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An economic analysis of proposals to improve coverage of longevity risk *

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Abstract

We use simulation methods to analyze the impacts of certain proposed reforms to improve the coverage of longevity risk. This risk, which may in principle be adequately covered by classic defined-benefit pension plans, has been of particular interest in Quebec for some years now, notably due to the decline in the participation to such plans. Recent proposals which aim to increase the coverage of longevity risk mostly deal with expansion of the "2nd pillar" of the retirement income system, currently comprised of the Quebec Pension Plan. We therefore consider a key proposal of the D'Amours committee (the longevity pension), in addition to two other proposals: that of Mintz and Wilson, which aims to increase the generosity of the current regime, and that of Wolfson, which introduces a concept of contribution and benefit rates differentiated by income. Using data from Statistics Canada surveys, we analyze the internal rate of return (IRR) of these proposals for various types of individuals taking into consideration inequality in life expectancy, temporal variability of income, and interactions with taxation and the different retirement income support programs. We contrast the results with those obtained when opting instead for additional contributions into existing voluntary savings vehicles combined with a basic annuity purchased at retirement.

Keywords: longevity risk, retirement savings, inequality, life expectancy.
JEL Codes: I14, J18, J26, J32.

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1 Introduction

With the aging of the population and the expected increase in life expectancy, management of longevity risk by households will become an increasingly important matter. Although at least since Yaari (1965), economists generally agree that annuitization of wealth at retirement offers the best protection against longevity risk, an important condition of this superiority is that the implicit price of the annuity bought in this way translates into an actuarially adequate return at the individual level. Satisfying this condition depends on, inter alia, the mortality risk of the individual as well as the net payments he will receive. The declining coverage of defined benefit supplemental pension plans, combined with the limited generosity of public retirement programs for individuals in the second income tercile only emphasize the need to review protection against this risk. In this article, we aim to quantify the implicit return – or internal return – of proposals recently put forward to increase protection against longevity risk. In order to effectively gauge the scale of individual heterogeneity of returns, we account for inequality in mortality risk by level of education (and thus, implicitly, by expected income) as well as interactions which the proposed reforms have with i) existing retirement income support programs, and ii) other retirement income that individuals would obtain in a no-reform world.

It is well known that mortality is associated with individual income and level of education. In Canada, for example, Adam (2012) demonstrates not only that mortality rates among QPP and CCP recipients vary with income, but also that the improvement in mortality seems to be fastest among the wealthiest. Since QPP/CPP contribution rates do not vary with income (except with respect to the maximum pensionable earnings), it is possible that the pension they procure offers an implicitly lower return to individuals with a higher than average mortality risk.

Additionally, the reform proposals we analyze – as well as several others formulated in recent years – may yield lower returns for lower income households, who qualify for the federal Guaranteed Income Supplement (GIS) and would see their benefits reduced due to the implementation of these reforms. Evaluation of the implicit returns of new modalities of contributions and benefits should therefore account for their total effect on an individual's post-retirement income net of taxes and transfers (or disposable income, according to the Statistics Canada terminology), and not only for the effect of these new modalities on their own.

It is in this context that we consider here three proposals of reform of public programs to improve the coverage of longevity risk. To start with, we address the proposal of the Expert Committee on the Future of the Québec Retirement System, presided by Alban D'Amours, which consists of introducing a "longevity pension" similar to an increase in the benefit of the Quebec Pension Plan (QPP) after the age of 75 years (D'Amours et al., 2013). This pension would be financed by additional contributions from workers and employers and would replace a maximum of 28.5% of earnings starting at age 75. A second proposal consists of increasing the generosity of the current regime, a proposal made by Jack Mintz of the University of Calgary and Thomas Wilson of the University of Toronto (Mintz and Wilson, 2013). This proposal aims to increase the replacement rate of the current QPP (and of the Canada Pension Plan, CPP) to 35% instead of 25%. Finally, another proposal, by Michael Wolfson of the University of Ottawa, does away with the principle of a uniform contribution rate by linking the contribution rate to income, while doubling the ceiling of pensionable earnings to $105,000 from the 2014 level of $52,500 (Wolfson, 2013).

In order to obtain comparable alternatives based on existing individual savings vehicles, we also consider two simple possibilities of voluntary savings accruals, with specified parameters and savings vehicles. Thus, we first model an alternative scenario using a Voluntary Retirement Savings Plan (VRSP), a vehicle recently created in Quebec and similar to the Registered Retirement Savings Plan (RRSP); and second, we use the Tax-Free Savings Account, or TFSA. We model an additional contribution made by all workers into each of these vehicles, and assume that the amounts are invested in long-term Canadian bonds. In these scenarios, individuals buy an annuity on private markets upon retirement, using the entire amount of capital accumulated in their VRSP or TFSA.

Section 2 of the article presents the structure of the modelling. Section 3 presents the different scenarios considered. Section 4 quantifies the returns of the proposals considered for households with different characteristics, both in terms of income replacement rate and of internal return, and presents some counterfactual analyses. Section 5 concludes.

2 Modelling

2.1 The agents

We consider a worker starting his career in 2011 at the age of 25 years. This salaried worker may, at the beginning of his career, have a variable level of education and initial income (i.e. income at age 25). We construct representative cases of 54 types of workers, defined by 3 levels of education $e \in E$ and 18 levels of initial income $Y_{25} \in \$5,000, \ldots, \ \$175,000$ (the mid-points of 18 income brackets of \$10,000 each). These two sources of heterogeneity allow us to account for two dimensions of differential mortality and for possible interactions between proposed new modalities and existing programs. To simplify the analysis and the presentation of results, the worker is assumed to be single and without children for his entire life.

2.2 Labour income

We use the wage structure proposed by Gourinchas and Parker (2002). The labour income model assumes that annual earnings are given by:

$$Y_{e,t} = Y_{25} G_{e,t} P_{e,t} U_{e,t}, \quad t > 25 \tag{1}$$

where Y_{25} is initial labour income, $G_{e,t}$ is a component of earnings that depends on age, t, and level of education, e (with $G_{e,25} = 1$), $U_{e,t}$ is a transitory shock with $\log U_{e,t} \sim N(0, \sigma^2_{u,e})$, and $P_{e,t}$ (with $P_{e,25} = 1$) is a permanent shock which follows

$$\log P_{e,t} = \rho_e \log P_{e,t-1} + \epsilon_{e,t}, \quad t > 25, \tag{2}$$

where $\epsilon_{e,t} \sim N(0, \sigma^2_{\epsilon,e})$. The agent retires at 65 years of age, after having worked for 40 years with no interruption. These processes are estimated separately by level of education for respondents to cycles 2 through 5 of Statistics Canada's Survey of Labour and Income Dynamics (SLID). Annex A presents details on the estimation method as well as the main results. The results show that earnings have an inverse-U shape over the life cycle, reaching a maximum at about 55 years. Income growth is much stronger among individuals with a university degree. As for estimation of the error term's structure, we find that ρ_e declines when education increases, which suggests that the incomes of the most educated individuals depend less on their past situation. The estimated variance of the transitory shock also decreases with education level, while that of the permanent shock increases with level of education.

We use these estimated parameters to simulate 100 times the dynamic pathway of labour income (between 25 and 64 years) for each of the 54 initial income-education grouping. We then use the average of the 100 simulations for each grouping to determine income for each of our representative cases.

2.3 Mortality

There are no existing prospective mortality tables by level of income or education. In order to obtain mortality rates by level of education for an individual aged 25 years in 2011, we combine the forecasts for aggregated mortality rates and the current differences in mortality rates by level of education. This method was used by French (2005). It assumes, however, that the current mortality gaps between individuals with different education levels will be maintained in the future, which is not necessarily the case.

We start by using the 2009 mortality table of the Institut de la statistique du Québec (ISQ). We denote death between age t and age $t+1$ as M_{t+1}, and so the probability of death is given by $\Pr(M_{t+1} = 1|t)$.

We then calculate $\Pr(M_{t+1} = 1|E = e, t)$, using the fact that

$$\Pr(M_{t+1} = 1|E = e, t) = \frac{\Pr(E = e|M_{t+1} = 1, t)}{\Pr(E = e|t)} \Pr(M_{t+1} = 1|t). \tag{3}$$

We estimate $\Pr(E = e|M_{t+1} = 1, t)$ and $\Pr(E = e|t)$ using the National Population Health Survey (NPHS), cycles 1994-2010, to then calculate $\Pr(M_{t+1} = 1|E = e, t)$. Annex B gives details on the application of this method as well as the results. We estimate that the mortality gaps are higher before the age of 65 and decrease after 65 years. One of the likely reasons is a dynamic selection effect: individuals surviving up to 65 years who belong to the group with a structurally higher risk of mortality probably have some unobservable characteristics which reduce their individual probability of death to below the average of that group of individuals with structurally lower mortality risk. Estimated life expectancy at birth varies from 78.3 to 84.6 years, depending on level of education and conditional on having survived to 25 years (since this is the age of our agents at the beginning of the simulations).

3 The scenarios

In order to analyze the different reform proposals, we start by constructing a reference scenario which should represent the retirement system faced by our representative agents in 2011. An alternative scenario is then constructed for each of three reform proposals considered, and these results are compared to those of the reference scenario in order to evaluate the impacts. We thus model the longevity pension proposed by the D'Amours committee (D'Amours et al., 2013), due to its originality; a simplified version of the proposed enlargement of the QPP/CPP formulated by Mintz and Wilson (2013), which consists mostly of an increase in the replacement rate; and the proposal put forward by Wolfson (2013), consisting of doubling the income ceiling insured by QPP/CPP, and introducing income-variant contribution and payout rates.

It is worth noting that a good number of other reform proposals have been formulated in recent years, notably aiming to enlarge the QPP/CCP, in particular since the 2008 financial crisis (see, for example, Milligan and Schirle, 2014). We have chosen these three proposals because in our opinion they constitute a pertinent and representative sample of existing proposals, in addition to differing substantially in their spirit and their parameters.

3.1 Reference scenario

The reference scenario accounts for the specifics of the Quebec tax system and retirement system. The first pillar of the retirement system is the Old Age Security (OAS) benefit and the Guaranteed Income Supplement (GIS), two federal programs. The second pillar is comprised of the Quebec Pension Plan (QPP) payments. The third pillar is composed of supplemental pension plans and of private savings, whether registered or not.

Benefits from public programs (pillars 1 and 2) as well as the taxation function presented below are calculated using SimTax, a tax calculator (pertinent details provided in annex D).

3.1.1 Old Age Security

The OAS benefit is given by B_{PV}. For all Canadian citizens residing in the country for at least 40 years since their 18th birthday (which is assumed to be the case for the individuals in our simulation), this taxable benefit was \$6,368 in 2011. Tax recovery applies at a 15% rate for income above \$67,700 after deductions (but including the OAS).

3.1.2 Guaranteed Income Supplement

The GIS benefit is given by B_{GIS}. In 2011, the basic payment was \$8,039 for a single person (the calculation is different for couples) and it declines at a 50% rate as other income increases, except for the OAS and a \$3,500 exemption for labour income. Since 2011, the GIS also includes an additional \$600 for individuals with very low income, which is reduced at a 20% rate starting at a total income of \$2,000, excluding the OAS. All of these parameters are accounted for in SimTax.

3.1.3 QPP contributions

Contributions to the Quebec Pension Plan (QPP) are given by S_{QPP}. In 2011, they amount to 9.90% of pensionable earnings, i.e. those between the general exemption of $3,500 and the maximum pensionable earnings (MPE) $48,500. This rate is shared half and half (4.95% each) by employer and employee.[1] The contributions are net, i.e., we deduct the non-refundable federal tax credit linked to it.

3.1.4 QPP retirement benefits

QPP retirement income is a function of the average pensionable earnings, APE_t. They are also a function of age at the beginning of payments, but since all agents retire at 65 years, the "normal age", this parameter has no impact. We denote the benefit as B_{QPP}.

3.1.5 Market income in retirement: benefits from supplemental pension plans and income from personal savings

Individuals may receive private retirement income, for example from a supplemental defined benefit (DB) or defined contribution (DC) pension plan, or from individual or group Registered Retirement Savings Plans (RRSPs) or unregistered individual savings. Tax-free savings accounts, with their own tax treatment, are not modeled in the reference scenario. These sources of income are denoted together as B_{PP}, and depend in particular on the final employment income before retirement, Y_{64}. They are estimated at an aggregate level (i.e. together), using the method described in annex C.

[1] The question of whether a share of the employer's contribution may actually be passed on to employees in the form of lower wages is not relevant here, as opposed to the alternative scenarios shown below, since in this case it is the same as in the reference scenario to which the others are added. As such, we only consider the contributions effectively paid by the employee.

3.1.6 Taxation of labour and retirement income

“Net income" (or disposable income) is given by

$$H_t = \tau(\max(Y_t, (B_{PV} + B_{QPP} + B_{PP}))) + B_{GIS} - S_{QPP}. \quad (4)$$

The function $\tau()$ accounts for taxation rates and the structure of provincial and federal taxes on income as well as related contributions, such as the health contribution (see annex D, details on SimTax). It only applies to Y_t or to all other types of taxable income together, and never on the two groups of taxable income at the same time, since retirement is defined as a complete stoppage of employment. We therefore also assume that workers do not receive any retirement benefit.

3.2 Alternative scenario 1: Add a longevity pension

In this scenario, we model the introduction of a longevity pension payable starting at 75 years, according to the modalities envisaged by the D'Amours committee (D'Amours et al., 2013). This longevity pension is additional to the existing structure described in the reference scenario.

We therefore assume a contribution rate of 3.3% up to a ceiling (the MPE). This rate is shared half and half between employer and employee, such that for tax purposes the agent pays a rate of 1.65%. For simplicity, a non-refundable tax credit is linked to this contribution, following the same modalities as for the QPP contributions. This is the main difference with the program proposed by the D'Amours committee, which instead recommends a tax deduction, which is potentially better for the worker. The net contribution is denoted as S_{RL} and is subtracted from disposable income.

We consider that the employer contribution is partially passed on to workers through lower wages. Following Roy-Cesar and Vaillancourt (2010), we assume that half of the employer contribution is passed on to workers. Thus, the worker's total contribution amounts to 1.65%∗1.5, or 2.475% of earnings. However, only the "direct contribution" of the employee is accounted for in the calculation of the non-refundable tax credit. These same assumptions are also made with regard to the other reform proposals of the "2^{nd} pillar".

The benefit is a function of the same base used to determine the QPP benefit, APE_t. The replacement rate, however, depends on the number of contribution years. It is 0.5% per year of contribution, which comes to 20% for our simulations, in which the agents work for 40 years. The benefit is denoted as B_{RL} and is added to disposable income (and thus appears within the $\tau()$ function above).

3.3 Alternative scenario 2: QPP enlargement (Mintz-Wilson proposal)

For many reasons, Mintz and Wilson (2013) propose a simple and modest increase in the income replacement rate offered by the QPP/CPP, from 25% to 35%. They recommend leaving the MPE unchanged, in part because individuals with income above the MPE have many other options available to prepare for their retirement.

To fund these increased benefits, Mintz and Wilson suggest an increase in the contribution rate of 2.5 percentage points, to be covered equally by employers and employees — but assumed to be effectively covered 3/4 by workers through lower wages, as in the case of the longevity pension, yielding an effective rate of 1.875% for workers which we use to calculate the rate of return (see section 4). In the case of the QPP in 2011, the total contribution rate thus goes from 9.9% to 12.4%. It must be noted that the authors have not quantified in a detailed manner the cost of the benefit increase they propose, such that the increase in contributions they suggest could very well, in reality as in our simulations, turn out to be insufficient or excessive for financing the proposed increase in benefits. However, given that QPP/CPP retirement benefits at their current level cost about 5.2% of earnings (Wolfson, 2013), it seems likely that a 40% ($(35\% - 25\%)/25\%$) benefit increase could indeed be financed by increasing the proposed contribution rate by 2.5 percentage points.

3.4 Alternative scenario 3: QPP enlargement (Wolfson proposal)

The last proposed reform that we model is that of Wolfson (2013), built using Statistics Canada's Lifepaths microsimulation model. This proposal first consists in doubling the MPE in the QPP, to twice the average Canadian income, or nearly $97,000 for 2011 ($ 105,000 in 2014). This element is also part of numerous other proposals put forward.

The other part of the proposal consists of introducing differentiated contribution and benefit rates according to income level. Thus, for an income which does not exceed half of average income (i.e., 50% of the pre-reform MPE), the contribution rate remains the same, at 9.9%. Then, between half of average income and double average income, i.e. between 50% and 100% of the pre-reform MPE,the contribution rate increases by about 3.1 percentage points, based on the above-mentioned estimated cost of "current service". [2] Finally, between one and two times average income, or between 100% and 200% of the pre-reform MPE, the contribution rate is set at 8.3% (it is 0% in the reference scenario). The post-reform contribution rates are thus 9.9% up to half of average income; 13.0% thereafter up to average income; and then 8.3% between one and two times average income.

On the retirement benefits side, this contribution structure makes it possible to keep the income replacement rate unchanged (at 25%) for individuals earning less than 50% of the pre-reform MPE, and to provide a replacement rate of 40% for those having earned between 50% and 200% of the pre-reform MPE. [3] According to the author, this structure aims as much as possible to target the needs found in his prospective analysis of future retirement incomes. Figure 1 shows the contribution rate and the replacement rate associated with the QPP/CPP in the reference scenario and under the proposal of Wolfson (2013). The main characteristics of the scenarios considered to reform the "2$^{\text{nd}}$ pillar" are summarized in table 1.

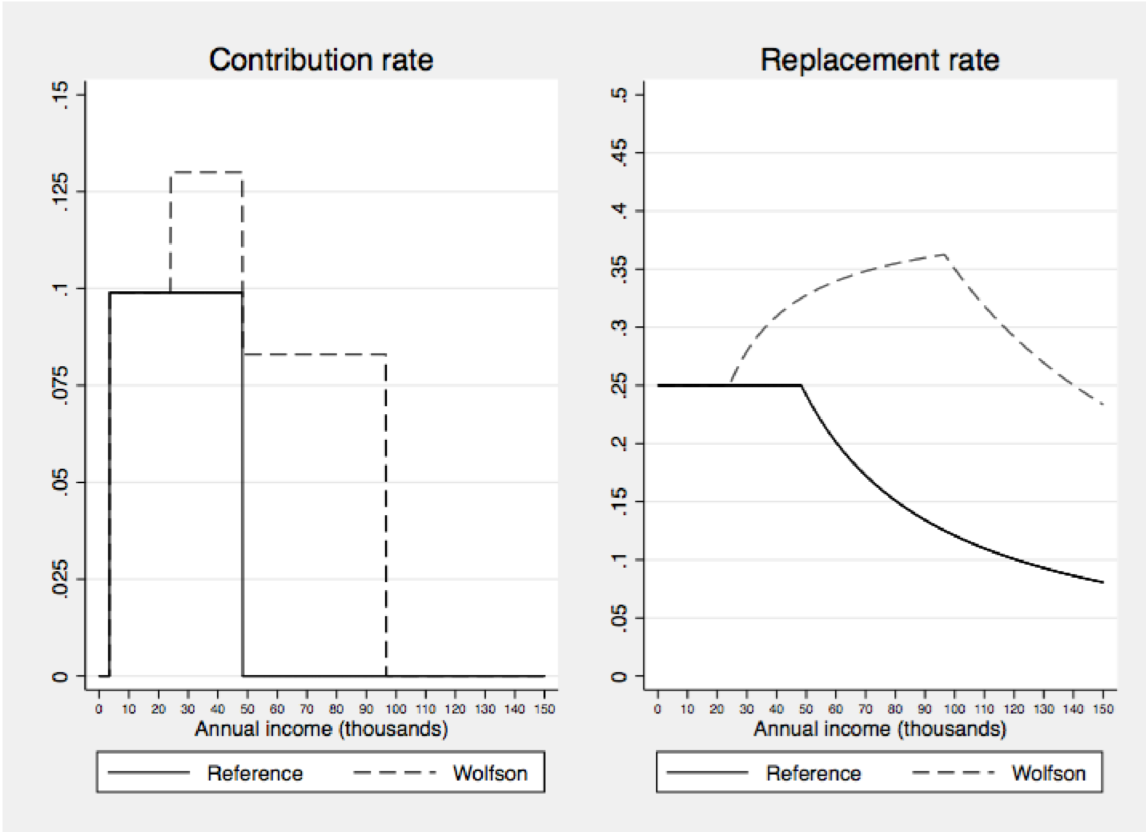
[2]This cost is 5.2% according to Wolfson (2013), which gives $(15\%/25\%) * 5.2\% = 3.1\%$ since the additional benefit is 15% — see below.

[3]Despite a uniform replacement rate of 40% beyond half of the pre-reform MPE, the contribution rate between 50% and 100% of the pre-reform MPE is 4.7 percentage points higher. This difference serves to finance other types of QPP benefits, but also and especially compensates for past under-financing of the plan, brought about by contribution rates that were historically too low.

Table 1: Summary table of reforms

	Annual contribution rate (variation in % points)			Annual benefit rate (variation in % points)	
	0 to $0.5 * MPE$	$0.5 * MPE$ to $1 * MPE$	$1 * MPE$ to $2 * MPE$	65 to 75 years	75 years +
Longevity pension	+1.65	+1.65	—	—	+20
Mintz-Wilson	+2.5	+2.5	—	+10	
				0 to $0.5 * MPE$	$0.5 * MPE$ to $2 * MPE$
Wolfson	—	+3.1	+8.3	—	+15

Figure 1: Contribution and replacement rates as share of income, proposal of Wolfson (2013)



3.5 Alternative scenario 4: Personal savings in a VRSP and purchase of a life annuity

In order to compare the returns from proposed reforms of public programs, we would like to obtain comparable alternatives based on existing individual savings vehicles. To do this, we consider two simple possibilities of increased voluntary savings, with specific parameters and savings vehicle contexts. In the first case, we model a scenario using a Voluntary Retirement Savings Plan (VRSP), a vehicle recently created in Quebec and similar to a Registered Retirement Savings Plan (RRSP) in that the contributions are tax deductible (in the year they were made) and withdrawals are taxed at the marginal tax rate applicable at the time of withdrawal. The returns accumulate free of tax.

More specifically, we model an annual contribution of 2% of labour income (before taxes) for each type of worker. This contribution rate corresponds with the default rate in VRSPs until the end of 2017. We assume that the capital is invested in long-term government bonds and offer a return of 3%, approximately the return on a Canadian 30-year bond. [4] The choice of financial product is dictated by a need for low risk and stable returns in order to ease comparison with public program reforms, but it would be possible to model different capital investment strategies.

Each worker thus contributes about 2% of his income in each year of work, between 25 and 64 years of age inclusively. Upon retirement at age 65, the entirety of accumulated capital — contributions plus returns — is used to buy a simple life annuity, with a 10-year payment guarantee and with no other optional characteristics. The price of this annuity is the average of the price for a man and for a woman, and corresponds to the average price required in mid-2014 by 11 major Canadian financial institutions, obtained in the CANNEX database.[5] Since the amounts used to buy the annuity come from a VRSP, the annuity payments are taxable. This aspect is accounted for in the SimTax calculator.

The average price corresponds to $15.83 for each dollar of annual income paid out by the financial institution, calculated based on annual payments of $6,316 per $100,000 invested (men: $6,660; women: $5,972): $100,000 / $6,316 = $15.83. We note that the price seems, on average, rather fair from an actuarial point of view. Indeed, using the ISQ mortality tables and an expected return of 3%, we get annual payments in the range of $6,239 to $7,237 depending on the individual's level of education (and, thus, his life expectancy). The university graduate therefore has a small advantage in procuring such an annuity, while the individual without a degree receives 14% less income than the actuarially fair value of the amount they paid to buy the annuity. We thus see that "actuarial fairness" varies significantly by level of education, which risks creating adverse-selection problems if public authorities wish to promote voluntary usage of a life annuity. However, we also see from this very approximate calculation that the average price of annuities in Canada seems competitive from an actuarial perspective, a conclusion that applies to most countries except Australia, according to Milevsky (2013).

[4] We postulate that this return is net of administrative fees, which may be optimistic in the case of a VRSP but may be justified if a simple bond is purchased. Certain savings accounts offered in the VRSP framework have fess as low as 0.25% of assets, including sales taxes.

[5] See www.cannex.com.

3.6 Alternative scenario 5: Personal savings in a TFSA and purchase of a life annuity

Alternative scenario 5 is identical to scenario 4 in all respects with the exception of the vehicle used to accumulate capital via personal savings. This scenario thus assumes that the additional savings (the 2% from scenario 4) is instead directed into a Tax-Free Savings Account (TFSA), a vehicle established by the Canadian government in 2009. The main difference which results is that the tax rate differential between working and retirement years has no impact in this case—the TFSA contributions are made “after taxes" (i.e. they are not deducted) and withdrawals are not taxed.Personal savings accumulated in a TFSA are therefore used to buy the annuity with no additional taxation.

4 Income replacement and internal returns

The income replacement rate in retirement and the internal rate of return are two simple and commonly used tools to evaluate the impact of the proposed reforms. We apply them in this section to the different proposed reforms that we study.

4.1 Income replacement rates

The income replacement rate in retirement is a measure that is often used by analysts and financial advisors and is often cited in the media. There is not, however, a single manner to calculate this rate and many different measures are found in the literature. For simplicity and due to the existing data, here we define this rate as the ratio between disposable income for a given year in retirement, after the age of 65 years, and disposable income during the period before retirement, between 25 and 64 years. We should note that retirement income is constant in all of these scenarios, except for alternative scenario 1, where it changes at age 75 with the introduction of the longevity pension.

If we denote annual disposable income of the individual at age t as $H_t(k)$, in scenario $k = 0, 1, \ldots, K$, where $k = 0$ is the reference scenario, we obtain for each individual i and each scenario k the following replacement rate:

$$RR_{i,t} = \frac{H_{i,t}(k)}{\sum_{j=25}^{64} H_{i,j}(k)/40}, t > 64. \tag{5}$$

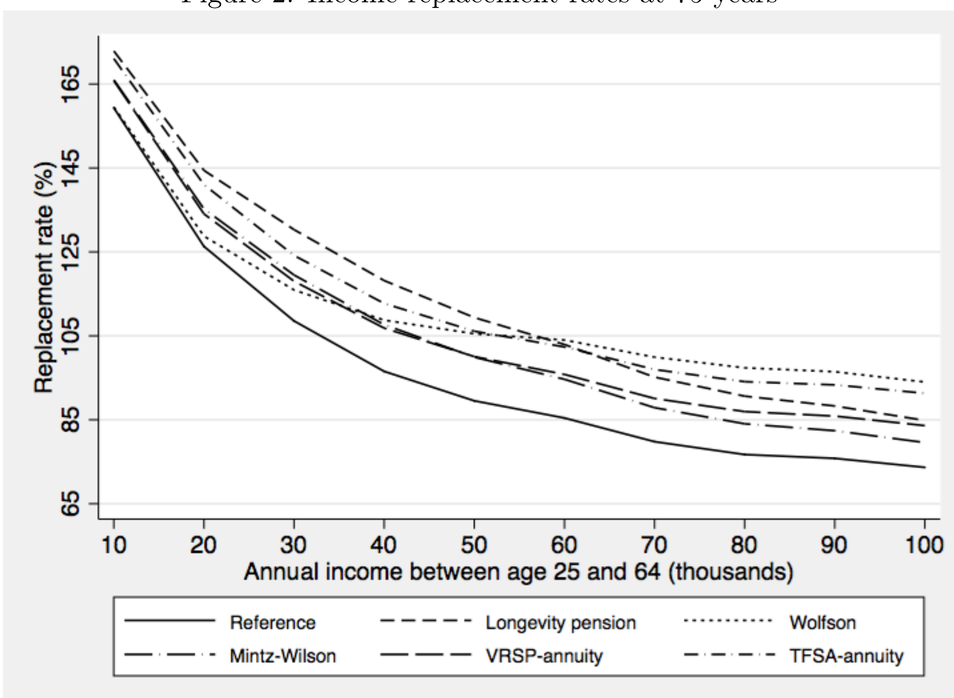
Figure 2 presents the replacement rate at 75 years for each alternative scenario, as well as for the reference scenario (i.e. the situation in place in 2011).[6] We find that it is the longevity pension that increases the replacement rate by the most for individuals with low average income, and that this holds up to annual income of about \$60,000. Contrast this with the proposal of Wolfson which leaves replacement rates largely unchanged for individuals earning an average of \$20,000 or less; it is beyond a gross (pre-tax) income of about \$60,000 that the increase in replacement rates is greater than in the other reform scenarios considered. It should be kept in mind, however, that the increase in replacement rates brought about by the introduction of the longevity pension, while more generous for many income brackets, does not apply until after 75 years of age, and thus offers as many as 10 fewer years of benefits than the other proposals.

The Mintz-Wilson proposal is somewhere between the two and offers a modest increase in the replacement rate across all levels of income, but most especially for individuals earning an average of between \$20,000 and \$85,000. We find that the profile of the replacement rate of the Mintz-Wilson proposal is very similar to that in the VRSP-annuity scenario, especially up to an average income of about \$60,000. The difference between the two scenarios is higher thereafter but remains small. Finally, we find that the TFSA-annuity scenario performs well enough in terms of replacement rate, and is only exceeded by the longevity pension under \$60,000 and by the Wolfson's proposal at higher incomes.

[6] We present the rates at 75 years because income in retirement is presumed constant, such that before this age, the results for all scenarios would be identical to those presented here, except for the longevity pension, whose curve would barely differ from the reference scenario's. Indeed, no benefit is paid before the age of 75 years in the longevity pension scenario, while the contributions slightly affect pre-retirement disposable income and, therefore, the replacement rate obtained between 65 and 74 years. Recall that the rates calculated and shown here correspond to "total" replacement rates, i.e., including all sources of income in retirement, and not only income from public programs or the 2[nd] pillar.

We can also clearly see that in all cases the replacement rates are very high for those with low income and that they decrease when income rises. These rates exceed 150% at $10,000 and remain above 125% at an average income of $20,000. After this level of income, the slope falls abruptly and then declines slowly to reach between 75% and 95% at $100,000, depending on the scenario. The gap in the replacement rate increases with average labour income in every scenario, standing testament to the fact that the different reforms analyzed primarily target individuals with average or high income. Thus, all of the reforms analyzed here increase the replacement rates relative to the reference scenario, and more so for individuals with higher than $20,000 average annual income.

Figure 2: Income replacement rates at 75 years



4.2 Internal rates of return

The internal rate of return is another measure that is commonly used by analysts, especially in project evaluation. In this case, we must compare future flows associated with each reform (alternative scenario) to those associated with the *status quo* (reference scenario). This exercise allows us to obtain the rate of return which brings to zero the net present value of each reform.

For a discount rate r, the expected value at age 25 years of expected disposable income LY of an individual with education level e in the reference scenario ($k = 0$) is given by

$$LY_{k=0}(Y_{25}, e, r) = E_Y \left[\sum_{j=0}^{T-25} \frac{s_{e,t+j}}{(1+r)^j} H_{25+j}(k=0) \big| Y_{25}, E = e \right]. \tag{6}$$

We have set T, maximum possible age, at 110 years. The survival rates are given by $s_{e,t} = \prod_{j=0}^{t}(1 - \Pr(M_j = 1|E = e, j))$. The contributions enter negatively into the calculation while the benefits enter positively. The rate of return of scenario k is denoted by $r_k(e, Y_{25})$ and is given implicitly by

$$LY_k(Y_{25}, e, r_k(e, Y_{25})) - LY_0(Y_{25}, e, r_k(e, Y_{25})) = 0 \tag{7}$$

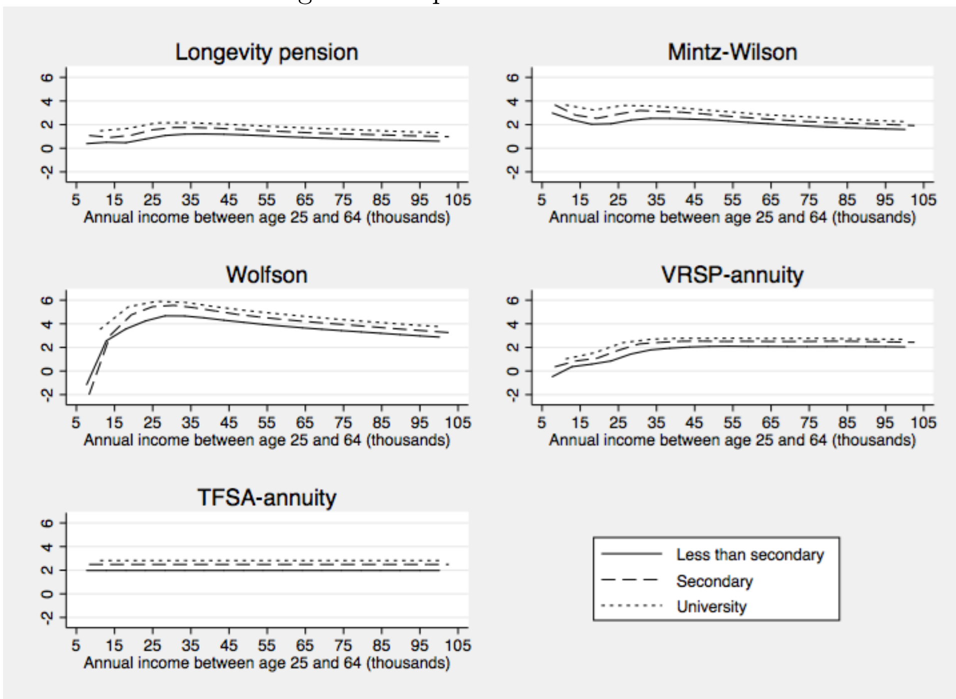
$$E_Y \left[\sum_{j=0}^{T-25} \frac{s_{e,t+j}}{(1 + r_k(e, Y_{25}))^j} (H_{25+j}(k) - H_{25+j}(0)) \big| Y_{25}, E = e \right] = 0 \tag{8}$$

We can computationally solve for $r_k(e, Y_{25})$, using, for example, the bi-section (see chapter 5 in Judd, 1998).

Figure 3 presents the internal rates of return by education and income group in each of the alternative scenarios. We note that in all scenarios, these rates of return are greater for individuals with a higher level of education, notably due to the life expectancy gap between education groups. Also, the maxima in the scenarios generally lie between \$25,000 and \$45,000, with some exceptions as can be seen in the figure. In general, also, due to the tendency for income to grow with age and the interaction between these and the MPE, the rates of return decline with increases in average income of the individual.

The longevity pension offers fairly low returns, especially for individuals with less education. University graduates earning between \$35,000 to \$55,000 obtain about 2%; other individuals obtain a lower rate. We find that, regardless of income grouping, university graduates always obtain a more than 1.5% return due to their greater longevity. The profile of the returns of the longevity pension is similar to that of the VRSP-annuity scenario, this last of which offers

Figure 3: Implicit rates of return



a lower return for individuals with low income — who are strongly disadvantaged in such a scenario due to interaction with the GIS — and a higher return for individuals earning more than $35,000. This identical return of 2% to 3% for all those earning more than this threshold is also the return offered by the TFSA-annuity scenario, which does not vary with income. The "tax neutrality" of the TFSA-annuity scenario generates a profile of returns which is perfectly horizontal across income levels, which questions the pertinence of the VRSP with respect to the TFSA for individuals with low or average income.

The Mintz-Wilson proposal differs from the longevity pension and the VRSP-annuity scenarios with regard to the rate of return that it offers, which is comparable to that of the VRSP-annuity scenario for average and high incomes, but also to the exemption from QPP contributions for income up to $3,500. This exemption is particular to Mintz-Wilson, since Wolfson does not increase contributions until beyond $0.5 * MPE$, while the three other scenarios do not include any contribution exemption. This exemption explains the difference in the profile of the returns of those in the lower income group.

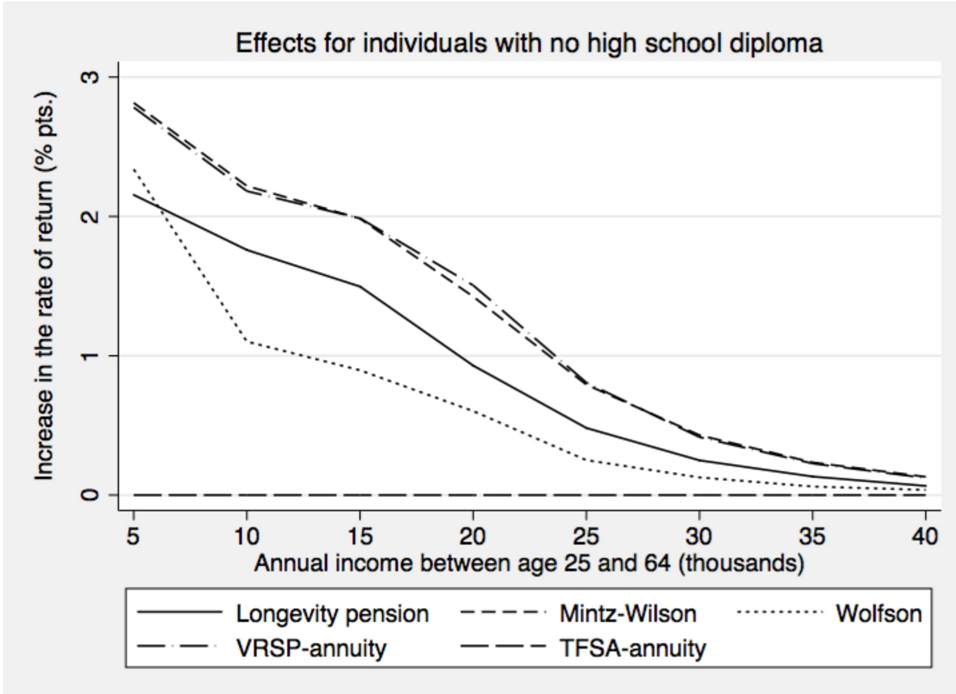
Finally, the Wolfson proposal seems to offer very high returns, in the order of 4% to 6%, for individuals earning between about $20,000 and $65,000. Those earning more still obtain between 2% and 4%. We observe that individuals earning $15,000 or less obtain smaller, or even negative, returns. While they should not be affected by the Wolfson reform, income variation during a career implies that they are in fact affected (see the following sub-section). The last observations nevertheless make it possible to conclude that the Wolfson proposal seems to best target the groups defined as being “at risk" in terms of retirement income, namely, individuals in the middle of the income distribution — with a potential undesirable effect at the bottom of the distribution. The TFSA-annuity scenario, which would be difficult to implement on a voluntary basis, nevertheless offers the most neutral return from the perspective of labour income and existing taxation, and maintains a constant gap between education groups.

4.3 Decomposition of internal rates of return

It is instructive to analyze the effect on internal rates of return of the presence of i) the GIS, and ii) mortality rates differentiated by level of education. By simulating “counterfactual" situations, it is possible to identify the role played by the GIS (due to its structure, including the 50% clawback rate) and the mortality differentials between individuals with different education levels. To start with, figure 4 shows the effect on the implicit rates of return of eliminating the GIS in each of the 5 different scenarios. The figure presents the effects of eliminating the GIS *ceteris paribus* in percentage points of additional return each scenario offers in this hypothetical world. Here, we only show the case of individuals with no secondary diploma, who have the highest mortality risk — and thus, as a result, who obtain the lowest return in all of the reform scenarios.

Unsurprisingly, the TFSA-annuity scenario does not change, since withdrawals from a TFSA have no consequences with regard to taxes or reduction in the GIS. Contrast this with the VRSP-annuity scenario, as well as with Mintz-Wilson, which see an appreciable increase in returns for low income individuals when we eliminate the GIS: nearly 3 percentage points for those having earned an average of $5,000, and more than 2 points for annual career average incomes of up to $15,000. That is to say that these reform scenarios are actually very unfavourable for these

Figure 4: Increase in the implicit rate of return in a no-GIS world



individuals in the real world, given the presence — and structure — of the GIS. In all of the reform scenarios, the impacts of the presence of the GIS get smaller as average career income increases, up to the point that it disappears completely, at $40,000 (the reason that figure 4 stops at this income level).

In the case of the longevity pension, the presence of the GIS also has the effect of reducing the rate of return among those with lower income but to a somewhat lesser degree. The difference with the other scenarios is mostly due to the fact that the longevity pension is not paid out until 75 years, which ends up "reducing the disadvantage" faced by low income individuals. Despite this difference, when there is no GIS , the longevity pension has a 2 percentage point higher return for individuals earning $5,000, and is still about 1.5 percentage points higher for those with an average income of $15,000.

Under the Wolfson proposal, the GIS should have little impact because those with low income are excluded from the reform. We do, however, observe a certain effect, generally weaker than in the other reform scenarios. This effect is principally due to variation in income throughout a career: our process to generate labour income includes many shocks over the course of the years, which means that an individual earning a very low career average income is liable to earn sufficient income in some of the years to fall into the increased contribution regime — with only partial recovery in terms of benefits received during retirement, since his average career income renders the individual ineligible for additional benefits. This aspect illustrates the huge importance of accounting for the complete path of labour income throughout a career, particularly when the Wolfson reform is considered, i.e., with contribution and benefit rates differing by income.

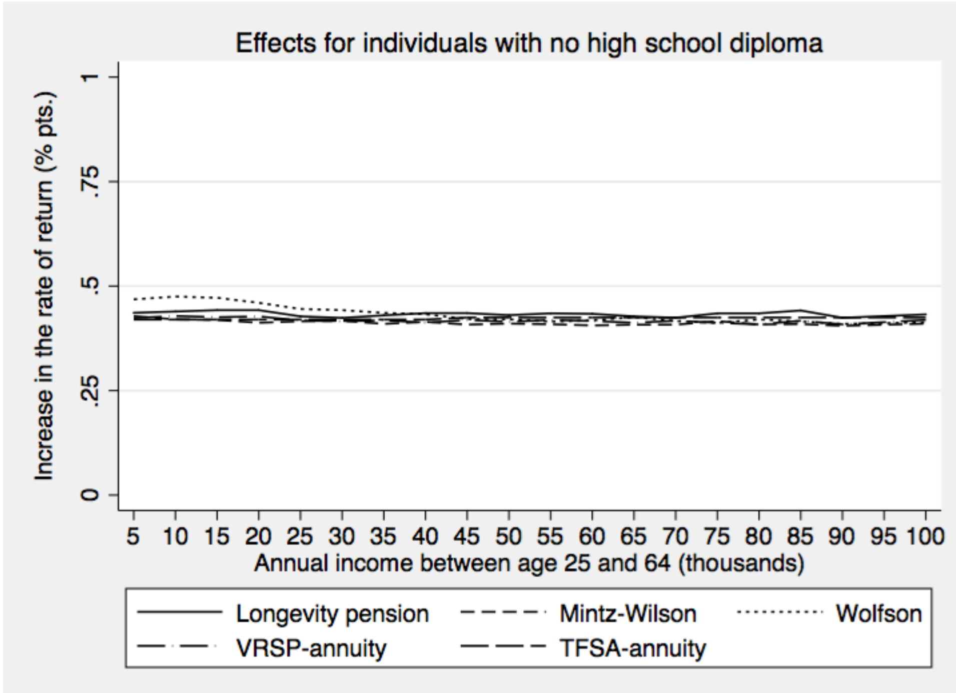
Another potential source of differences in the returns of different reform scenarios is mortality — or life expectancy — differentiated by level of education. Figure 5 indicates that this factor has a more limited impact on the returns brought about by the different proposals, which sits at about 0.4 percentage point for individuals without a secondary diploma. Otherwise stated, in a world where these individuals were to have a mortality risk identical to the average, the additional return they would receive in each reform scenario would be higher by 0.4 percentage point. This effect is far from insignificant, but we see that it is much smaller than the GIS effect for individuals with low income. It is individuals earning more than $30,000 per year who are disadvantaged more by the differences in mortality than by the presence of the GIS, which is expected since the GIS is targeted to low income individuals.

4.4 Simulation of the internal returns in the absence of private retirement income

A possible critique of our analysis relates to the way of imputing private retirement income before any of the reforms. We thus explore the effect on rates of return in the different reform scenarios of completely eliminating these private retirement incomes, other than those generated by the proposed reforms themselves, that is. Figure 6 shows these rates of return in the absence of private retirement income (RRSPs or supplemental pension plans).

We see that all reforms except for the TFSA-annuity scenario offer a smaller return in the absence of private retirement income. In the case of the longevity pension, this is particularly

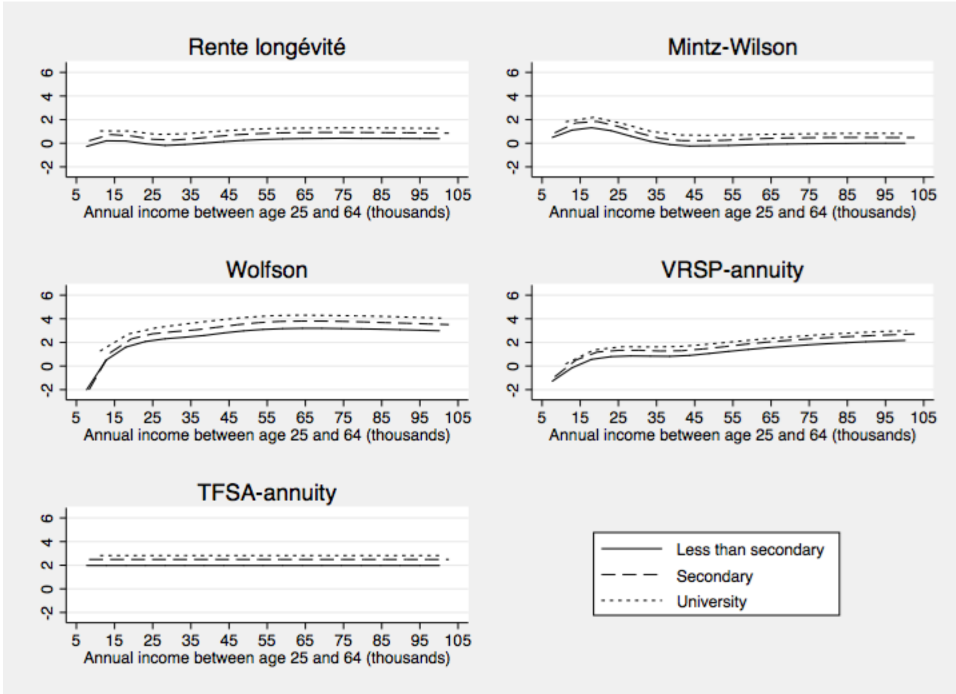
Figure 5: Increase in the implicit rate of return in a world without differences in life expectancy



the case for individuals earning less than $75,000. Mintz-Wilson offers a relatively low, or even negative, return, beyond the middle of the earnings distribution; Wolfson's proposal sees all of its curves moved markedly downwards for individuals earning less than $65,000; and the VRSP-annuity scenario now offers low returns for individuals earning under $85,000. To understand these differences, we have to look at the interaction between the different proposals and the GIS.

Indeed, in a world with no private retirement income, all individuals in our simulation are eligible for the GIS pre-reform since retirement income comes entirely from the OAS and QPP and thus yields a right to small GIS benefits. With the introduction of a reform, many lose access to GIS benefits, leading to a major decline in the return they receive in each reform scenario, especially for individuals with average-high earnings (who do not actually receive GIS in the real world, where there *is* private retirement income). Differences in the decline in returns reflect the difference in the contributions-benefits structure of the different reform scenarios.

Figure 6: Implicit rates of return in absence of private retirement income



5 Conclusion

Our results suggest that the three proposals of reforms to public programs considered in this article have some common aspects. To start with, they all increase the income replacement rate relative to the reference scenario, especially beyond an average annual income of $25,000. The profile of this increase differs substantially between the different reforms, however. The longevity pension offers the largest increase for those with income below $60,000 and the Wolfson proposal is the most generous beyond this threshold. The two options for increased private savings with purchase of a life annuity generate differentiated increases in the replacement rate: a contribution of 2% of income in a VRSP procures a modest increase in the replacement rate, while an identical contribution to a TFSA procures a larger increase across all income levels. All of the observations made in these private annuity scenarios are conditional on extra (or "new") savings being effectively generated and directed towards the concerned vehicles, which is not necessarily so in reality.

As well, all scenarios except the TFSA-annuity procure a low return for individuals with modest labour income, mostly due to the presence of the GIS but also to their higher mortality risk. For individuals with higher career labour income, it is the differentiated mortality that plays a larger role, since they are not eligible for GIS benefits. This ordering applies for all reform scenarios beyond an earnings threshold of about $35,000.

We also find that the profile of returns as a function of income varies considerably from one scenario to the next, as does the level of return. While the longevity pension offers a fairly low return for all, the TFSA-annuity scenario offers an average return for all, in the order of 2% to 3%. We can therefore consider that the longevity pension will be less attractive than certain private alternatives, which is not necessarily the case for the Mintz-Wilson and the Wolfson proposals. Mintz-Wilson offers average returns for all, a level similar to that of the TFSA-annuity, while Wolfson offers higher returns to individuals earning more than $20,000 per year, but with negative effects at the bottom of the distribution. The VRSP-annuity scenario also generates negative returns at the bottom of the earnings distribution, as in the other scenarios, due to the interaction with the GIS. Thus, the longevity pension and the VRSP-annuity scenario seem to be outperformed by other scenarios analyzed, with Wolfson offering the best return to the targeted "middle class" group and the TFSA-annuity offering a neutral return with respect to income and taxation (i.e., which does not depend on differences between the marginal tax rates during working life and retirement).

In this article we have calculated the income replacement rates and the internal rates of return associated with different reform scenarios, which are three modifications to public programs of the 2^{nd} pillar and two comparison scenarios which make use of existing private savings vehicles. We have illustrated the effect on the returns offered by these potential reforms of i) variations in labour income; ii) the presence and structure of the GIS; and iii) the presence of mortality differentials by level of education. We should note that our conclusions only deal with the financial return of the different scenarios analyzed. Another aspect that merits being included in a future analysis is the insurance value of the proposals and, by extension, the value of these in terms of utility for the affected individuals. These considerations will be incorporated into our future works.

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Annex A: Pre-retirement labour income

We use cycles 2 to 5 of the SLID, which offer a sample of respondents $i = 1, \ldots, N$, each observed a maximum of 6 times between 1996 and 2010. We select men from Quebec who are not self-employed and who are aged 25 to 100 years; we do not include females in the sample simply to have as complete a working history as possible. We eliminate observations with labour income in excess of $250,000 and use Statistics Canada's consumer price index to convert monetary values into 2011 dollars.

Since we estimate the labour income processes by level of education, we omit this aspect. Taking the log of the income process and denoting the log variables by using lower case, we obtain for individual i in period t:

$$y_{i,t} = y_{i,25} + \sum_{j=26}^{65} g_j + p_{i,t} + u_{i,t} \tag{9}$$

$$p_{i,t} = \rho p_{i,t-1} + \epsilon_{i,t} \tag{10}$$

Denoting $\eta_{i,t} = p_{i,t} + u_{i,t}$, and assuming for now that $E[\eta_{i,t}|t, y_{i,25}] = 0$, we can estimate the g_js in deviation with respect to the average. We also find the fixed effect for each respondent, $y_{i,25}$.

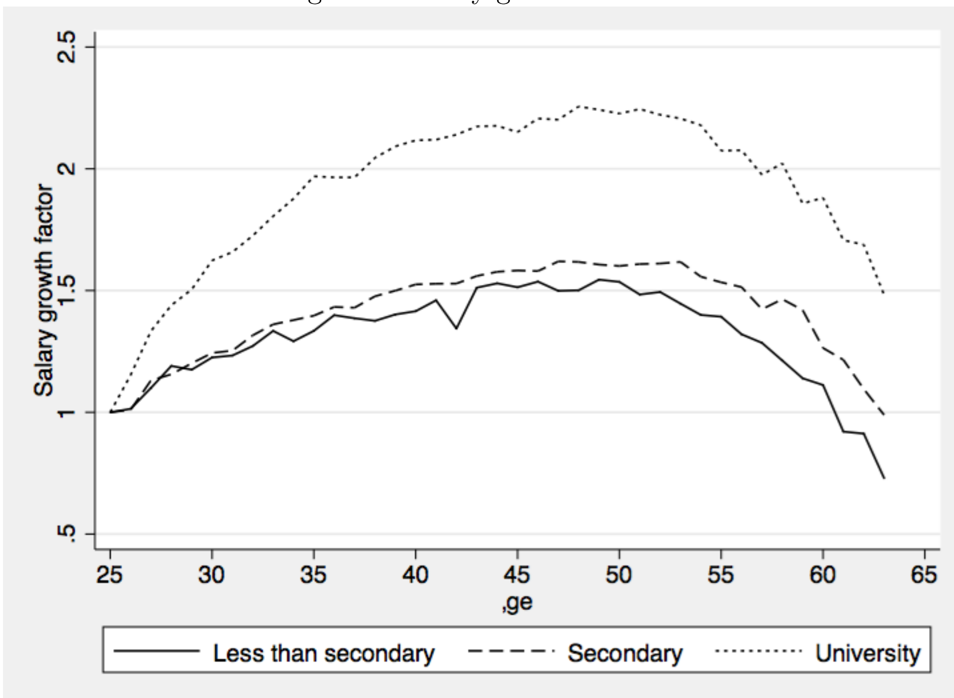
Figure 7 shows the age-education profiles $G_{e,t}$. These are smoothed using a non-parametric lowess estimator using the estimated values of g_j.

We estimate the parameters $(\rho, \sigma_u, \sigma_\epsilon)$ by minimum distance using the fact that $E[\eta_t \eta_{t-s}] = \rho^{|t-s|} \frac{\sigma_\epsilon^2}{1-\rho^2}, \quad s > 0$ and $V[\eta_t] = \frac{\sigma_\epsilon^2}{1-\rho^2} + \sigma_u^2$.

Let the parameters to estimate be denoted θ, and their real value θ_0. Let $\hat{\Omega}(\theta_0)$ denote the variance-covariance matrix of the data, and $\Sigma(\theta)$ denote the theoretical variance-covariance matrix based on the foregoing assumptions. The estimator is given by

$$\hat{\theta}_{MD} = \arg\min_{\theta} \text{vech}(\Sigma(\theta) - \hat{\Omega}(\theta_0))' M_N \, \text{vech}(\Sigma(\theta) - \hat{\Omega}(\theta_0)). \tag{11}$$

Figure 7: Salary growth factors



We use $M_N = I$ as the weighting matrix. Table 2 presents the results for each level of education.

Table 2: Estimated parameters of labour income processes

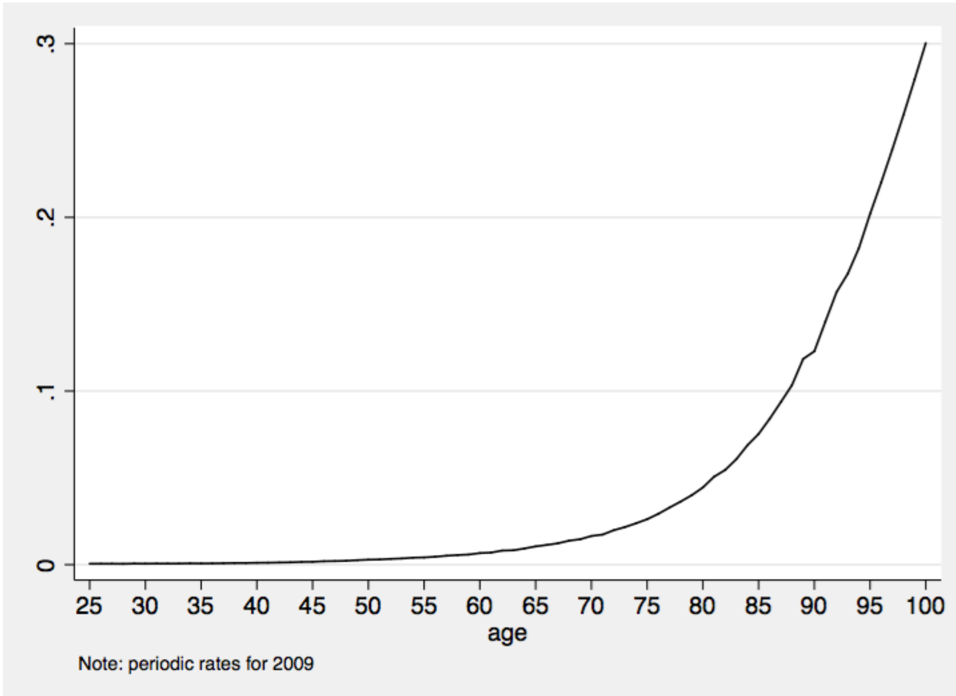
Education level	ρ	σ_ϵ	σ_μ
No degree	0.9500	0.0259	0.1168
Secondary	0.9301	0.0292	0.0778
University	0.9261	0.0375	0.0649

Annex B: Mortality

Figure 8 gives the 2009 periodic mortality rates reported by the Institut de la statistique du Québec (ISQ). We denote this rate for period t by $m_t^0 = P(M_{t=1}|t)$.

We use the 1994-2010 (biannual) cycles of the NPHS to estimate the mortality process specific to each education level, for both sexes combined because our simulated representative cases (or agents) are also non-gender specific. We only consider the household component of the survey. We first estimate $p_{e,j,t} = \Pr(E = e|M_{t+1} = j, t)$ for $j = 0$ and $j = 1$ using a multinomial logit

Figure 8: Mortality rates by age (ISQ)



model and including a linear age effect allowed to change at age 50 (*spline*). We can then correct the rates of the ISQ to make them specific to each education level using the following formula:

$$m_{e,t} = \frac{p_{e,1,t}}{p_{e,0,t} + p_{e,1,t}} m_t^0 \tag{12}$$

Figure 9 presents the estimated correction factors $\frac{p_{e,1,t}}{p_{e,0,t}+p_{e,1,t}}$.

Figure 9: Mortality rates correction factors

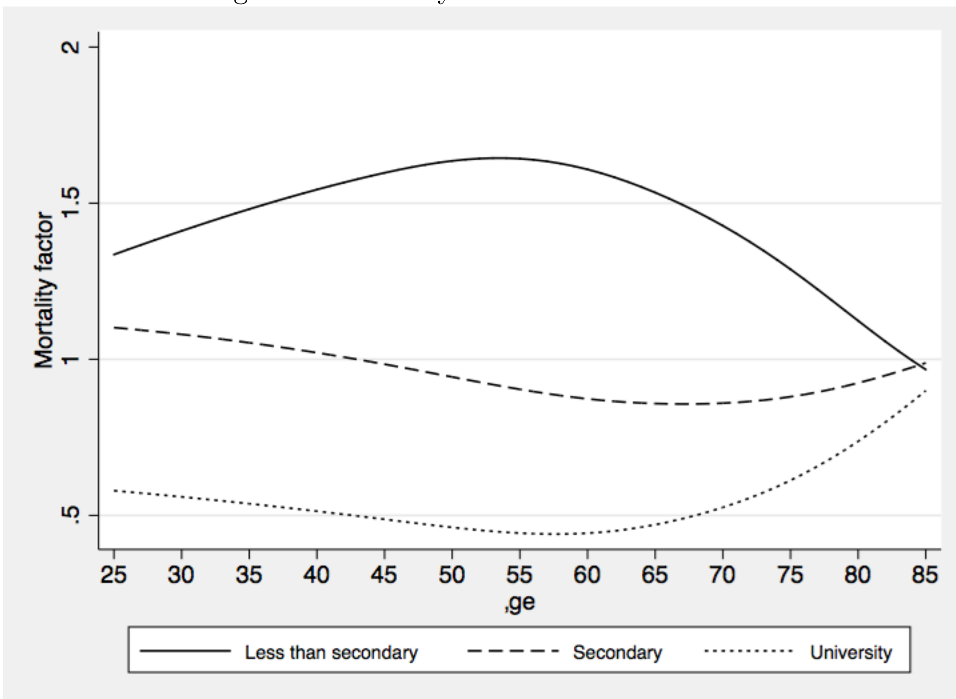
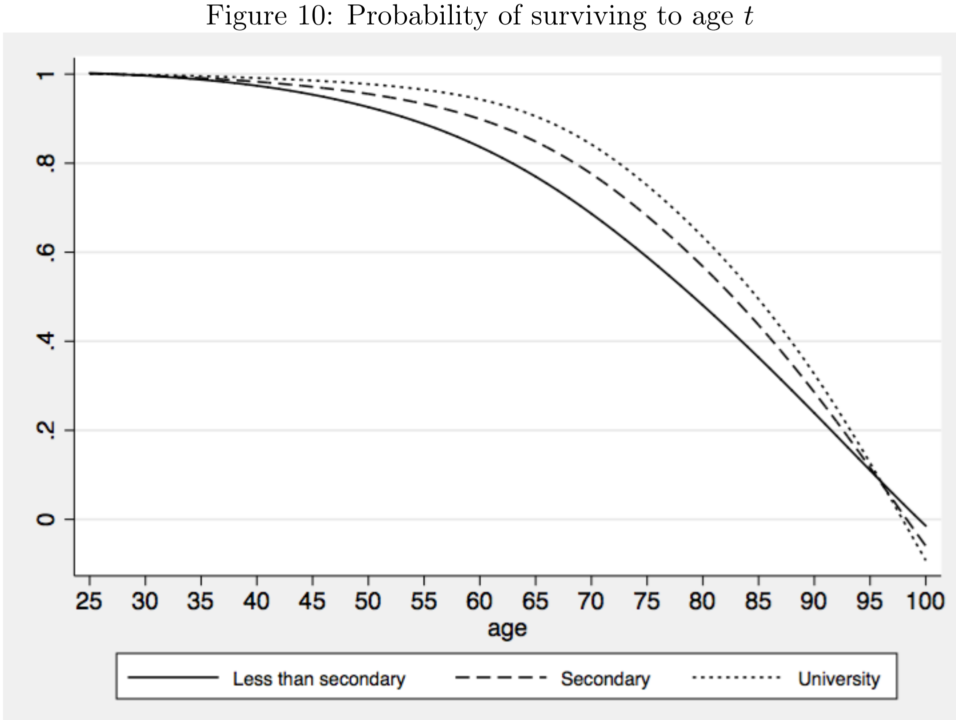


Figure 10: Probability of surviving to age t

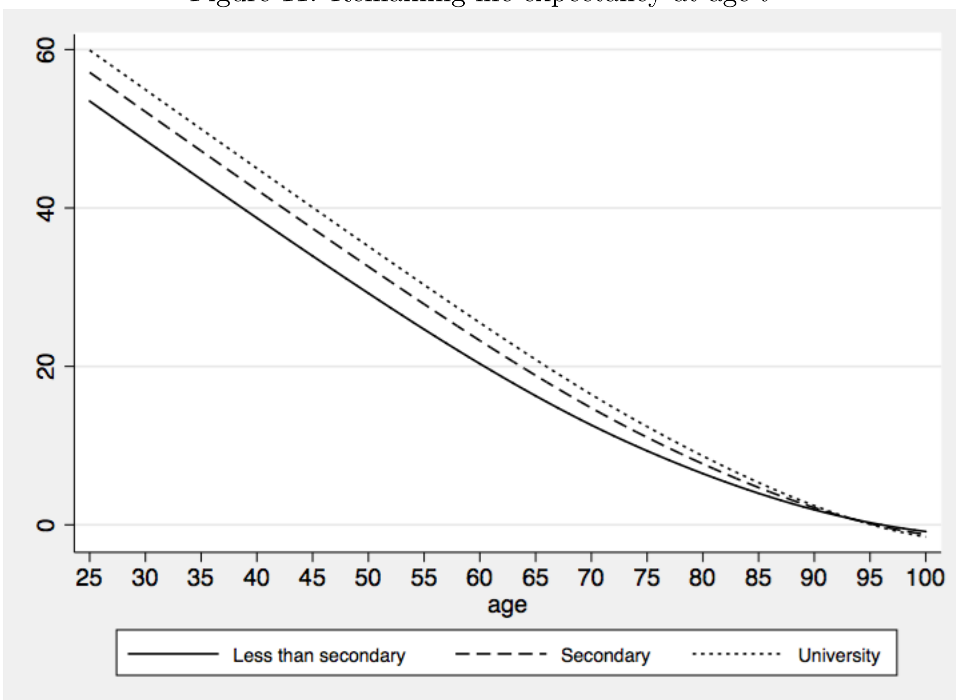


The survival rate at age t given that an individual has survived to 25 years is given by

$$s_{e,t} = \prod_{j=0}^{t} (1 - m_{e,j}). \tag{13}$$

Figure 10 gives the survival curves by level of education while figure 11 shows the curves of remaining life expectancy conditional on having survived to age t.

Figure 11: Remaining life expectancy at age t



Annex C: Estimation of market income in retirement

We select, from cycles 2 to 5 of the SLID, individuals who stopped working only once, without restarting, between 50 and 70 years of age. Due to the low number of available observations in this specific grouping, here we aggregate observations pertaining to both men and women, and from all of Canada. Proceeding otherwise would not have allowed us, with SLID data, to have enough observations for our simulations.

We estimate the average pre-retirement earnings of each individual i just before he/she stops working. Note that the SLID is designed to interview the same individual up to a maximum of 6 times. The number of periods used to calculate the pre-retirement income thus varies between 1 and 5 among surveyed individuals, given that we also need at least one observation of post-retirement income. To make the link with our model, where retirement age is strictly 65 years, we denote this "pre-retirement labour income" as $Y_{i,64}$. We eliminate observations for which $Y_{i,64} < \$10,000$, in order to avoid as much as possible including part-time workers, as well as those for which $Y_{i,64} > \$250,000$.

We then calculate, still using SLID, market income in retirement. Once the individual stops working, we add his/her income from supplemental pension plans or investments and take the average over the observed period after retiring (the number of periods varying between 1 and 5 depending on the individual). We denote this income by $B_{PP,i}$. We drop outlier observations for which $B_{PP,i} > \$100,000$. Finally, we estimate by ordinary least squares the effects of income and education on the "private replacement rate", $R_{PP,i} = B_{PP,i}/Y_{i,64}$ by the following model:

$$R_{PP,i} = \alpha_0 + \alpha_p Y_{i,64} + \alpha_e + \nu_i. \tag{14}$$

Table 3 shows the estimated parameters of this model. All parameters are positive and statistically significant. These coefficients are then used to calculate market income in retirement as a function of education level and labour income at 64 years ((or "prior to retirement").

Table 3: OLS estimation of the private replacement rate

	Coefficient		Standard deviation
Secondary	0.0645414	***	0.0213239
University	0.1302574	***	0.0299713
Labour income	0.0000009	**	0.0000004
Constant	0.2443028	***	0.0196956

* significant at a 10% threshold
** significant at a 5% threshold
*** significant at a 1% threshold

Annex D: Taxation and social transfers

The disposable incomes H_t presented and used in this article are calculated accounting for the complexity of the federal and provincial taxation systems and also for the main social transfers which individuals may benefit from as a function of their income. We use the SimTax calculator, developed by team members and other researchers at Université Laval. Note that the version available at the time of preparing the present work only made it possible to use parameters which were in place for the 2011 tax year.

SimTax uses as inputs market income (labour income, interest, private pensions) and QPP benefits as well as various individual characteristics that can affect credits or transfers (age, marital status, etc.). Table 4 presents the elements of the tax and social transfers system that are relevant for Quebec and which are accounted for in SimTax. For the present article, SimTax was also adjusted to account for modifications required in order to simulate the studied reforms.

Table 4: List of elements accounted for in SimTax

Income Tax
– Federal tax
– Tax rates and thresholds
– OAS clawback
– Provincial tax
- Tax rates and thresholds
– Health contribution
– Non-refundable tax credits
– Basic amount
– Canadian employment amount
– Pension income amount
– Age amount
– Contributions amount
Social Transfers
– Old Age Security pension
– Guaranteed Income Supplement [a]
– Welfare
– Work Premium (QC)
Contributions
– Quebec Pension Plan
– Quebec Parental Insurance Plan
– Employment Insurance

[a] Including the additional low income benefit implemented in 2011.