



Aging and Retirement

The CPP Take-Up Decision

Risks and Opportunities



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Executive Summary

Improving retirement financial security for Canada's ageing population is a high and widespread priority. One existing tool to achieve this within the current Canadian public pension system is to delay the take-up of Canada Pension Plan (CPP) retirement benefits. Taking CPP payments later is a cheap and safe approach to receive greater secure income in retirement; nevertheless, more than 95% of Canadians have consistently taken CPP payments at normal retirement age (age 65) or earlier since the CPP introduced flexible retirement in the 1980s.

This paper investigates the financial consequences of delaying CPP payments. Our intent is to provide a quantitative basis to better inform the take-up decisions of Canadians for whom delaying CPP benefits might provide improved financial outcomes and greater retirement income security.

Specifically, the analysis addresses workers retiring at age 65 who intend to use some portion of registered retirement savings plan/registered retirement investment fund (RRSP/RRIF) savings towards securely increasing their lifelong annual retirement consumption, with this portion sufficient to bridge the five-year income gap left by delaying CPP pension income from age 65 to age 70. While the priority of this portion of RRSP/RRIF savings is lifetime income security, any remaining savings could have any number of purposes, such as an emergency fund, a bequest, and financing further retirement spending.

While the typical focus of mainstream advice calculates the cashflows associated with the CPP delay choice (the "return"), the financial risk implications are often absent. A major advantage of increasing CPP payments via postponement is that it promises additional secure, lifetime income that increases each year alongside the price of consumer goods, thereby helping to protect seniors against the financial risks associated with inflation, financial market returns, and longevity. With Canadians increasingly bearing the primary responsibility for managing their post-retirement risks, this paper seeks to address this gap by carrying out a comprehensive financial risk/return evaluation of the timing decision for CPP take-up.

Key Findings

Choosing between alternative CPP take-up ages is complicated, as is the corresponding analysis, since there are infinite combinations of relevant factors (in terms of personal characteristics and economic scenarios). This paper begins with a conceptual mathematical framework that is reasonable and sufficiently manageable to make effective communication possible.

The conceptual framework developed in this paper rigorously compares two otherwise identical financial strategy options that differ only in the timing of the take-up decision:

- Option #1: Delay CPP payments from age 65 to 70, using a portion of RRSP/RRIF savings (the bridging funds) to provide for withdrawals during that five-year period that exactly match the income that the CPP pension (adjusted for inflation) will provide when an individual takes it up at age 70.

versus

- Option #2: Claim CPP payments at age 65 and self-manage the portion of RRSP/RRIF savings (that would have otherwise been used to bridge the five-year gap in Option #1) over retirement so as to achieve the same net annual income (as in Option #1) throughout retirement (maintaining that level until death or the exhaustion of the bridging funds).

In both options, therefore, the same initial level of savings is used to target the same annual secure net income. The only difference between the two options is the CPP take-up timing (and the financial risks undertaken in each).

We first present and examine this conceptual framework through actuarial mathematics. We next quantify the financial trade-offs between the two options. Both analyses reveal a number of insights, including:

1. **The cost of delaying CPP payments can be expressed with simple formulas:** Using a 1.1% national real wage growth assumption, the choice to delay CPP payments to age 70 increases constant-dollar benefits by 50% over what they would be for an age-65 take-up. If the bridging funds needed to replace the CPP benefits between ages 65 and 70 are safely invested in risk-free assets over the five-year delay period, the cost for CPP delay can be clearly explained. This is because both the savings required to bridge the gap, and the withdrawals made under both options, then become functions of only the individual's CPP pension at age 65.

Assuming a risk-free rate of return that matches inflation plus 1%:

A 65-year-old retiring Canadian can increase his/her real (after inflation) CPP pension by 50% until death by claiming CPP benefits at age 70 and employing RRSPs/RRIFs to provide bridging funds over the five-year gap:

- *The amount of savings required to fund the five years of withdrawals (e.g. "bridging funds") is 7.35 times the age-65 CPP pension.*
- *A payment of 20.4% of this fund would be withdrawn at age 65 (equal to 150% of the constant-dollar age-65 CPP pension), which would be indexed by inflation for each of the following four years.*
- *At the end of the five years, the bridging fund would be exhausted, but the individual would begin to receive an equivalent real amount of CPP pension that would continue until death.*

2. **Between these two options, the financial trade-offs underlying the CPP delay decision depend on the expectations of mortality and investment returns:** For retired Canadians with sufficient bridging funds in their RRSP/RRIF savings that they intend to use towards increasing their lifelong annual retirement consumption, the financial trade-offs underlying the decision to delay CPP payments depend on mortality and financial market returns. In other words, from a cashflow and savings perspective, the CPP timing decision is *unaffected* by those considerations that are normally key to retirement financial planning – such as Guaranteed Income Supplement (GIS) benefits, taxes, pension income, other savings, or even the level of the CPP benefit itself. *Mortality expectations and financial market returns are the only direct factors affecting the financial trade-offs in terms of cashflow and savings.*

It was comprehensive dynamic microsimulation modeling of Canadians with varying financial characteristics – and reaching the conclusion that the outcomes were the same – that pointed to this insight, although the explanation is relatively simple. If a person targets a single net annual lifetime income, and attempts to get there by either employing RRSP/RRIF wealth to augment income or delaying CPP payments, the ramifications on personal income taxes and GIS eligibility remain the same between both options. The output variables are, therefore, independent of the individual's other sources of income (earnings, workplace pension plan benefits, Old Age Security (OAS), non-registered savings) and taxes.

3. **One size can pretty much fit all:** This dependency property also allows the results to be generalized across Canadian retirees of varying personal financial characteristics, with the only driver of the financial risk/return trade-offs being the financial investment returns and the mortality of the individual. It also allows easier communication of the results to a broader audience, since the user has only to consider anticipated financial market returns and his/her longevity expectations. So, while it is normally necessary to employ a spectrum of illustrative examples to compare financial planning strategies in academic analysis, or to collect a client's full financial circumstances before tailoring financial planning advice in the practical world, the financial trade-offs associated with the CPP delay option are relatively simple to present: for Canadians with sufficient bridging funds from RRSP/RRIF savings intended to provide income to support consumption in retirement, the choice to delay or not delay CPP payments comes down to expectations about longevity and financial market returns.

4. **Communicating risk and return:** Since the financial risk and reward trade-offs associated with the CPP delay decision depend solely on how the bridging funds are otherwise invested, and mortality, this simplifies the communication of risk and return.

- **Apples to Apples (investing in risk-free assets for Option #2):** If the objective is to enhance lifetime income, delaying CPP payments is reasonably defined as a risk-free investment. That is, there is a secure real return on this investment for as long as the person is alive. This report finds that the risk-free “breakeven” age for the CPP delay choice can be directly calculated with a single formula (as opposed to the conventional tables employed for this purpose). From a risk-free perspective of income security, we calculate the following using the breakeven equation developed in this paper. Assuming as before that the risk-free rate of return matches inflation plus 1%:

If the individual otherwise chose to take CPP payments at age 65 rather than delay to age 70, he/she would run out of bridging funds by age 80 to achieve the same net income target without risk. In other words, only those who die before age 80 would receive more income from taking CPP payments at age 65. However, only a fifth of female CPP recipients and a quarter of males actually die before age 80 under current CPP actuarial tables.

- **Apples to Oranges (investing in risky assets for Option #2):** One alternative is to take CPP payments at age 65 and invest the RRSP/RRIF bridging funds (those funds that could have otherwise been used as a bridge) in a portfolio subject to market risks, making annual withdrawals that generate the same (age-70) net income that delaying CPP payments could have provided.

In this strategy, there is potential for greater income in case of a short life expectancy or high investment returns, but this potential correspondingly carries significant risk that is generally ignored.

This paper illustrates this risk by employing a longitudinal dynamic individual microsimulation model that incorporates stochastic markets, stochastic mortality, and the interactions among sources of retirement income within the complex Canadian tax and social benefit system, in such a way that captures the realistic interdependence for the CPP take-up decision within this system. We find that, if investments stochastically yield annual net (after fees) nominal returns that are independently and normally distributed with a long-term average rate of 4%, and 4% standard deviation, then:

- An age-65 male with high longevity expectations (life expectancy of 21.7 years) choosing not to delay CPP payments would face a 73% probability of receiving less net income (from the bridging funds and CPP benefits) than had he delayed CPP take-up to age 70.
- If he had low longevity expectations (life expectancy of 19.7 years), his probability would be reduced to 66%.
- Because women have greater longevity, the financial trade-offs of choosing not to delay CPP payments are more pronounced. With a high longevity expectation (life expectancy of 24.2 years), she would face an 81% probability of receiving less income than had she delayed CPP take-up to age 70.
- With low longevity expectations (life expectancy of 22.7 years), the corresponding proportion is 76%.

Research and reason suggest that higher self-managed investment returns and lower longevity expectations decrease the attractiveness of delaying CPP payments. We therefore also investigate the financial trade-offs for high investment returns with low longevity. Even if investments were to stochastically yield a mean long-term annual net (after fees) nominal rate of return of 6%, this extreme scenario results in a male with low longevity still facing a 51% probability of not achieving the same income as he would have had through delayed CPP payments.

These results demonstrate that risk matters, and the income certainty offered by the CPP delay decision is valuable. This is an important message for those advising Canadians, since it emphasizes the fact that deterministically treating the future as having no risk, which is the conventional approach to financial planning, undermines and undervalues the option of delaying CPP take-up. Attention should be paid to helping Canadians to think twice before forfeiting the secure, lifetime income that delaying CPP payments provides.

There are three comments regarding these results:

1. It is important to note that these results do not necessarily apply to Canadians without RRSP/RRIF savings – particularly those who are eligible for the GIS. The reason is that, without taxable income to substitute for the lost CPP benefits during the deferral period, delaying CPP payments essentially concentrates higher income later and reduces it earlier. The progressive Canadian tax system generally favors smooth income, and this is especially true in retirement when higher income triggers significant GIS repayments. Overall, as demonstrated in Laurin, Milligan, and Schirle (2008), the interactions between the tax and transfer system with a seniors' taxable income can make taking CPP payments as early as possible more attractive for Canadians without RRSP/RRIF income sources. This outcome is not a product of the CPP delay; rather, it reflects the way that the Canadian tax and transfer system treats all taxable income.
2. This paper examines the decision to delay CPP payments as long as possible by redirecting lifetime income from an RRSP/RRIF to provide a temporary bridge until the delayed CPP start date. The CPP take-up option is not a binary choice, however, as the payments can begin in any month before age 70. There could be situations in which a person has nearly enough secure income (such as from an employer-sponsored defined benefit (DB) pension plan), desires a top-up that is lower than the age-70 CPP payment, and therefore would prefer to keep some of the RRSP/RRIF bridge savings as accessible wealth or a legacy. In such a situation, Canadians have the choice to delay CPP payments to the specific month that delivers the desired level of secure lifetime CPP income. Holding onto the RRSP/RRIF savings, however, forfeits the opportunity to make those savings go further in terms of secure CPP income with its risk protection. Similarly, there might also be situations in which an individual wants as much secure lifetime income as possible but does not have enough RRSP/RRIF savings to support his/her income for the entire five-year period, in which case he/she could also choose to delay as far as the savings allow.
3. There are also very particular circumstances worth noting that could allow a person to leverage off the ups and downs of the effective marginal tax rates, and these limited circumstances could affect their CPP delay decision. For example, we noted that the progressive Canadian tax system generally favors smooth income. This is not necessarily true for Canadians at the threshold of the GIS phase-out, as well as the start and end of the OAS clawbacks. More specifically, it may be more advantageous for such a person to target their CPP income so that it, along with the minimum RRIF withdrawal and other fixed taxable income sources, keeps them within the eligibility range of receiving GIS/OAS benefits for as many years as possible, and only withdrawing larger lump sums of income from their RRIFs when they need it (and consequently minimizing the loss of GIS/OAS benefits).¹

Overall, **for the majority of Canadians with sufficient RRSP/RRIF savings intended to increase secure lifetime annual retirement income**, the right decision on whether to delay CPP payments depends on current investment returns and life expectancy. Given today's low-interest-rate environment and general population longevity expectations, this paper finds that delaying CPP payments is clearly a financially advantageous strategy. Even in an extreme case that favors not deferring CPP payments (low longevity expectations and very high expected investment returns), a person faces a 50% probability of receiving more income by delaying CPP payments, while still carrying the risk that

¹ Insight provided by Michael Wolfson of the Project Oversight Group on March 10, 2020, via personal correspondence.

they could do much worse. In the more appropriate risk-free investment comparison, 75–80% of Canadians within this framework would do better to delay their CPP payments.

With baby boomers now entering retirement, the timing of CPP take-up is gaining interest among the Canadian population. There are over 20 million Canadians participating in the CPP (and Québec Pension Plan, or QPP), so helping to inform decisions about the timing of CPP take-up has the potential to help many Canadians to improve their financial well-being in retirement.

Introduction

WHY DELAY CPP PAYMENTS?

Currently, a CPP pension can be taken as early as age 60, which carries a 0.60% reduction for each month prior to age 65 (or 36% for the full 60 months earlier). Delaying the CPP pension beyond age 65, up to age 70, increases the payment amounts by 0.7% for each month after age 65 (or 42% for the full 60-month deferral). Delays beyond age 70 would increase neither annual nor lifetime benefit levels. Sixty-five-year-old Canadians who cease employment also have the choice to delay CPP take-up to age 70 without impacting their base benefits; that is, the pension benefit calculation does not include any years of zero salary after age 65. A final, and often overlooked, advantage of delaying CPP payments is that, at age 70, the calculation is based on 142% of the earnings base at take-up (e.g. “Maximum Pensionable Earnings Average”²), which increases with the compounding of inflation and wage growth over those five years (from age 65 to age 70). Assuming that wages increase by 1.1% beyond inflation (following the CPP actuarial valuation report; Office of the Chief Actuary (OCA), 2016b³), the 142% would grow by 1.1% in excess of inflation. Therefore, choosing to delay CPP payments from age 65 to age 70 would result in about a 50% increase in the real benefit payout value (42%, taken together with real wage growth of 1.1% each year for five years, yields a 50% increase in real terms).

Delaying QPP payments operates in a similar way – with the exception that the non-contributory years between age 65 and 70 could impact the earnings base calculation if the retiree has insufficient drop-out room.

Although projecting the CPP payments stream at alternative take-up ages is a relatively straightforward calculation, the reduction in financial risk requires a deeper analysis. For example, if 65-year-olds have sufficient RRSPs/RRIFs to bridge the five-year gap by delaying CPP payments to age 70, not only do they have the potential to increase expected income stream over retirement, they can also reduce financial risk exposure, since the CPP secure payments would mitigate the consequences of:

1. Poor investment returns;⁴
2. High inflation; and
3. Living longer than anticipated.

These kinds of uncertainty can lead to running out of money before death, as well as being an unwanted source of anxiety during advanced ages when chronic health conditions and widowhood are more likely, inflation has eroded

² The Maximum Pensionable Earnings Average (MPEA), which is the basis for determining the contributor’s average pensionable earnings and therefore the value of his/her CPP pension, equals the average yearly maximum pensionable earnings in the year of retirement and the four previous years. The MPEA used for determining a benefit is the one for the year in which the benefit is first paid.

³ Note that, since the completion of this report, the OCA reduced the real wage growth projection assumption to 1.0% in the 30th CPP actuarial valuation report (OCA, 2019).

⁴ MacDonald and Osberg (2013) found that the fixed income provided by the CPP shields Canadian seniors from poor financial markets.

any fixed pension income (such as reducing by a third for 2% inflation compounded over 20 years), and wealth is potentially already depleted.

In addition to its protection against the financial risk of poor actual investment returns, unexpectedly high inflation, and living longer than expected, an additional benefit of delaying CPP payments is its capacity to provide better expected returns on investment for Canadians interested in augmenting lifetime retirement income. The argument in favor of purchasing higher levels of secure income (either through employer-sponsored DB pension plans, purchasing an annuity, and delaying the take-up of CPP pension benefits) is supported by the value of collective risk-sharing when pooling retirement savings. This consists primarily of the added return of mortality risk pooling – that is, when seniors pool their mortality risk, those who live longer will profit from the invested capital of those who die earlier. On top of this mortality premium, pooled funds also offer opportunities for economies of scale that can create augmented returns through better investment governance and reduced fees. When the mortality premium is added to a higher investment return, the overall rate of return for those who continue living can become quite substantial. Because of these financial gains, as reflected within the CPP actuarial adjustments, delaying CPP take-up offers the opportunity to improve the expected income stream for consumption throughout retirement, in addition to providing valuable financial risk protection.

PURPOSE OF STUDY

According to Statistics Canada’s 2016 Survey of Financial Security, 70% of Canadian families nearing retirement have RRSP/RRIF savings, with a median balance of about \$90,000.⁵ The idea of delaying CPP take-up is very unpopular despite its greater later-life income security and the financial capacity for many Canadians to fund a CPP delay. Fewer than 2% of Canadians choose to delay their CPP take-up to age 70⁶.

The purpose of this study is to frame and analyze the CPP delay decision for workers who cease working (retire) at age 65 and who intend to use some portion of their RRSP/RRIF savings towards increasing their lifelong annual retirement consumption; and this portion is sufficient to bridge the five-year income gap left by delaying CPP pension income as long as possible from age 65 to age 70.

The mainstream advice in popular financial planning is to take-up CPP payments as early as possible, or to compare the “breakeven” age (the age that the cumulative CPP pension payouts after delaying CPP payments equal the cumulative CPP payouts from having taken them at the earlier age) to the person’s subjective longevity expectations. This comparison says nothing about the trade-offs in taxes and OAS/GIS benefits, or the short- and long-term consequences of drawing down retirement savings. It also ignores the associated financial and mortality risks. A primary objective of this project is to move beyond shallow comparisons, and comprehensively present the cost and process of delaying CPP payments, as well as examining the trade-offs in terms of both risk and return, in order to provide a basis for informing Canadians’ take-up decisions.

A second objective of the paper is to present this information with sufficient clarity to be meaningful and accessible to professionals in the financial service industry, public policy analysts, pension plan sponsors, and Canadians who take an active interest in this topic – as well as the academic audience. This wider audience has a better opportunity to employ the research when guiding Canadians faced with this decision.

⁵ Statistics Canada. Table 11-10-0016-01 Survey of Financial Security (SFS), assets and debts held by economic family type, by age group, Canada, provinces and selected census metropolitan areas (CMAs) (x 1,000,000)
DOI: <https://doi.org/10.25318/1110001601-eng>

⁶ Authors’ calculations using averages since 1992. Source: Open Government data, <https://open.canada.ca/data/en/dataset/ea075020-b9f4-43c4-8d04-075132cbbc7d>

We carry out the analysis using Ruthen, developed over the past decade by co-authors Morrison and Avery. Ruthen is an established longitudinal microsimulation package for building models to simulate the consequences of alternative financial strategies. Outputs include distributions for rich realistic sets of outcomes that would flow from using those strategies. Large-scale, complex, dynamic microsimulation models like Ruthen are increasingly becoming the international tool of choice for assessing financial planning strategies, as well as a variety of other analyses, since such models have the capacity to capture and integrate the complexity of a person’s full financial circumstances, the spectrum of risks that they face, and the complex tax and transfer environment that they live in. By having the ability to more fully measure the financial outcomes of alternative strategies, better strategies can be identified and adopted to manage those outcomes (like delaying CPP payments). Ruthen modeling has been the tool of analysis in a variety of other programs of research, including MacDonald, Morrison, Avery, and Osberg (2018).

This paper is broken into three parts. The first – Part A – presents a conceptual framework for understanding the CPP delay decision through the use of actuarial mathematics. Part B employs the conceptual framework developed in Part A to present and quantify the financial risk/return trade-offs associated with delaying CPP payments. Part C discusses future areas of research.

Part A: Conceptual Framework and Insights

Choosing among alternative ages for CPP take-up is complicated. The choice is made within the complex Canadian retirement income system, where financial implications are driven by personal circumstances, government program regulations, financial markets, and other economic outcomes, with interdependencies that evolve and co-evolve in known and unknown ways into the future. These interdependencies include the trade-offs in potential benefits from the CPP/OAS/GIS, tax implications, and the continuing interactions with retirement’s array of financial risks.

This paper addresses the situation for a retiring Canadian worker who has sufficient RRSP/RRIF savings to bridge the five-year income gap left by delaying his/her CPP. Although such an individual could take-up a CPP pension in any month throughout the age range 60 to 70, this analysis focuses on the discrete choice between age 65 (and ceasing work) or age 70 (delayed take-up, but with no work beyond age 65). For Canadians aged 65, therefore, the evaluation is reduced to the following question:

- What are the risk and consumption trade-offs between (1) delaying CPP payments to age 70 and using RRSP/RRIF savings to bridge the five-year gap between ages 65 and 70, and (2) taking CPP payments at age 65 and self-managing the RRSP/RRIF savings?

The answer to this question depends on how retirement savings are self-managed. And the challenge is that there are infinite possible approaches to drawing down savings, thereby leading to an unwieldy analysis with output that can be difficult to interpret and communicate to a wider audience.

We begin, therefore, by building a conceptual structure to capture this decision formulaically; we then use this structure to quantify and communicate the financial trade-offs in Part B. We also find that an explicit mathematical expression of the CPP delay decision allows us to define the cost and process of delaying CPP payments, as well as identifying various insights.

Section A.1 summarizes the conceptual approach, which Section A.2 presents algebraically.

A.1 CONCEPTUAL APPROACH OVERVIEW

To structure a manageable analysis, the comparison is between two otherwise identical financial strategy options (to delay or not delay). Both options exhibit the same features as regards the economic and tax/transfer environment, and the subject’s mortality. Both options:

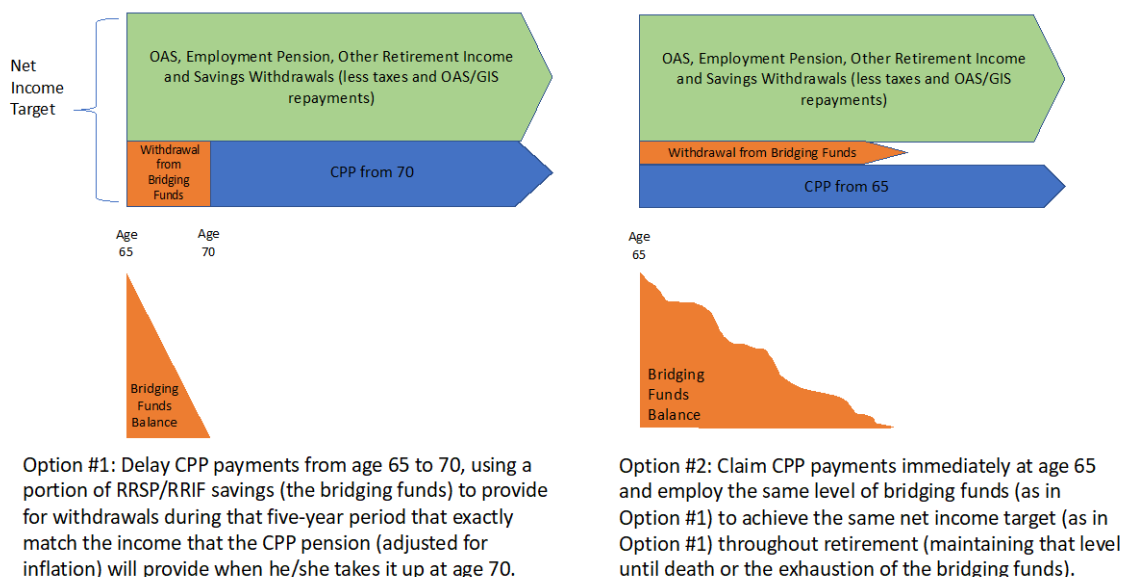
- Target the same annual income available for consumption each year, which are both after taxes and OAS/GIS net benefits (“net income”):
 - The individual’s other income (such as income from a DB pension plan, other RRSP/RRIF withdrawals, and non-registered savings) is managed in the same way between both options to achieve the desired net income target for that particular year.
- Employ the same initial portion of RRSP/RRIF savings at age 65 to reach that target:
 - The bridging fund is computed to fund a constant real income bridge to the CPP benefit level that will be received at the end of the delay.

The two options differ only in the take-up decision timing. Specifically, within this structure, the individual has two choices:

- Option #1: Delay CPP payments from age 65 to 70, using a portion of RRSP/RRIF savings (the bridging funds) to provide for withdrawals during that five-year period that exactly match the income that the CPP pension (adjusted for inflation) will provide when he/she takes it up at age 70.
- Option #2: Claim CPP payments immediately at age 65 and employ the same level of bridging funds (as in Option #1) to achieve the same net income target (as in Option #1) throughout retirement (maintaining that level until death or the exhaustion of the bridging funds).

Both options employ the same initial level of bridging funds, which are used to target the same level of lifetime secure net annual income. Figure 1 illustrates this conceptual framing of the decision for individuals aiming for a constant real net income target from one year to the next.

Figure 1: Two take-up options in conceptual framing of CPP timing choice, with a constant real net income target from one year to the next



During initial analysis, we tested and explored the financial implications associated with these two options for a spectrum of Canadians with varying financial characteristics in terms of levels of CPP benefits, employer pension plan income, annuity income, additional withdrawals from RRIFs each year (above and beyond the withdrawals

made from the bridging fund), withdrawals from tax-free savings accounts (TFSA), withdrawals from non-registered investments, and other variants. We carried out our investigation using the stochastic microsimulation model described in Part B; it incorporates stochastic implementations of inflation, financial markets, and mortality, while addressing the interactions among sources of retirement income within the complex Canadian tax and social benefit systems.

We found that, within this structure, the tax and social transfer implications were the same for both options. The reason is that if a person targets a particular net income in a particular year, and attempts to get there by either employing RRSP/RRIF wealth to augment income or delaying CPP payments, then the ramifications for personal income taxes and GIS eligibility remain the same. The formulas presented in Section A.2 are independent of the individual's other sources of income (earnings, workplace pension plan benefits, OAS, non-registered savings) and taxes, so long as those other sources of income are managed the same way to achieve that particular year's net income target.

A.2 MATHEMATICAL PRESENTATION OF THE FRAMEWORK

This section outlines and formally presents the conceptual approach described in Section A.1.

Let:

- CPP_x represent the baseline CPP pension payable at age x for age-65 take-up;
- CPP_x^* represent the delayed CPP pension payable at age x for age-70 take-up;
- p_x represent inflation between ages x and $x+1$; and
- w_x represent the adjustment to the CPP earnings base between ages x and $x+1$ above the inflation adjustment (i.e., national real per capita wage growth).

The relationship between the CPP payment at age 65 and the delayed CPP payment at age 70 is as follows:

$$CPP_{70}^* = 1.42 \times CPP_{65} \times \left[\prod_{y=65}^{69} (1 + w_y) \times (1 + p_y) \right] \quad (1)$$

We next present the formulas that compute the necessary bridging fund and withdrawal payments under both options.

Option #1: Delay CPP payments from age 65 to 70, using a portion of RRSP/RRIF savings (the bridging funds) to provide for withdrawals during that five-year period that exactly match the income that CPP pension (adjusted for inflation) will provide when he/she takes it up at age 70.

If the person delays take-up to age 70, there is an initial drawdown from the RRSP/RRIF in the first five years to fund the missing delayed CPP revenue between age 65 and 70.

The income target can be achieved with the following bridging funds withdrawals:

$$\begin{aligned} \text{Withdrawal Payment}_x &= \frac{CPP_{70}^*}{\left[\prod_{y=x}^{69} (1 + p_y) \right]}, \quad x = 65, \dots, 69.^7 \\ &= \frac{1.42 CPP_{65} \times \left[\prod_{y=65}^{69} (1 + w_y) \times (1 + p_y) \right]}{\left[\prod_{y=x}^{69} (1 + p_y) \right]} \quad (2) \end{aligned}$$

The required bridging funds are determined at age 65 under the assumption that the funds grow by a fixed real rate of return over the five-year deferral period. With a short five-year investment horizon, the assumption is essentially that bridging funds are invested in risk-free assets. In practice, a person investing over a five-year period (a 2.5-year average duration) would be well advised to take substantially less risk than someone investing over a longer

⁷ This notation signifies all ages x between 65 and 69 inclusive.

duration. An alternative approach to expressing this framework in actuarial terms is that the bridging funds are used to purchase a five-year term annuity-due with a fixed real rate of return.

Let:

- i_x represent the nominal return on investments between ages x and $x+1$; and
- r_x represent the real return on investments between ages x and $x+1$.

The bridging funds required to fund CPP delay (age 65 to age 70) at age x are:

Bridging Funds $_x, x = 65, \dots, 69$

$$\begin{aligned} &= \sum_{y=x}^{69} \left\{ \frac{\text{Withdrawal Payment}_y}{\prod_{z=x}^{y-1} (1+i_z)} \right\} \\ &= \sum_{y=x}^{69} \left\{ \frac{1.42CPP_{65} \times \left[\prod_{z=65}^{69} (1+w_z) \times (1+p_z) \right]}{\left[\prod_{z=y}^{69} (1+p_z) \right]} \times \frac{1}{\prod_{z=x}^{y-1} (1+i_z)} \right\} \\ &= \sum_{y=x}^{69} \left\{ \frac{1.42CPP_{65} \times \left[\prod_{z=65}^{69} (1+w_z) \times (1+p_z) \right]}{\left[\prod_{z=x}^{69} (1+p_z) \right]} \times \frac{\prod_{z=x}^{y-1} (1+p_z)}{\prod_{z=x}^{y-1} (1+i_z)} \right\} \\ &= \sum_{y=x}^{69} \left\{ \frac{1.42CPP_{65} \times \left[\prod_{z=65}^{69} (1+w_z) \times (1+p_z) \right]}{\left[\prod_{z=x}^{69} (1+p_z) \right]} \times \frac{1}{\prod_{z=x}^{y-1} (1+r_z)} \right\} \\ &= \sum_{y=x}^{69} \left\{ 1.42CPP_{65} \times \left[\prod_{z=65}^{69} (1+w_z) \times \prod_{z=65}^{x-1} (1+p_z) \right] \times \frac{1}{\prod_{z=x}^{y-1} (1+r_z)} \right\} \end{aligned}$$

As discussed, we assume that the bridging funds are invested in a risk-free asset that grows by a fixed real rate of return “ r ”. We also estimate the future CPP benefit by setting the national per capita real wage growth at w (which we estimate according to the OCA’s current projection assumption). In other words, $r_x = r$ and $w_x = w, x \in [65, 69]$:

Bridging Funds $_x, x = 65, \dots, 69$

$$\begin{aligned} &= \sum_{y=x}^{69} \left[1.42CPP_{65} \times (1+w)^5 \times \prod_{z=65}^{x-1} (1+p_z) \times \frac{1}{\prod_{z=x}^{y-1} (1+r)} \right] \\ &= 1.42CPP_{65} \times (1+w)^5 \times \prod_{z=65}^{x-1} (1+p_z) \times \left[\sum_{y=x}^{69} \frac{1}{\prod_{z=x}^{y-1} (1+r)} \right] \\ &= (1.42CPP_{65} \times (1+w)^5) \times \prod_{z=65}^{x-1} (1+p_z) \times \ddot{a}_{\overline{69-x+1}|r} \end{aligned} \tag{3}$$

where $\ddot{a}_{\overline{n}|r}$ is the actuarial present value of \$1 (inflation-indexed) at the beginning of each year for n years (e.g., inflation-indexed n -year annuity-due)⁸

$$\ddot{a}_{\overline{n}|r} = \sum_{t=0}^{n-1} \frac{(1+i)^{-t}}{(1+p)^{-t}} = \sum_{t=0}^{n-1} (1+r)^{-t} .$$

and total savings required to fund CPP delay (age 65 to age 70) at age 65 are:

$$\text{Bridging Funds}_{65} = [1.42CPP_{65} \times (1+w)^5] \ddot{a}_{\overline{5}|r}$$

The savings withdrawals in the first five years are:

$$\text{Withdrawal Payment}_{65} = 1.42CPP_{65} \times (1+w)^5$$

$$\text{Withdrawal Payment}_x = \text{Withdrawal Payment}_{x-1} (1+p_{x-1}), x = 66, \dots, 69 \tag{4}$$

Combining eqs. (3) and (4), therefore, the fraction of the savings that would be withdrawn in the first five years is:

⁸ See Brown and Kopp (2012) for further information on the mathematical notation.

$$\begin{aligned}
 \text{Withdrawal Percent}_x &= \frac{\text{Withdrawal Payment}_x}{\text{Bridging Funds}_x} \\
 &= \frac{1.42CPP_{65} \times (1+w)^5 \times \prod_{z=65}^{x-1} (1+p_z)}{(1.42CPP_{65} \times (1+w)^5) \times \prod_{z=65}^{x-1} (1+p_z) \times \ddot{a}_{69-x+1|_r}} \\
 &= \frac{1}{\ddot{a}_{69-x+1|_r}} \tag{5}
 \end{aligned}$$

and the savings withdrawn in the first year at age 65 would be:

$$\begin{aligned}
 \text{Withdrawal Percent}_{65} &= \frac{\text{Withdrawal Payment}_{65}}{\text{Bridging Funds}_{65}} \\
 &= \frac{1}{\ddot{a}_{5|_r}}
 \end{aligned}$$

As discussed, this analysis makes the simplifying (as well as realistic) assumption that the invested funds needed to bridge the five-year gap should be invested in a risk-free real asset that grows by a fixed real rate of return. As demonstrated in Equation (3), this is the equivalent of using the bridging funds to purchase a five-year annuity-due with payments that are indexed by inflation.

Option #2: Claim CPP immediately at age 65 and employ the same level of bridging funds (as in Option #1) to achieve the same net income target (as in Option #1) throughout retirement (maintaining that level until death or the exhaustion of the bridging funds).

While sufficient funds remain, the withdrawal payments for Option #2 are as follows:

$$\text{Withdrawal Payment}_x = CPP_x^* - CPP_x, \quad x \geq 65$$

Between ages 65 and 69:

$$\begin{aligned}
 \text{Withdrawal Payment}_x &= \frac{CPP_{70}^* - CPP_{70}}{\left[\prod_{y=x}^{69} (1+p_y) \right]} \\
 &= \frac{1.42CPP_{65} \times \left[\prod_{y=65}^{69} (1+w_y) \times (1+p_y) \right] - CPP_{65} \times \prod_{y=65}^{69} (1+p_y)}{\left[\prod_{y=x}^{69} (1+p_y) \right]}, \quad x = 65, \dots, 69 \tag{6}
 \end{aligned}$$

Fixing the real wage growth at w between ages 65 to 70, as before, the withdrawal payments for ages 70 and over:

$$\begin{aligned}
 \text{Withdrawal Payment}_x &= CPP_{70}^* - CPP_{70} \times \left[\prod_{y=70}^{x-1} (1+p_y) \right] \\
 &= CPP_{65} \times \left[1.42 \times \prod_{y=65}^{69} (1+w_y) - 1 \right] \times \prod_{y=65}^{x-1} (1+p_y), \quad x \geq 70
 \end{aligned}$$

At ages 65 to 69:

$$\begin{aligned}
 \text{Withdrawal Payment}_{65} &= 1.42CPP_{65} \times (1+w)^5 - CPP_{65} \\
 \text{Withdrawal Payment}_x &= \text{Withdrawal Payment}_{x-1} (1+p_{x-1}), \quad x \in [66, \text{earlier of death or fund exhaustion}] \tag{7}
 \end{aligned}$$

Combining eqs. (3) and (7), therefore, the percent of bridging funds that would be withdrawn in the first year is:

$$\begin{aligned}
 \text{Withdrawal Percent}_{65} &= \frac{\text{Withdrawal Payment}_{65}}{\text{Bridging Funds}_{65}} \\
 &= \frac{1.42CPP_{65} \times (1+w)^5 - CPP_{65}}{(1.42CPP_{65} \times (1+w)^5) \ddot{a}_{5|_r}}
 \end{aligned}$$

$$= \frac{1.42 \times (1+w)^5 - 1}{(1.42 \times (1+w)^5) \ddot{a}_{\overline{5}|r}} \quad (8)$$

Fixing the risk-free investment of the bridging funds is a key feature of this analysis because it anchors the needed amount of funds to bridge the five-year gap to a constant amount. Combined with secure CPP income flows under each option (the age-65 CPP payments are fixed in real terms, as are the delayed CPP payments at age 70), we now have a single drawdown strategy to evaluate under each option to make up the difference in the CPP income streams (eqs. (5) and (7)) that uses all of the bridging funds.

By not fixing the amount of savings required to bridge the five-year gap to a constant amount, alternative financial market scenarios would produce varying drawdown strategies to evaluate. Making this limited deterministic assumption – one that also reflects sound, established investment practices – enables a direct comparison and simplifies the analysis sufficiently to allow for a practical resolution of an otherwise complex question.

Appendix A presents the same formulas, except for using a retiring 60-year-old worker with an option to delay CPP payments to age 65.

Part A Findings

The cost of delaying CPP payments can be expressed with simple formulas. The necessary RRSP/RRIF savings and annual withdrawals to delay CPP payments to age 70 are all functions of the age-65 CPP pension benefit (that is, they are independent of the individual's other financial income flows).

The savings required to fund the delay (Equation 3), and the withdrawals for either options (eqs. 4 and 7), are all functions of the age-65 CPP pension. This insight substantially simplifies communicating the cost and process of delaying CPP payments.

Assuming that real risk-free investment returns and real wage growth are fixed at 1% and 1.1% respectively during the five-year delay period:

Option #1: *A 65-year-old retiring Canadian can increase his/her real (after-inflation) CPP pension by 50% until death by claiming CPP payments at age 70 and employing RRSP/RRIFs to provide bridging funds over the five-year income gap:*

- RRSP/RRIF Savings Required: 7.35 times the age-65 CPP pension payout (from Equation (3)).
- Savings Withdrawals: 20.4% of this bridging fund at the beginning of the first year, with the initial withdrawal amount indexed by inflation for each of the following four years (from Equation (5)). This would equal 25.4% of the remaining fund at the beginning of the second year, 33.7% in the third year, 50.3% in the fourth, and 100% in the fifth.

Option #2: *Claiming CPP payments at age 65 and employing RRSP/RRIF to top-up CPP pension benefits by 50% from age 65 onwards:*

- Savings Withdrawals: 6.8% of this fund in the first year, with that initial amount indexed by inflation for each year until death or exhaustion of the fund (from Equation (8)).

For example, a 65-year-old who has accumulated a CPP benefit of \$13,600/year would require approximately \$100,000 to bridge the five-year delay:

- Option #1: He would withdraw \$20,400 at age 65 (150% of the age-65 CPP benefit, or 20.4% of the fund), which he would index by inflation for the next four years.
- Option #2: Having taken up CPP payments at age 65, he would withdraw \$6,800 at age 65 (50% of the age-65 CPP benefits, or 6.8% of the fund), which he would index by inflation each year until death or exhaustion of the fund.

Part B: Quantifying and Communicating the Risk and Rewards of Delaying CPP Payments

This section presents the risk-mitigation of the CPP delay decision – beginning from a risk-free perspective in terms of income security, and then examining the introduction of financial market, inflation, and longevity risk.

B.1 APPLES TO APPLES: A RISK-FREE PERSPECTIVE

As discussed in the Introduction, the most common approach to evaluating the CPP delay decision is by comparing the breakeven age (the age that the cumulative real payouts from delaying CPP payments match those from having taken them at the earlier age) to the person’s subjective longevity expectations. This calculation is often done incorrectly, and this section aims to rectify some of the issues and propose a more appropriate formula.

The first limitation of the conventional approach is that it does not address the many considerations discussed throughout this paper, namely the associated financial and mortality risks of not delaying. Introducing investment, inflation, and mortality risk would require risk metrics to adequately represent the financial trade-offs. We do this in Section B.2.

To reconcile this issue for the purpose of producing a “breakeven age”, the calculation explicitly requires a risk-free investment environment to fairly reflect the security of the CPP income.

Further, the mortality statistics employed in the mainstream financial advice to inform the person’s subjective longevity expectations often make the error of using life expectancy from birth, or of the entire population – both of which underestimate the longevity expectations of a 65-year-old with sufficient financial means to consider delaying CPP payments (which includes the anticipated longevity improvements over the next few decades). This paper’s analysis uses more appropriate statistics.

Another practical issue with the conventional breakeven approach is that the analysis is often very bulky since the results are presented in large, cumbersome tables. Using the framework established here, the breakeven age can be expressed in a single formula.

The breakeven age is the point by which the withdrawals in Option #2 have depleted the bridging funds (determined for both Option #1 and #2). In our initial deterministic analysis here, this is determined by solving for age z when the bridging funds equal the discounted stream of Option #2 withdrawals at age 65, calculated using the risk-free return on investments.

*Bridging Funds*₆₅

$$\begin{aligned}
 &= \sum_{x=65}^z \text{Withdrawal Payment}_x \times \frac{1}{(1+i)^{(x-65)}} \\
 &= \sum_{x=65}^z \text{Withdrawal Payment}_{65} \times \frac{(1+p)^{(x-65)}}{(1+i)^{(x-65)}} \\
 &= \sum_{x=65}^z \text{Withdrawal Payment}_{65} \times \frac{1}{(1+i)^{(r-65)}} \\
 &= \text{Withdrawal Payment}_{65} \ddot{a}_{z-65|r}
 \end{aligned}$$

Substituting eqs. (3) (bridging funds at age 65) and (7) (withdrawal payment at age 65 for Option #2), we can solve for the breakeven age z :

$$\begin{aligned}
 \text{Bridging Funds}_{65} &= \text{Withdrawal Payment}_{65} \ddot{a}_{z-65|r} \\
 (1.42\text{CPP}_{65} \times (1+w)^5) \ddot{a}_{\bar{5}|r} &= (1.42\text{CPP}_{65} \times (1+w)^5 - \text{CPP}_{65}) \ddot{a}_{z-65|r}
 \end{aligned}$$

$$\ddot{a}_{z-65|r} = \frac{(1.42 \times (1 + w)^5) \ddot{a}_{5|r}}{(1.42 \times (1 + w)^5 - 1)}$$

Applying the actuarial formula for an annuity-due with a fixed term (which is derived from employing the sum of a geometric progression; see Brown and Kopp, 2012), the term to the breakeven age can be calculated directly:

$$z - 65 = \frac{-\ln\left(1 - \left(\frac{(1.42 \times (1 + w)^5) \ddot{a}_{5|r}}{1.42 \times (1 + w)^5 - 1}\right) \frac{r}{1 + r}\right)}{\ln(1 + r)}, r > 0$$

$$z - 65 = \frac{(1.42 \times (1 + w)^5 \times 5)}{1.42 \times (1 + w)^5 - 1}, r = 0 \tag{9}$$

Equation (9) enables the user to directly calculate the breakeven age at any risk-free real rate of return. Assuming that real risk-free investment returns and real wage growth are fixed at 1% and 1.1% respectively, the term to the breakeven age is 15.80 years. Note, however, that the payments are assumed in this framework to occur annually at the beginning of the year. In other words, 15.8 indicates that the first payment occurs at age 65 and the last full payment occurs at age 79, with enough funds remaining to fund 80% of a payment at age 80 before being exhausted. Hence, to achieve the same risk-free income stream as that delivered by the CPP by investing in risk-free assets, the savings would be depleted by age 80.

For a zero real rate of return, which is closer to current Canadian bond rates, the term is 15 years, making 79 the last year of a payment (e.g., breakeven age).

The breakeven term for a 2% risk-free real rate of return is 16.8 years (or 16.8 annual payments), 3% is 18, 4% is 19.5, and so on.

The breakeven age can also be seen as the deterministic age by which the funds are exhausted within a risk-free investment environment. The next section examines the stochastic age that funds are exhausted within a risky investment environment.

B.2 APPLES TO ORANGES: CHOOSING TO INVEST BRIDGE FUNDS

Canadians could choose not to delay CPP payments in the expectation that investing the bridging funds in risky assets will potentially generate a greater lifetime income.

This section examines the risk and reward trade-offs associated with this option relative to delaying CPP payments. The analysis is complicated by the necessity to choose suitable risk metrics that adequately represent the financial trade-offs that occur when investment, inflation, and mortality risks are introduced. Section B.2.1 begins by discussing the financial trade-offs, and the risk metrics to capture those trade-offs.

We next employ dynamic individual microsimulation modeling to analyze and quantify these risks and rewards by considering two financial market scenarios and four levels of mortality (detailed in this section):

- Long-term average real (after inflation) net (after fees) annual rate of return on savings: 2% and 4% (with 4% and 12% standard deviations), based on current financial planning standards guidelines.
- Four levels of survival rates for each gender based on the mortality rates conditional on CPP pension levels, as computed from program data for CPP recipients.

Section B.2.2 describes our analytical tool, B.2.3 details our assumptions, and B.2.4 presents our results.

B.2.1 DEFINING THE FINANCIAL RISK/RETURN TRADE-OFFS VARIABLES

We next discuss and define the metrics for evaluating the financial risk/return trade-offs of delaying CPP payments. We then employ these in the rest of Part B for carrying out the analysis and communication of risk and return.

When one contemplates whether to use savings to purchase a secure lifetime income (either through joining an employer-sponsored DB pension plan, purchasing an annuity, or delaying the take-up of CPP pension benefits), the two primary competing goals are generally income security and access to wealth during retirement. This analysis captures both the income security and the remaining funds that are used either for bridging in Option #1 or to fund consumption in Option #2:

- **Income Security:** To capture the risk associated with choosing not to delay CPP payments, i.e., to take them up at age 65, we evaluate the likelihood that the bridging funds will run out (under Option #2) and not provide the predictable income that the delayed CPP income could have provided. To measure this risk, the first variable we track is the annual net consumable income (net income) associated with each alternative option across simulations. More specifically, we are interested in knowing when the net income drops because the funds that could have been used for bridging have become exhausted – hence, when does the net income of having delayed CPP payments (Option #1) exceed the net income of having taken CPP payments at age 65 (Option #2).
- **Bridging Funds Remaining:** One consequence of taking up CPP payments earlier is that more savings remain accessible at need. To capture this trade-off, the second output measure that we focus on is the year-by-year constant-dollar account balances of the funds that could have been used for bridging as a fraction of its initial balance. Although this study employs the standing account balances to represent accessible wealth, a fairer comparison between the variables would be to make “accessible wealth” similarly after-tax, as is “net income”. This could be done by applying an appropriate marginal tax rate to the account balances. Clearly, if the balance were high enough and the person withdrew all of the funds in a single year, this could generate higher, and possibly the highest, marginal tax rates. Applying the current marginal tax rate treats the savings as a continuing entity – essentially assuming that the person could take some of it, but not a large amount in any particular year.

As previously indicated, the focus of this study is to examine retiring Canadians who intend to use a particular portion of RRSP/RRIF savings towards increasing their lifelong annual retirement consumption, with this portion sufficiently large to provide a constant real income bridge to the CPP benefit level that will be received at the end of the delay. In other words, while the person may have other savings that are intended to serve as accessible funds, the priority of the bridging funds is income security and not accessible funds. The goal of having accessible wealth remaining from the bridging funds is, nevertheless, noted in this section for completeness.

With the two goals under examination (i.e., net income and accessible wealth), the uncertainty that will drive risk is only associated with Option #2. The explicit assumption outlined in Section A.2 is that there is no risk associated with delaying CPP payments in Option #1, which features:

- A net income that is secure and inflation-adjusted (implying that the CPP and OAS programs are treated as sustainable, and the indexing of the tax system remains unchanged);
- A determined and fixed amount of funds necessary to bridge the gap, with these bridging funds assumed to be invested in a risk-free investment that is depleted uniformly during the five-year deferral period; and
- No accessible wealth remaining after age 70 from the initial bridging funds.

Choosing Option #1 to delay CPP take-up to age 70 is treated as an essentially risk-free income option. Note that there is potential for unused wealth in Option #1 in the event of death before age 70. However, given that there is probability of survival past age 70 of over 95% according to the mortality tables, incorporating this additional analysis would unnecessarily complicate the communication of the results for an unlikely outcome.

Another observation is the risk event in Option #2. When comparing alternative drawdown strategies, risk is generally defined as being associated with

- Year-to-year volatility in the level of retirement income;
- The probability of “ruin” (e.g., that savings will be exhausted prior to death); and
- The probability that retirement income falls below a specified threshold (shortfall risk) (see Pfau et al., 2017).

In this analysis, these three events would occur simultaneously for Option #2 in the year in which the bridging funds (savings that would have been allocated to bridge the CPP to age 70) are exhausted. The next section describes our tool to stochastically model this event, while tracking the relevant income flows and account balances.

B.2.2 INDIVIDUAL MICROSIMULATION MODEL

This paper employs a longitudinal dynamic microsimulation model to examine the financial consequences of alternative drawdown strategies within the Canadian retirement income system, while accounting for the uncertainty of future financial returns, inflation rates, and mortality. An important benefit of the microsimulation approach is that, while deterministic modeling examines a single “average” potential future, individual microsimulation modeling simulates many (here, a million) independent futures, all of them following from a specified financial strategy. It tracks the income flows year by year as they interact with the financial market, inflation, and with the set of tax and benefits programs relevant for the individual. Flexible detailed outputs provide significant analytical flexibility to fully and clearly examine the distributions of financial consequences associated with alternative financial strategies. With this greater analytical flexibility, we can better investigate and gain a clearer understanding of the resilience of alternative financial strategies to future risk.

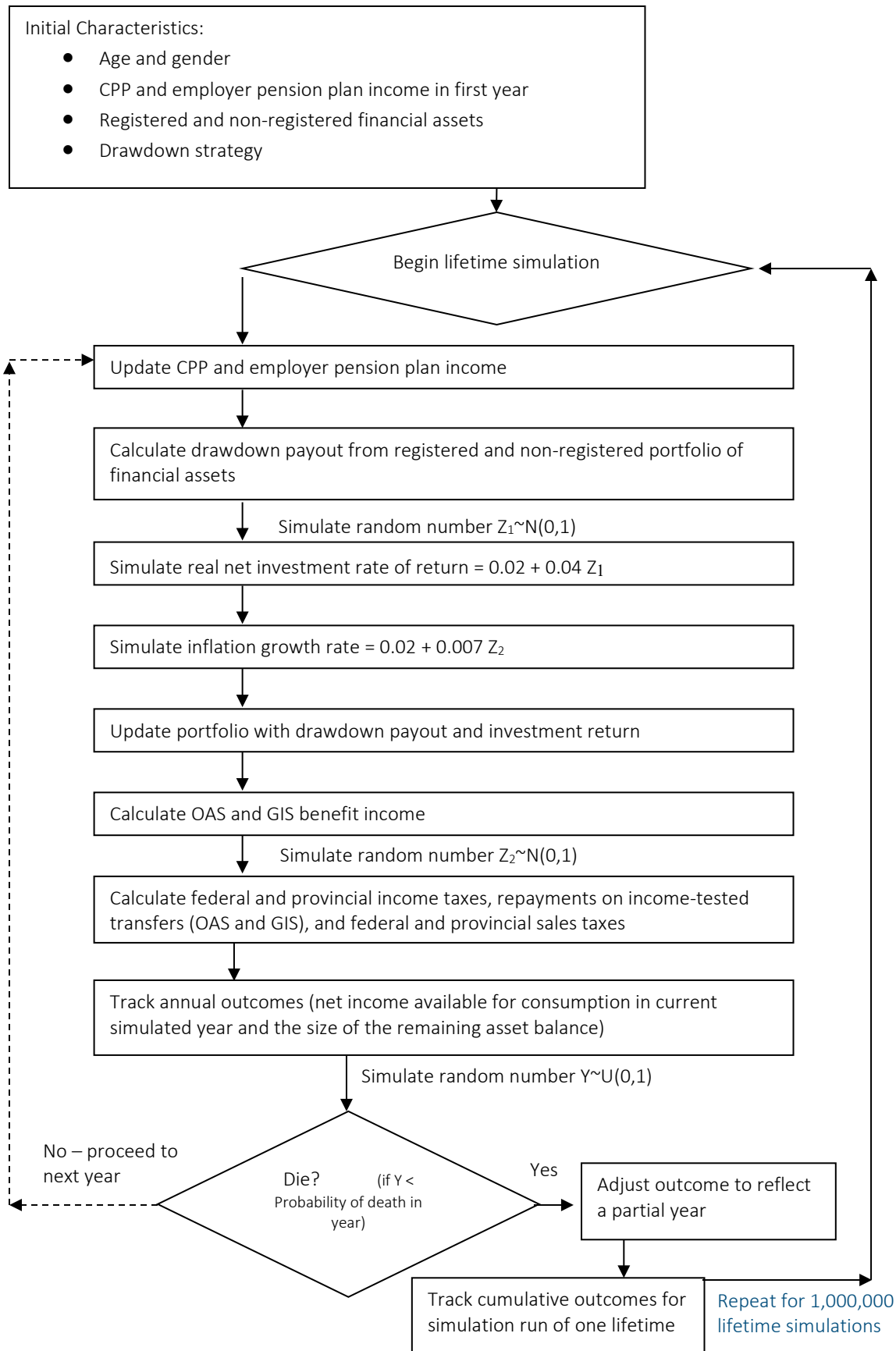
Figure 2 illustrates the general simulation structure⁹. The top box of Figure 2 represents the input at the outset of each simulated lifetime. This information includes the subject individual’s chosen drawdown strategy, personal characteristics, and financial resources in term of the tax-assisted and non-tax-assisted portfolio sizes at retirement, and the CPP and private (employer) pension benefit levels. The simulation first determines the various income sources that the person is eligible to receive during the coming year. Based on this, it next calculates the drawdown amount, which is then subtracted from the portfolio of financial assets, which accumulates according to the simulated asset returns, generating dividends, interest income, and a mix of realized and unrealized capital gains. The realization of capital gains, asset returns, and withdrawals from the portfolio all affect both the taxes payable and the composition of the portfolio heading into the next year. The individual pays all relevant income taxes at the end of the year, including repaying any government income-tested benefits that are “clawed back” as a result of the year’s income level, as well as taxes on realized capital gains. Sales taxes are then payable on amounts remaining to be spent after all of the taxes, benefit repayments, and health care charges have been paid. Inflation and returns to funds are stochastic, as is mortality (described below). Models could further include stochastic elements for unemployment and involuntary retirement, since these also affect the outcomes associated with financial strategies, but because our subjects are entering retirement we have not included those risks here.

Year by year, the model records the relevant annual information. This process continues until the individual has died, which is determined by comparing a pseudo-random draw against appropriate mortality table rates each year (here using CPP program data that reflect both gender and pension level), and is treated as happening at the end of the year. Once the individual dies, the model records the relevant end-of-life information for the particular lifetime,

⁹ This description summarizes that given in MacDonald et al. (2018).

and moves on to the next instantiation. For the analyses used in this paper, each run generates one million independent instantiations of the subject individual.

Figure 2: General simulation structure of longitudinal dynamic microsimulation model (modified from Figure 1 in MacDonald et al., 2018)



The choice of a microsimulation approach reflects the challenges associated with using classical statistical and optimization techniques when evaluating alternative financial strategies. As discussed in MacDonald et al. (2013), more traditional optimization techniques encounter a variety of difficulties when modeling the realistic outcomes of alternative financial strategies, the most obvious challenge being their inability to incorporate the discontinuous functions and derivatives inherent in the Canadian tax and transfer system.

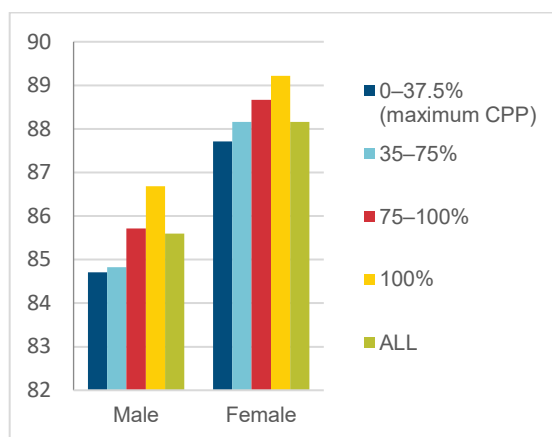
The second important advantage of the microsimulation approach is that it allows the analyst to track and examine the necessary simulated information in as much detail as is desired, and to use custom metrics best suited to the topics under consideration. So, while the traditional approach is often very limited in its output measures, microsimulation opens the scope to evaluate the trade-offs between alternative financial strategies from a variety of perspectives – risks and returns such as annual or lifetime mean/medians for the various income flows, the quantiles associated with those income flows, or other distribution statistics such as “ruin”, the probability that a particular government benefit is received, etc. Finally, having access to the full slate of intervening variables considerably facilitates model validation – that is, ensuring that the model is doing what it is supposed to be doing, which is particularly important given the complexity of the Canadian tax/transfer system.

B.2.3 KEY PROJECTION ASSUMPTIONS SUMMARY

When simulating the drawdown of wealth over the individual’s retirement we use:

- Gender-specific CPP population mortality rates, by four levels of CPP income as provided in the CPP mortality study published by the OCA (2015), corresponding with cohort mortality of a 65-year-old male and female in 2018, with assumed future improvements in mortality of the general population going forward:
 - <35% Maximum CPP Pension: 26% of CPP recipients;
 - 35–75% Maximum CPP Pension: 26%;
 - 75–99.5% Maximum CPP Pension: 32%; and
 - >99.5% Maximum CPP Pension: 17%.

Figure 3: Life expectancy for 65-year-old in 2018 at four levels of the maximum CPP (OCA, 2015)



Note: 65-year-old cohort life expectancies that take into account assumed future improvements in mortality of the general population, using base data and mortality improvements from the OCA (2015).

- Canadian Government tax/benefit values assuming the 2018 rules, including those regarding indexation, extended into the future.¹⁰
- Self-managed asset portfolio modeling: We stochastically simulate future self-managed assets’ annual net (after fees) real (after inflation) rates of return assuming that they are independently and identically normally distributed with a mean of 2% and standard deviation of 4% (as well as a higher financial market outlook mean 4% and standard deviation of 12%). The purpose of these assumptions is to provide a reasonable demonstration of the range of outcomes that flow from adding uncertainty into future investment returns, although the expected returns and associated standard deviation are an area of large debate.¹¹
- Inflation: We assume that inflation is independently and identically normally distributed from year to year with a mean of 2.0% and a standard deviation of 0.7%, as calculated from historical inflation rates over the past two decades (see MacDonald et al. (2018) for details on parameter estimates).

B.2.4 TABULAR PRESENTATION OF RISK/REWARD RESULTS

Academic research often reports on risk using a spectrum of graphics and technical summary statistics, while mainstream advice often does not deal with risk, at least quantitatively other than “best/worst”-case scenarios (a practice that can severely exaggerate the implications of risk; MacDonald et al., 2018). This Section’s presentation of results seeks to provide key risk statistics that are informative, accessible, and streamlined, as well as compelling.

The first four rows of Table 1 capture the financial market risk implications by age for the two goals: income security versus bridging funds remaining. A major barrier to good financial planning at the point of retirement is the challenge of anticipating and budgeting for a far-off future. Retirement can span over 30 years, and even more for workers who retire early. And beyond the time period involved, changing factors such as family composition (namely divorce and widowhood), the corrosive effects of inflation on fixed income purchasing power, and the deterioration of health can all have dramatic effects on lifestyle and income needs. An effective approach to helping retiring workers better understand the value of delaying CPP payments is by helping them to consider their far-off future (and potentially much more vulnerable) selves. The presentation of results by age is, therefore, useful to drawing a user’s attention to later ages and thereby helping him/her to foster a greater appreciation of risk implications across retirement.

To illustrate the implications of mortality risk, rather than add more dimensions to Table 1 a more streamlined (and accessible) approach is to add a mortality table that aligns with the financial market risks as presented by age. Users can then reference the by-age probabilities of income, wealth, and survival to understand the risks that could be mitigated by delaying CPP payments. The bottom half of Table 1 shows the probability of living to ages 75, 80, 85, 90, and 95. These mortality statistics suggest that there are relatively fewer differences between the rows for high and low longevity relative to the more significant differences between males and females. It is also interesting that the high-longevity males are more likely to die at each age than their low-longevity female counterparts.

¹⁰ We assume no individual-specific personal tax deductions – such as childcare or running a business, or credits for items such as charitable donations or medical expenses. Note, however, that if these existed and were constant in real terms, they would effectively cancel out between the two options.

¹¹ These baseline return estimates were motivated by the 2017 projection assumption guidelines compiled by the Institut québécois de planification financière and the Financial Planning Standards Council, where the recommended net nominal return after fees for a balanced portfolio is approximately 4% (pg. 11, Bachand et al., 2017), leading to a 2% net real return. Assuming that the risk-free rate of return is 1%, the equity risk premium is 4%, and the standard deviation of equities is 16%, then a balanced portfolio with an expected nominal return of 4% would imply a 25% allocation to equities (2% inflation plus 1% real risk-free plus 1% equity risk premium), leading to a standard deviation of 4%. We also test a higher expected rate of return of 6%, implying a 75% allocation to equities with a corresponding 12% standard deviation. Historically, the annual equity return standard deviation has been 15–20%, although there is much debate on the volatility of investments going forward (see Ambachtsheer, 2019, for discussion).

The bottom half of Table 1 would allow users to match longevity expectations to their profiles, and inform them about the probability of living beyond a particular age. The added benefit of having this type of table is that it emphasizes to the user the relatively high likelihoods that he/she will live to advanced ages, thereby personalizing and encouraging an interest to plan for that time. The user could next align these results with the financial market risk results in the upper half of Table 1, where they would be informed on the probability that their income would drop below the CPP delayed income, as well as the savings that they would have forfeited at that age by delaying CPP.

In this way, Table 1 has illustrated the trade-offs between financial market and inflation risks in terms of retirement income security and having accessible funds, as well the mortality risk that the user faces. This enables them to clearly see, and appreciate, a fuller picture of future risk exposures. This information thereby provides a quantitative basis for a more informed choice that encourages the user to reflect on their comfort level with regard to risk.

Another option is to align the financial market risk results in Table 1 with more granular presentation of mortality risk – for example, the results could be aligned with individual estimates from the Actuaries Longevity Illustrator (www.longevityillustrator.org).

Table 1: By-Age Probability Statistics between Option #1 (taking CPP payments at age 70 and cash-flowing ages 65–70 with bridging funds) and Option #2 (taking CPP payments immediately at age 65 and investing the bridging funds to achieve the same net income)

		Age				
		75	80	85	90	95
Financial Market Risk:		Probability that Option #2 (CPP at 65) will deliver less income than Option #1 (CPP at 70) by Age				
<i>Income Security</i>						
<i>Net Rate of Return</i>						
4%		0%	25%	97%	100%	100%
6%		2%	28%	58%	76%	85%
Financial Market Risk:		Expected Proportion of Bridging Funds Remaining for Option #2 (CPP at 65) by Age				
<i>Bridging Funds</i>						
<i>Net Rate of Return</i>						
4%		41%	10%	0%	0%	0%
6%		60%	39%	25%	18%	15%
Longevity Risk		Probability of Survival to Age				
Female						
<i>High Longevity</i>		93%	85%	73%	55%	30%
<i>Low Longevity</i>		89%	80%	67%	49%	25%
<i>All</i>		90%	82%	69%	50%	26%
Male						
<i>High Longevity</i>		89%	79%	64%	42%	19%
<i>Low Longevity</i>		83%	71%	55%	35%	15%
<i>All</i>		86%	75%	59%	38%	17%

Note: Financial Market Risk and Longevity Risk by Age between Option #1 (taking CPP payments at age 70 and cash-flowing the income for ages 65–70 with bridging funds) and Option #2 (taking CPP payments immediately at age 65 and investing the bridging funds to achieve the same net income): (1) probability of sustaining income target by age, (2) average proportion remaining of initial bridge savings, and (3) longevity statistics for 65-year-old Canadians by gender and CPP income profiles – low (<35% Maximum CPP Pension) and high (99.5% Maximum CPP Pension).

Appendix B presents a sample of richer graphical results, geared to a more technical audience, that combine the mortality and longevity risk.

B.2.5 LIFETIME STATISTICS

The tabular presentation of results is useful for guiding individuals to a greater appreciation of risk implications throughout retirement. We next combine the by-age probabilities of income and survival to produce lifetime statistics, which are useful in communicating overall information quickly (as is demonstrated in the Executive Summary of this report).

Table 2: Lifetime Risk Statistics for Option #2 (taking CPP payments immediately at age 65 and investing the bridging funds to achieve the same net income as Option #1)

Expected Nominal Net (After Fees) Rate of Return on Savings	4% Low		6% Low		4% High		6% High		4% All		6% All	
	Life Expectancy		Life Expectancy		Life Expectancy		Life Expectancy		Life Expectancy		Life Expectancy	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Taking CPP Payments at age 65 (Option #2):												
Probability of receiving less income than Option #1	66%	76%	51%	60%	73%	81%	57%	65%	69%	78%	53%	61%
Average proportion of retirement with reduced income	29%	34%	22%	26%	31%	36%	24%	27%	30%	35%	23%	26%
Average funds remaining at death (% initial bridging funds)*	15%	10%	33%	27%	11%	8%	29%	24%	13%	9%	31%	26%

Note: Lifetime Risk Statistics for Option #2 (taking CPP payments immediately at age 65 and investing the bridging funds to achieve the same net income as Option #1), by gender, financial market returns, and mortality expectations: (1) probability of receiving less income than in Option #1, (2) average proportion of retirement spent with reduced income, and (3) average proportion remaining of initial savings at death.

* Note that these values reflect the situation before the taxes – see Section B.2.2.

To explain Table 2, we will focus on the two most extreme results, which are (1) a male with low longevity expectations and the higher investment returns (the third column of results) versus (2) a woman with high longevity expectations and medium investment returns (the sixth column of results).

1. Testing if investments stochastically yield an annual net (after fees) nominal rate of return of 6%, alongside the low longevity expectations, this extreme scenario finds that a male would face a 51% probability of receiving less income than having delayed CPP payments (Option #1), with an average of 22% of his retirement with reduced income, and 33% of “the available-for-bridging” funds remaining at death.
2. In contrast, a woman with investment returns with an annual net (after fees) nominal rate of return of 4% would face an 81% probability of receiving less income relative to having delayed CPP payments (Option #1), an average of 36% of her retirement with a reduced income and an average of only 8% of her funds remaining at death.

In general, Table 2 emphasizes that, in all scenarios, the majority of seniors with sufficient RRSP/RRIF savings choosing not to delay CPP take-up would not sustain the income that they could have had had they delayed CPP payments. While it is possible that investment returns will be so good that individuals who opt for CPP benefits at age 65 will be able to confidently rely on RRIF withdrawals, in most cases the entire reward from this option will be in the form of a small balance remaining at death, to be taxed in their estate and paid to their heirs. Overall, all of the cases tend to spend down the bulk of their retirement savings before death by trying to keep up with the sustainable pension and income that a delayed CPP would have provided. Even for individuals with low longevity who aim to achieve a high rate of investment return, an expected non-trivial portion of the life is spent in the reduced circumstances. The higher return also carries much more risk – for example, as Table 1 shows, there is already a positive probability of running out of bridging funds by the time one reaches age 75.

B.3 DISCUSSION ON RISK/REWARDS: ONE SIZE CAN PRETTY MUCH FIT ALL

It is often difficult to generalize financial planning advice owing to the diversity of individual circumstances and the complexity of the Canadian retirement income system, where one choice or change in circumstances triggers a complex network of financial repercussions. Normally it is necessary to employ a variety of illustrative examples of people to compare financial planning strategies to cover a representative spectrum of financial circumstances. In recognition of this, financial planners typically first collect a client's full financial circumstances before offering advice.

On the other hand, generalizations are more easily disseminated to a broader audience. They are less data-intensive, and require less time.

In both the apples-to-apples "risk-free investment" comparison and the apples-to-oranges "risky investment" comparison, the CPP delay decision was independent of the individual's other sources of income (earnings, workplace pension plan benefits, OAS) and taxes. The savings required to bridge the gap, as well as the withdrawals made under both options, are both functions of only the individual's age-65 CPP pension. As a result, whether we do an apples-to-apples comparison by taking a risk-free perspective (as in Section B.1), or an apples-to-oranges comparison by examining the consequences of instead investing the bridging funds (in Section B.2), the resulting risk/return financial trade-offs of the CPP delay choice vary only with financial and mortality scenarios, with the advantage that they can be generalized across Canadians with varying financial characteristics (RRSP/RRIF, CPP, OAS, GIS benefits, other income sources, and taxes).

Regardless of their specific income flows, therefore, users can obtain some guidance and insights on the financial trade-offs of alternative take-up CPP ages by only needing to reflect on the financial and mortality expectations that most closely match to their own profiles. The individual's decision then depends on his/her personal preferences. This streamlining of the analysis removes the data hurdles and thereby increases the potential for better communication of the CPP delay option reaching the public, leading ultimately to more informed choices by Canadians.

We believe these results also continue to hold reasonably true whether the person is married or not. The reason is that the necessary features of the framework presented in this paper are not affected by the person's marital status. There could be some special circumstances for a married Canadian where, in choosing between options #1 and #2 to achieve a particular net income target, moving from higher CPP income to higher RRSP/RRIF income could have slightly different tax implications on account of different income-sharing rules between spouses for each option. But these differences should be small and unique, making these findings reasonably applicable to married as well as single Canadians. Note also that the survival benefit is calculated from the age-65 CPP pension, whether it was delayed or not (again not affecting the CPP take-up decision).

Another implication of these results relates to low-income seniors. The results of this analysis were originally not intended for Canadians who are likely to be recipients of GIS benefits. That is because literature suggests that the advantages of delaying CPP are likely much less relevant for lower-income Canadians given their lower likelihood of holding sufficient private savings to fund a delay in receiving a CPP pension, their relatively lower life expectancies, and the income test in the GIS benefit calculation. For example, the OCA finds that 65-year-olds who receive the GIS are living approximately 2.5 years less than those not receiving it (Table 1, OCA, 2016a), and this mortality gap has been relatively stable for the last three decades. In addition, the CPP pension is taxable and counts towards the income-tested clawbacks in the GIS benefit calculation. Earlier research by C.D. Howe finds this severe financial penalty can make it preferable for GIS recipients to take CPP payments as soon as they turn 60 (Laurin, Milligan, and Schirle, 2008). Overall, lower-income Canadians are advised to save in TFSAs and take their CPP payments as soon as possible (see, for example, Chisholm and Brown, 2007; Shillington, 2003; and Stapleton, 2018).

So, while this paper supports these earlier findings, it highlights the important distinction that, for Canadians with sufficient RRSP/RRIF savings that they intend to use towards lifelong annual retirement income consumption, it is not the prospect of not receiving the GIS that makes taking CPP payments earlier the preferable choice. In fact, using RRSP/RRIF income or delaying CPP payments to target the same net income will have the same implications on the GIS. Rather, it is the lower longevity expectations of the GIS recipients that makes delaying CPP payments less attractive. In other words, regardless of whether a person with RRSP/RRIF savings receives the GIS or not, the choice falls down to longevity expectations, financial market returns, and personal preferences in terms of risk aversion and any desire for accessible wealth or estate left at death over income security.

(And, just as higher-income Canadians have longer life expectancies than lower-income Canadians, females generally live longer than males, and therefore it would more often be in their best interest to delay CPP payments.)

There can be very particular circumstances worth noting that could allow a person to leverage the ups and downs of the effective marginal tax rates. Such instances might affect the CPP delay decision. For example, it may be more advantageous for Canadians at the threshold of the GIS phase-out, as well as the start and end of the OAS clawbacks, to target their CPP income so that it, along with the minimum RRIF withdrawal and other fixed taxable income sources, keeps them within the eligibility range of receiving GIS/OAS benefits for as many years as possible, and only withdrawing larger lump sums of income from their RRIFs when they need them so as to minimize the loss of GIS/OAS benefits.¹²

Part B Findings

In this framework, the financial risk/reward trade-offs for the CPP decision depend on investment returns and mortality – they are independent of the individual’s other financial income flows (including the CPP pension benefit level itself).

The savings required to fund the delay (Equation 3), and the withdrawals for either options (eqs. 4 and 7) are, as previously noted, all fractions of the age-65 CPP pension. Moreover, they are independent of the other income flows (RPP, taxes, OAS, and GIS). As a result, the risk metrics – the probability that income is not sustained and the expected proportion of savings remaining – operate identically across all levels of CPP income and are not affected by other income sources and their underlying risks and processes. The risk metrics are driven only by the economic and mortality scenarios.

¹² Insight provided by Michael Wolfson on March 10, 2020, via personal correspondence.

Part C: Scope Considerations and Future Research

The aim of this report has been to present a meaningful and practical quantitative comparison of the CPP delay choice. This analysis considers workers ceasing to work (retiring) at age 65 who have sufficient registered savings to replace the CPP pension income that would be delayed to age 70. If those variables were changed – such as an individual having no RRSP/RRIF savings and having exclusively TFSA savings, for example – the conclusions might be different.

Similarly, we do not examine the other take-up ages between ages 60 and 70. Much of the same analysis can be extended to the age 60 to 65 delay decision, but there are challenges because the deferral years can enter into the CPP benefit calculations if the drop-out years had been already exhausted (as discussed in the Introduction with regard to delaying the QPP from ages 65 to 70). In short, the comparison is less straightforward for those ceasing to work prior to age 65.

Similarly, for workers who continue working after age 65, the comparison is also complicated by the fact that if they defer their CPP pension, they need to continue contributing to the CPP, possibly increasing or reducing the value of the financial trade-offs underlying delaying CPP payments. Whether or not those years of additional contributions would affect the ultimate pension amount depends on the value of their post-65 earnings and how they compare to their past earnings. For example, each month of contributions after 65 effectively replaces a lower-value month earlier in the individual's work history, if there is such a month to replace; otherwise, the earnings in that month are not factored into the calculation of their pension amount. At the other extreme, self-employed workers who have achieved the maximum CPP benefits would continue to pay the double contributions during the deferral period without increasing the benefits beyond the regular actuarial adjustment. Once CPP retirement benefits have commenced, employed and self-employed individuals aged 65 or older have the option of suspending contributions or continuing contributing to earn post-retirement benefit increases.

Another topic outside this paper's scope is the potential behavioral response associated with delaying CPP payments that impacts the value of the financial outcomes. For example, in the apples-to-oranges evaluation, individuals delaying CPP payments could potentially achieve higher rates of return on any remaining assets not required to fund the delay by shifting their remaining RRSPs/RRIFs to a riskier asset mix, since the CPP payments are reasonably perceived as safely replacing future RRSP/RRIF withdrawals, thus leaving the individual better able to take risks with the smaller remaining amounts invested in the RRSP/RRIF. This greater appetite for investment risk for someone who has higher secure income on account of delaying CPP payments could be an area for future work. We expect that, on the whole, it would further support the benefit of delaying CPP payments.

Our apples-to-apples comparison created (by design) the same annual income target between both options. In reality, however, people have varying preferences that often result in balancing the pros/cons associated with two different options, rather than requiring that both options lead to identical outcomes. For example, individuals taking CPP payments at 65 may well choose to top-up their age-65 CPP pensions by accepting a fluctuating withdrawal from their savings, one that responds to the underlying asset returns. In return for a fluctuating income stream, such a strategy could ensure that the individual would not run out of money. Testing the implications of a spectrum of preferences alongside the computed risk/returns of varying financial strategies is outside the scope of this analysis. However, it should be noted that when such analyses are attempted, delaying is generally deemed optimal. *In the US, for example, a 2017 Society of Actuaries report found that, among 292 retirement income strategies examined, delaying social security (which is less generous in its deferral provisions than the CPP, having an 8% increase for each year of deferral¹³) was the most effective strategy for a 65-year-old American (Pfau et al., 2017).*

An important further area of research that is treated as outside this paper's scope is the choice to also delay OAS payments. They can be taken as early as 65, with a 0.6% increase for every month delayed thereafter (or 7.2% per

¹³ www.ssa.gov/planners/retire/1943-delay.html

year), until age 70. Also, OAS is not wage-indexed during the deferral period. Like CPP payments, this financial decision can help to increase secure retirement income. The value of delaying OAS is therefore qualitatively comparable to the presented conclusions, although it will be smaller because of the lower actuarial adjustment for deferring. Another wrinkle is that the deferral dynamics provide more OAS pension – and can be used to avoid/minimize the effects of the recovery tax for high-income Canadians (which is to say, for people subject to the tax, waiting is better).

Another consideration for future research is the extent to which the advantages of delayed CPP take-up will be affected by the CPP enhancements coming into effect, and, given the phase-in period for those enhancements, how those effects depend on retirement cohort. It would also be interesting to test the sensitivity of the results found in this paper to the level of the actuarial adjustments. The assumption underlying this report is that the actuarial adjustment factors do not change, although these factors could be re-evaluated depending on changes in financial markets, mortality, or the selection bias underlying claiming behavior – that is, people who are most inclined to delay CPP benefits are often those who have better longevity, making this feature more expensive.

Finally, an interesting future project would more broadly examine comprehensively the limited income-minimizing or social-transfer-maximizing opportunities within the tax and transfer system for Canadian seniors, such as at the threshold of GIS eligibility or the beginning or the end of the OAS clawbacks as discussed at the end of Part B.

Overall, the purpose of this report was to provide streamlined guidance for Canadians faced with this decision, so as to help more Canadians take better advantage of the CPP delay option. But financial planning is nevertheless an ongoing, comprehensive, and integrated problem that includes an individual's full financial circumstances and personal preferences, the complex Canadian system of taxes and social benefits, and the current financial environment and spectrum of potential risks. Ideally, financial analyses should take the individual's specific situation and objectives into account, including factors additional to those that are developed in this analysis.

Conclusion

The purpose of this project was to provide rigorous guidance that is based on sophisticated, comprehensive, integrated, and individual-focused analysis – research that will help Canadians to more confidently make informed choices on the cost and value of alternative take-up ages for CPP payments, with a particular focus on delaying take-up beyond age 65.

This was done with two goals:

1. Comprehensively quantify the trade-offs in delaying CPP payments both in terms of risk as well as return for Canadians with various financial and personal circumstances; and
2. Present the results so that they are meaningful and accessible to a wider audience, such as professionals in the financial service industry, to help better inform the decision about when to take-up a CPP pension.

The report begins by structuring a conceptual mathematical framework that is sufficiently manageable for effective communication. The conceptual framework developed in this paper rigorously compares two otherwise identical financial strategy options that differ only in the timing of the take-up decision. It then presents insights on the financial trade-offs associated with the CPP take-up timing choice that enable the cost and process of CPP delay to be explained with significant clarity, and also produce risk statistics that not only demonstrate the trade-offs, but can be generalized across Canadians faced with this decision.

From a risk-free investment perspective, we find that the majority of seniors with sufficient RRSP/RRIF savings would be better off delaying their CPP payments. For individuals who instead invest the savings that could have otherwise been used to delay CPP payments, we find that there is no financial reward for taking on this risk from the perspective of income security – specifically, even in a high-investment-and-low-longevity scenario, there is more than a 50% probability of having done better by delaying CPP payments. Overall, all of the non-delay cases tend to spend down the bulk of their retirement savings before death by trying to keep up with the sustainable pension and income that a delayed CPP would have provided.

As for the second goal, the paper formulated the structure so that the results presented can be largely generalized. These findings can be directly employed in the practical world so as to move from the existing paradigm of taking CPP payments as soon as possible towards more effective communication and information that improves the understanding (and appreciation) of the risk-mitigating properties of delaying CPP payments.

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Appendix A: Conceptual Approach for Delaying CPP from Age 60 to Age 65

The same conceptual framework developed in this paper could also be used for the choice to delay CPP payments from ages 60 to 65, although this requires an additional simplifying assumption that the 60-year-old has sufficient drop-out room so that the level of the pension will not be affected by the delay. (Without the drop-out room, the decline in earnings base created by the delay is individual-specific, and therefore we would need to define a reasonable metric to characterize the degree of drop-out room remaining to generalize the results.)

Another distinguishing factor for the age 60 to 65 delay is that to achieve the same level of net income, there would also need to be sufficient funds to provide bridging income for the OAS benefits that will begin to be payable only at age 65. Moreover, although not done here, the same framework could be employed to delay CPP from age 60 to age 70 (where the effect of the 1.1% real wage growth would amplify the growth in benefit to 235%).

With the assumption of sufficient drop-out room, the same formulas outlined in Part A apply in structure, other than that ages 65 and 70 are replaced by ages 60 and 65, and the decrease (rather than increase) to the CPP pension is 7.2% per year, totalling a 36% reduction in the age-65 benefits by taking them five years earlier at age 60. The choice is similarly between the following two options:

Option #1: *Delay CPP payments from age 60 to 65, using a portion of RRSP/RRIF savings (the bridging funds) to provide for withdrawals during that five-year period that exactly match the income that the CPP pension (adjusted for inflation) will provide when the individual takes it up at age 65.*

Similar to Equation (3):

Total savings required at age 60 to fund CPP delay (age 60 to age 65):

$$\text{Bridging Funds}_{60} = \left[\frac{1}{1-0.36} \text{CPP}_{60} \times (1+w)^5 \right] \ddot{a}_{\overline{5}|r}$$

$$\text{Withdrawal Payment}_{60} = \frac{1}{1-0.36} \text{CPP}_{65} \times (1+w)^5$$

$$\text{Withdrawal Payment}_x = \text{Withdrawal Payment}_{x-1}(1+p_{x-1}), x = 61, \dots, 64$$

Option #2: *Claim CPP payments immediately at age 60 and employ the same level of bridging funds (as in Option #1) to achieve the same net income target (as in Option #1) throughout retirement (continuing until the death of the beneficiary or the exhaustion of the bridging funds).*

In Option #2, savings withdrawals at age 60 are:

$$\text{Withdrawal Payment}_{60} = \frac{1}{1-0.36} \text{CPP}_{60} \times (1+w)^5 - \text{CPP}_{60}$$

$$\text{Withdrawal Payment}_x = \text{Withdrawal Payment}_{x-1}(1+p_{x-1}), x \in [61, \text{earlier of death or fund exhaustion}]$$

This analysis could include, in parallel, the results of microsimulation-based analyses that would quantify the risks of running out of savings, characterizing them by mortality levels and returns to savings. Because of the longer periods involved, the distribution of risks would differ.

Appendix B: Fuller Graphical Presentation of Results

This appendix presents an example of a fuller graphic of the information summarized in Part B, providing a more detailed picture of the interplay between financial market returns and mortality. Figure 4 displays the solvency cumulative probabilities for the CPP take-up choice – “solvency” being defined as still having accessible savings from the bridging funds to match the income that could have been provided had CPP been delayed to age 70. Net income drops below the target once the savings that would otherwise be used to bridge the delay are exhausted. “Alive and Solvent” is therefore the probability of net income not dropping below the target – the equivalent of the probability of not exhausting bridging fund savings.

As suggested in Table 1, the probability is high at over 80% of exhausting savings between ages 78 and 84 under the 4% nominal net (after fees) rate of return scenario for both males and females. This decline begins earlier but occurs more gradually for the higher expected return because of its associated greater volatility.

Figure 4: For a Canadian taking CPP payments immediately at age 65 (versus choosing to delay to age 70): probability of survival and sustaining income target at each age at 4% and 6% net (after fees) nominal rates of return and medium-high mortality

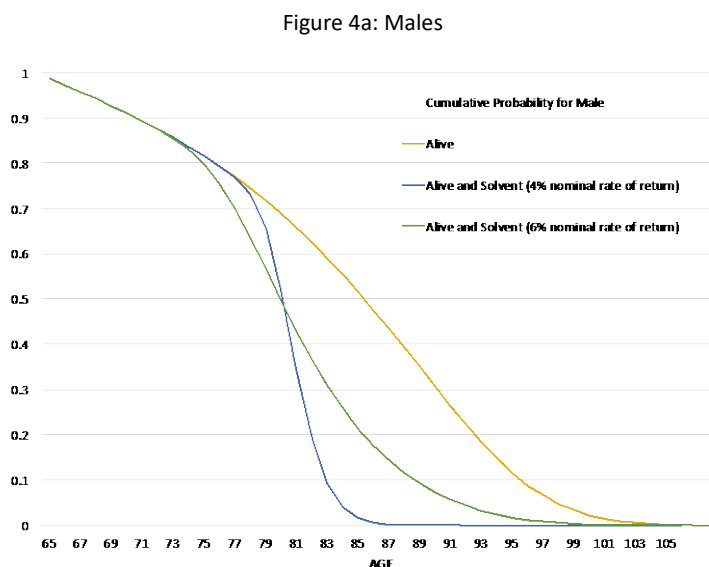


Figure 4b: Females

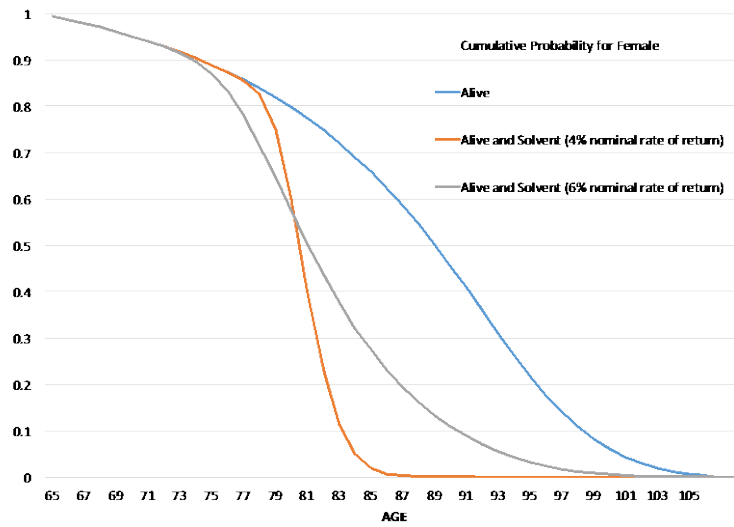
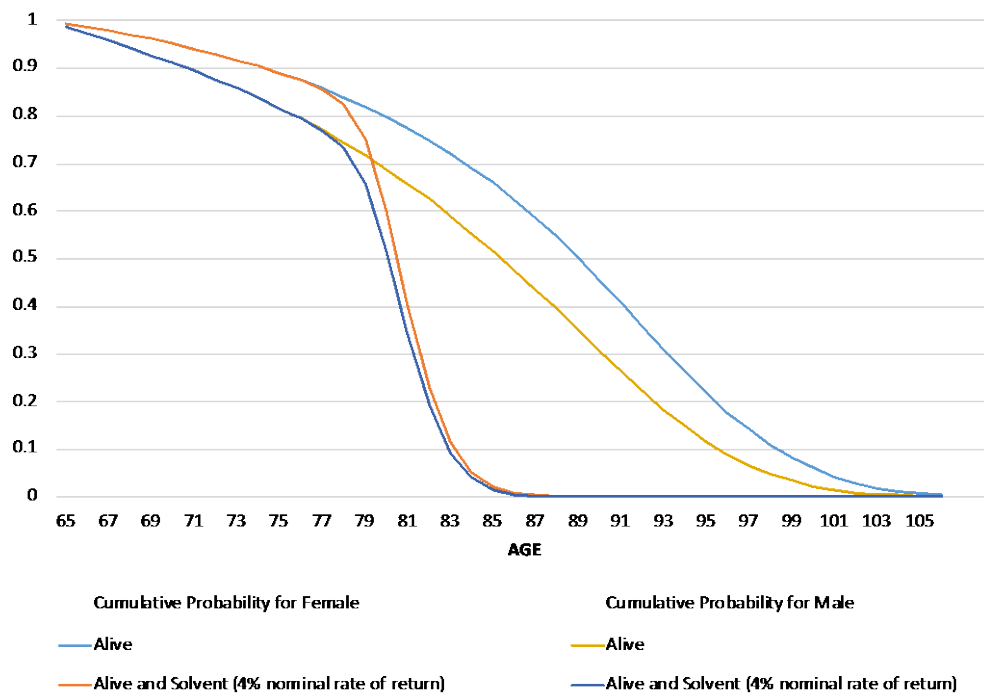


Figure 4c: Males and Females at 4% only



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We put the public interest ahead of our own. Our processes are transparent and volunteerism is at the heart of our activities.

Integrity

We are honest and accountable professionals; we uphold strict ethical principles. We use our expertise, rigorous standards, and objectivity to deliver actuarial services and advice of the highest quality.

Advancement

We are committed to demonstrating the value of effective risk management. We use innovation to advance actuarial science and its applications.

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About the Society of Actuaries

With roots dating back to 1889, the [Society of Actuaries](#) (SOA) is the world's largest actuarial professional organizations with more than 31,000 members. Through research and education, the SOA's mission is to advance actuarial knowledge and to enhance the ability of actuaries to provide expert advice and relevant solutions for financial, business and societal challenges. The SOA's vision is for actuaries to be the leading professionals in the measurement and management of risk.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research and analysis with an actuarial perspective for its members, industry, policymakers and the public. This distinct perspective comes from the SOA as an association of actuaries, who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques as well as individual reports on health care, retirement and other topics. The SOA's research is intended to aid the work of policymakers and regulators and follow certain core principles:

Objectivity: The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

Quality: The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and non-actuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

Relevance: The SOA provides timely research on public policy issues. Our research advances actuarial knowledge while providing critical insights on key policy issues, and thereby provides value to stakeholders and decision makers.

Quantification: The SOA leverages the diverse skill sets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

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