Authors' calculations.

retirement before age 60 to 48 percent of all retirements during 1997–2000 from 28 percent during 1987–1990 (Patrick 2001).

During 2006–2010, WLD stagnated, as the increase for women absorbed a reverse effect among men. Also, WLD increased for the older population, just enough to overwrite the decrease among young adults and mid-age adults. In contrast, negative contributions from workloads cancel out positive ones from mortality and participation altogether. The decrease continued through the last five years for both sexes, as a slight increase among the older population could not offset the decrease among young adults and adults.

Overall, not only are Canadians working longer than before but they are also spending a higher proportion of their increased longevity in the labour market. Moreover, although increased longevity has had a lower effect on WLD than behavioural factors, this effect is positive. Therefore, increasing life expectancy, a driver of population aging, has contributed to expanding the working life span in Canada. Of course, population aging goes beyond increasing life expectancy at the collective level. However, the distinctive effect at the individual level brings essential nuances to the ongoing debate on increasing the retirement age in Canada. Next, we discuss the findings and some of their implications for public policy in Canada.

Discussion

As population aging progresses, so too do concerns about financial pressure on public health care and pension systems. These concerns arise partly from assuming that added years of life are predominantly spent in retirement, collecting a pension but not contributing to government revenues. This study analyzes the levels of WLD and the contributions from changes in life expectancy and individual behaviours during the past four decades in Canada. The results show that not only did WLD increase between 1981 and 2016, but its ratio to life expectancy also increased. Between 1981 and 2016, WLD increased by 4.96 years, and its ratio to life expectancy increased by 3.55 percentage points. In other words, adjustments in individual behaviours have balanced time allocation between men and women, resulting in an overall positive effect on WLD. However, how these results predict future trends and fit in the ongoing debate to increase the retirement age in Canada remains a question.

Trends over the past four decades suggest that men and women have reached a stable balance in time allocation that only a major social or economic shock could break. Therefore, WLD for the next few decades will be driven by trends in mortality,[4] especially at older ages, where close to 100 percent of the improvement will be happening (Eggleston and Fuchs 2012).

This by no means implies that individual behaviours will play no role in future development. It does mean that increased longevity will provide a natural and default room for participation and workload to expand at older ages. Of course, individual behaviours respond to various factors that are hardly predictable. For example, financial readiness affects the decision to either retire or, for those who are already retired, to return to work (Bélanger, Carrière, and Sabourin 2016). Nevertheless, patterns over the past four decades, especially for older men for whom the improvement in WLD is shared evenly between behavioural and demographic components (Figure 7), suggest that individual behaviours adjust proportionately to the increase in life expectancy. Although past performance may not continue, we see no reason to suggest that these automatic adjustments would stop.

Alternatively, WLD could increase after an economic boom that induces greater engagement in the labour market. Labour shortage could, to some extent, be a trigger in two ways. First, it would allow salaries to rise (if only temporarily), motivating more people to enter the labour market while providing better prospects for recent immigrants. Second, and most important, it would induce companies to use their current workforce more effectively while reducing underemployment. It is also possible for WLD to decrease in the next few decades because of increased automation. This scenario is, however, the least probable because automation usually creates at least as many jobs as it eliminates (Dixon, Hong, and Wu 2021; Nikitas, Vitel, and Cotet 2021).

This study provides a novel estimate of WLD for which population aging has made a positive contribution over the past few decades in Canada. Nevertheless, it has left some questions unanswered. First, there is no definite answer as to how far in time automatic adjustment of personal behaviours will be enough to maintain a stable WLD-to-life-expectancy ratio, as has been the case over the past four decades. Second, although population aging is reduced to increasing life expectancy at the individual level, it encompasses the interactions among fertility, mortality, and immigration at the aggregated level. Therefore, it is essential for those involved in policy debates related to population aging to understand how aggregated labour supply responds simultaneously to demographic and behavioural factors.

Future research will also need to compensate for some of the limitations of the work presented in this article. First, the study only accounts for age and sex differences in mortality, participation, and workload. However, differences in demographic and behavioural components go beyond these factors. They include, for example, education, marital status, job type and migration, variables that could have provided more insight into work life differentials. Second, the study relies on cross-sectional data and thus suffers from the same shortcomings as studies that estimate period life tables. This implies that no actual cohort has experienced the series of mortality, labour participation, and workload that went into estimating WLD. As a result, the WLDs estimated in this study pertain to synthetic cohorts rather than actual ones.

Another limitation relates to the cyclical nature of labour market data, especially workloads, which is reflected in the estimates of WLD and could lead to bias when comparing two years. For example, many indicators, including WLD for men, appear to have stagnated between 1981 and 2016, but they have in fact increased from relatively low levels during the recession of the 1990s. Still, just as period life tables provide valuable insights into mortality trends, WLD estimated in this article provides essential elements for consideration when debating policy options in the context of longer life and population aging.

Conclusion

This article contributes to the ongoing debate on the effect of population aging on the labour supply by accounting for age- and sex-specific mortality, participation, and working hours in estimating WLD and its ratio to life expectancy. Results show that not only has WLD increased by 4.96 years but its ratio to life expectancy also increased by 3.55 percentage points. Labour participation has been the main driver of these changes, contributing 3.57 years compared with 0.73 and 0.65 years for worked hours and mortality, respectively. Most of the changes come from women, who contributed 9.6 years compared with 0.25 year for men. However, longer life expectancy has had a positive effect on WLD among men, contributing 1.25 years to their additional WLD compared with only 0.25 year for women.

In summary, Canadians have worked long enough to cover their increased longevity, and this trend will likely persist for the next few decades. Therefore, a policy to increase the normal retirement age on the basis of shrinking WLD appears neither necessary nor urgent. Furthermore, such a policy could be unfair for two reasons. On the one hand, life expectancy did not increase equally for all income groups. On the other hand, added years of life are not entirely healthy years during which individuals can work. What would be needed are policies that promote, support, and enhance existing trends in living and working longer. Also, the narrative behind these policies should focus less on the change in the relative size of age groups. Instead, monitoring the changes in measures of WLD similar to the one proposed in this article would provide a better base for policy discussion on population aging. Thus, raising the retirement age may still be an option, provided its potential benefits are widely discussed and accepted.

Notes

1 Perhaps as a result of a difference in methodology or study period, Lefebvre et al. (2012) found an increase of only two years from 1994 to 2007.

2 *Prime-age adults* refers to those well past school age but still far from retirement. Some studies equate this group with those aged 35–54 years, and others use those aged 25–54 years.

3 Although reasonable, converting one year into 2,000 hours is arbitrary, and a different choice would result in a different WLD. Nevertheless, this does not affect the trends and relative changes in WLD as well as in derived policy and social implications.

4 The United Nations projects an annual increase in life expectancy of about 0.18 percent until 2030 and 0.13 percent afterward. Details can be found at Macrotrends (n.d.).

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