DRAWING DOWN RETIREMENT SAVINGS—DO PENSIONS, TAXES AND GOVERNMENT TRANSFERS MATTER MUCH FOR OPTIMAL DECISIONS?

BY

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ABSTRACT

This paper examines the importance of pensions (employment and social security), taxes and government transfers for alternative retirement savings drawdown strategies (DS), compared to the conventional approach in published literature of using a gross income concept obtainable from retirement savings alone. Using a lifetime utility framework, our longitudinal dynamic micro-simulation model incorporates risk aversion, stochastic markets, stochastic mortality and the interactions among sources of retirement income within the complex Canadian tax and social benefit system, enabling us to rank commonly advocated DS and to ask whether incorporating pensions, taxes and transfers alters those rankings. Our findings show the importance of treating the evaluation of alternative DS as a comprehensive and integrated problem by including all sources of income — including pensions, taxes and government transfers. Using restricted income measures can potentially lead to simplistic, and possibly misleading, conclusions.

KEYWORDS

Annuity, self-managed retirement savings drawdown, taxes, government transfers, social security, comprehensive and integrated retirement planning, retirement, life-cycle model, stochastic micro-simulation.

1. INTRODUCTION

What is the best strategy for retirement savings drawdown? Clearly, calculations of the implications of different strategies will be easier and simpler if the complications of pensions, taxes and government transfers can be ignored (as much of the literature now does). But what is the cost of such simplification? How much might retirees, their advisors and researchers expect to go wrong in specifying a drawdown strategy (DS), if pensions, taxes and transfers are ignored? More

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specifically, does including them in analysis alter the ranking of commonly advocated alternative DS?

Whether the objective is to maximize expected utility, or to minimize the probability of lifetime ruin, published research has conventionally analyzed the question of DS choice using a gross income concept obtainable from the retirement savings alone. Beginning with Yaari (1965)'s seminal paper, some examples include Ameriks *et al.* (2001), Brown (2001), Jousten (2001), Blake *et al.* (2003), Davidoff *et al.* (2005), Butler and Teppa (2007), Horneff *et al.* (2008) and Webb (2009). Although the convention in this line of literature is to use a gross income concept, in the quest to explain the "annuity puzzle", several studies have examined the importance of pension income from employers and social security on the desirability of annuitization — for example, Mitchell *et al.* (1999) and Brown (2001), and recently Butler *et al.* (2011) and Pashchenko (2013) investigated means-tested government transfers/consumption floors. A significant barrier to incorporating other sources of retirement income, taxes and government transfers is computational complexity — for example, Kotlikoff (2006:2) argued that to compute "(t)axation by itself is a factor worthy of a Xeon processor" and "(c)omputing Social Security benefits is another nightmare". But these considerations should, nevertheless, influence optimal behavior during the drawdown phase — for example, Hubbard, Skinner and Zeldes (1995) found that means-tested government transfers dramatically influenced optimal savings behavior, particularly among low-income households.

To investigate the impact of pension income, taxes and government transfers on the ranking of strategies for drawing down retirement financial savings, this paper compares six popular DS (market annuitization, four distinct self-managed DS and one hybrid strategy) and asks whether incorporating pensions (employer and social security), taxes and government transfers alters their rankings. Our longitudinal dynamic micro-simulation model enables us to rank strategies by comparing estimates of the certainty equivalent income (CEI) corresponding to the expected discounted present value of utility of the projected year-by-year income flows under each DS.

Our model includes income flows from the drawdown of retirement saving (according to the strategy under examination), employer pension plan benefits, Canadian social security benefits and the Canadian taxes and social benefits (which are calculated based on the financial flows within each simulation year). Rather than imagining one possible "future" for an individual under each scenario, we explicitly model the uncertainty of future inflation, investment returns and mortality using stochastic simulation. Since we specify the probability distribution of each stochastic variable, we can add up across all simulation runs and calculate the expected present value of utility corresponding to each alternative strategy. We do this for various example case Canadians — poor, middle class and affluent single Canadians aged 65, with and without defined benefit pension entitlements, male and female and at various levels of risk aversion.

Canadian taxes and social transfers include income taxes (including taxes on realized capital gains), refundable and non-refundable tax credits, sales taxes, provincial health premiums and the Canadian social retirement programs — the flat Old Age Security (OAS) and the Guaranteed Income Supplement (GIS) for low-income Canadians (see Section 2 for description of the Canadian retirement pension system).

To determine whether incorporating pensions (employer and social security), taxes and government transfers alters the utility rankings of the six DS, our approach is to compare the implications of using the four following income concepts as the argument of the utility function:

1. ***Savings***: Gross withdrawals from financial savings brought into retirement (tax-assisted and non-tax-assisted financial savings).
2. ***Savings + Pension***: Savings + social security (Canada/Quebec Pension Plan benefits (C/QPP)) + employer pension plan benefits.
3. ***Savings + Pension − Taxes***: Savings + Pension − income taxes (including realized capital gains taxes) + non-refundable tax credits + refundable tax credits − sales taxes − provincial health premiums.
4. ***Savings + Pension − Taxes + Transfers***: Savings + Pension − Taxes + OAS/GIS benefits.

The progression between income concepts can also be viewed as

- including other stabilizing sources of income: i.e. comparing #1 to #2;
- including taxes: #2 versus #3; and
- including government transfers: #3 versus #4

In our view, the last income concept (i.e. 4: *Savings* + *Pension* − *Taxes* + *Transfers*) corresponds most closely to the appropriate measure of income available for individual consumption — but simple gross withdrawals (the first income concept: *Savings*) is what many researchers have conventionally used in the evaluation of alternative DS. The last income concept does not, however, include the net value of housing services received from owner-occupied housing. We recognize the importance of this type of implicit income, as well as other possible sources of consumption, but they are not measured in our data set (see MacDonald *et al.,* 2016 for more discussion on the components of consumption that can be relevant in retirement financial planning).

We present calculations for "typical" 65-year-old single Canadian males corresponding to the 10th, 50th and 90th percentile of the income distribution, using empirically representative levels of C/QPP benefits, employer pension plan benefits, tax-assisted financial assets and non-tax-assisted financial assets. We also include calculations for a stylized affluent senior without pension benefits, but with substantial assets, as well as examine females and various levels of risk aversion.

When evaluating alternative DS, the most common approach among the published literature has been to determine the optimal strategy, and the less common approach is to evaluate popular DS that households are likely to consider. To uncover the globally "optimal" DS, however, analysts must rely on numerical optimization techniques — but as Sun and Triest (2007: 37) wrote "The use of numerical optimization necessitates simplifying assumptions about asset returns and available asset allocation and decumulation strategies that detract from the realism of the model". This paper also argues that the details of pension and registered income regulations, income tax provisions and income-tested transfer programs are likely to have non-trivial implications for retirement planning. The simplifying assumptions exist in part to guarantee the needed continuity of functions and derivatives, which is not conducive with the tax/transfer/social insurance system, which is plagued with discontinuous functions, and even more so with discontinuous derivatives (e.g. the basic income tax schedule itself), since the underlying functions are almost exclusively piecewise linear. To illustrate the importance of taxes/pensions/transfers, therefore, we adopt the simpler strategy of comparing a sub-set of commonly advocated alternatives, which are already the result of considerable critical thought by both academics and financial analysts.

The rest of this paper is presented as follows. Section 2 outlines our methodology; Section 3 presents the results; and Section 4 contains our conclusions.

2. Methodology

2.1. The Canadian retirement income system overview

This analysis employs Canadian evidence; therefore, this section provides a short outline of the Canadian programs. The Canadian retirement income system is often categorized as a three-legged stool, whose components are aimed at keeping Canadian seniors out of poverty, while helping them to maintain working-life living standards:

1. Canadian government public pension programs.
   a. Compulsory employee C/QPP, which provides an earnings-related benefit aimed at replacing up to approximately 25% of the average industrial wage.
   b. Government of Canada's social pension programs funded from general revenues, which are
      i. OAS pension: a flat benefit for all Canadians meeting a residence requirement. As of January–March 2018, the maximum OAS benefit for a single was \$586.66 per month, which reduces at a rate of 15% for Canadians earning more than \$73,756, until it is eliminated entirely for retirement income exceeding \$119,512.
      ii. GIS: a low-income benefit that, as of January 2018, had a maximum benefit of \$876.23 per month for a single, reduced by \$0.50 for every dollar of income (excluding OAS benefits and depletion of non-tax-assisted savings).

GIS and OAS are both income-tested benefits — Canadian seniors repay "clawbacks" depending on their income and benefit thresholds in any given year (although OAS is only clawed back at higher levels of income).

2. Employer-provided pension and retirement savings plans.
3. Personal retirement savings (tax assisted and non-tax assisted).

(Section 2.5 illustrates the Canadian retirement system by presenting the income flows for the low-, median- and high-income Canadian senior case studies for the analysis.)

2.2. Outcome measure — utility framework

As is customary in this line of research, we assume a standard constant relative risk aversion power utility function, exponential time discounting at a fixed rate and additive separability. Examples of this approach include Yaari (1965), Mitchell *et al.* (1999), Brown (2001), Milevsky and Young (2002; 2007), Davidoff *et al.* (2005), Butler and Teppa (2007), Horneff *et al.* (2008), Webb (2009) and Pashchenko (2013).

We assume no bequest motive and that retirees draw down their wealth at the start of each year and consume that drawdown entirely during the coming year. Given some set of future events (i.e. instantiation i) the present value (PV_i) of utility for each individual at age 65, conditional on having T remaining years of life, is then as follows:

$$PV_i = \sum_{t=0}^{T-1} \beta^t \frac{(C_{i,t})^{(1-\alpha)}}{(1-\alpha)}, \tag{1}$$

where

- i is the specific instantiation of future events — i.e. the specific random draw from the probability distributions of random processes (asset returns, inflation and mortality).
- β is the discount factor (subjective time preference) for the individual. We set $\beta = 0.96$. Brown (2001:43) and Pashchenko (2013: 56) used 0.97, Blake *et al.* (2003:35) used approximately 0.95 and Milevsky and Young (2007:3152) used 0.95. Gustman and Steinmeir (2005:451) found that approximately 40% of the U.S. Health and Retirement Survey (HRS) data sample had a time preference rate above 95%, 21% had a time preference between 90% and 95% and the remainder were under 90%.
- α is the coefficient of relative risk aversion ($\alpha \neq 1$ and $\alpha \to 1$ correspond to logarithmic utility). We test three levels of risk aversion, $\alpha = 1.5$, 2 and 5. The most commonly used values for α have been between 0 and 2 (e.g. Mitchell *et al.*, 1999:1314). However, using the U.S. HRS, Brown (2001:45) found that two-thirds of the sample exhibited a risk aversion of 3.76 and over, which he then represented as 5. Milevsky and Young (2007:3152), Horneff

et al. (2008:402) and Webb (2009:16) similarly tested relative risk values of 5 or more when assuming the standard power utility function to compare alternative DS.

- t is time (set to 0 at age 65).
- T is the time of death.
- C_t is consumption between times $t-1$ and t (in constant dollars).

We model uncertainty in mortality, inflation and financial returns by stochastic simulation and obtain the expected present value of utility by averaging PV across one million simulated possible futures of the person under examination. For example, if $\mathrm{PV}_i^{\mathrm{DS\#1}}$ signifies the present value of utility in instantiation (simulated life-course) i using DS #1 (DS#1), then the expected present utility value of DS#1 ($E[\mathrm{PV}^{\mathrm{DS\#1}}]$) is as follows:

$$E[\mathrm{PV}^{\mathrm{DS\#1}}] = \frac{1}{1{,}000{,}000} \sum_{i=1}^{1{,}000{,}000} \mathrm{PV}_i^{DS\#1}. \quad (2)$$

While time of death (T) and consumption (C_t) are stochastic variables, β and α are fixed across all simulations.

While utility values are difficult to compare and interpret, we next use the "expected present utility value" in (2) ($E[\mathrm{PV}_{\mathrm{IC}(x)}^{\mathrm{DS\#}y}]$) to calculate an income flow measure that corresponds to the calculated utility value — the annual CEI. Letting

- $\mathrm{IC}(x)$ ($x = 1, \ldots, 4$) represents the income concept used as the argument underlying the utility function given in (1);
- DS#y (y = 1, . . . , 6) represents the DS under examination;
- D represents the average life expectancy (age 83 for males and 86 for females).

then the CEI ($C_{\mathrm{IC}(x)}^{\mathrm{DS\#}y}$) for IC(x) using DS#y is as follows:

$$E[\mathrm{PV}_{\mathrm{IC}(x)}^{\mathrm{DS\#}y}] = \sum_{t=0}^{D-1} \beta^t \frac{(C_{\mathrm{IC}(x)}^{\mathrm{DS\#}y})^{(1-\alpha)}}{(1-\alpha)},$$

$$C_{\mathrm{IC}(x)}^{\mathrm{DS\#}y} = \left[(1-\alpha)\, E[\mathrm{PV}_{\mathrm{IC}(x)}^{\mathrm{DS\#}y}] \Big/ \sum_{t=0}^{D-1} \beta^t \right]^{1/(1-\alpha)}.$$

By calculating $E[\mathrm{PV}_{\mathrm{IC}(x)}^{\mathrm{DS\#}y}]$ from (2) stochastically (as already described), we can determine the CEI corresponding to the expected discounted present value of utility.

2.3. Drawdown strategies

We compare six DS commonly found in the financial advisory literature (see Appendix A for formulas).

Annuitization: The purchase of a non-indexed single premium immediate life annuity.

- The individual purchases an immediate whole life annuity due at age 65.
- Payouts are nominally fixed until death.

Variable Drawdown to Age 95: Self-managed drawdown over lifetime.

- Variable DS (the drawdown amount is re-calculated each year).
- The individual aims to withdraw equal real amounts each year that exhaust the portfolio by age 95.

Variable Drawdown to Age 80: Self-managed drawdown over 15 years (exhaust by age 80).

- Variable DS.
- The individual aims to withdraw equal real amounts each year that exhaust the portfolio by age 80.

Fixed Drawdown 4% Rule: Self-managed 4% rule (inflation indexed).

- Fixed DS (fixed at age 65, adjusted only by inflation).
- The individual withdraws 4% of the portfolio in the first year, and the same amount indexed by inflation in each subsequent year until death or portfolio exhaustion.

Fixed Drawdown 6% Rule: Self-managed 6% rule (inflation indexed).

- Fixed DS.
- The individual withdraws 6% of the portfolio in the first year, and the same amount indexed by inflation in each subsequent year until death or portfolio exhaustion.

Hybrid: Hybrid of annuitization and self-managed 4% inflation-indexed fixed drawdown.

DS are commonly categorized as annuitization (#1), self-managed fixed DS (#2 and #3), self-managed variable DS (#4 and #5) and hybrid (#6).

2.3.1. *Annuitization.* When annuitizing, the individual uses his financial assets at age 65 to purchase a single premium immediate whole life annuity that pays a guaranteed fixed stream of income until death. The primary advantage is guaranteed future income — even at advanced ages. Beginning with Yaari (1965), existing literature has nearly unanimously agreed that, from a pre-tax, pre-transfer perspective, annuitization improves the financial welfare of retirees owing to the stability of the income stream and the sharing of mortality risk (a surviving annuitant receives an additional "mortality premium" on top of the underlying rate of return). For example, Babbel (2008) reviewed 70 published papers since 1999 that examined the tradeoffs between annuities and alternatives, and reported "for most people, lifetime income annuities should comprise from

40% to 80% of their retirement assets under current pricing" (pg. 5). Despite this advice, seniors around the world rarely voluntarily annuitize their personal savings, a fact now known as the "annuity puzzle". See James and Song (2001) for an international perspective that includes Canada.

Annuitization is the only strategy examined that fixes payments in nominal terms — consequently, the purchasing power of annuity payments in the first and last DS becomes increasingly eroded by inflation year after year. We assume a 2000–2007 average industry annuity price, as described in Section 2.4. The first year payment (before taxes) is 8.36% of initial wealth for males and 7.58% for females.

2.3.2. *Self-managed strategies.* In a self-managed DS, the discretionary management of financial assets has the advantage of availability of liquid assets in the case of large, unplanned expenses. As well, assets remaining upon death can be bequeathed.

Self-managed "variable" drawdown is when annual withdrawal amounts vary by year according to investment performance so that the funds do not run out prematurely if investments perform poorly. A self-managed "fixed" DS fixes the annual withdrawal amount from year to year (either nominally or inflation indexed) — which implies a risk of running out of wealth in the event of poor market performance (Blake *et al.*, 2003). Bengen (1994) argued that funds are likely not to run out under a 4% inflation-indexed fixed strategy (i.e. 4% Rule), and "Fixed Drawdown 4% Rule" has traditionally been a popular self-managed strategy that represents a desire that funds do not run out before death (see also Pye (2000) and Ameriks *et al.* (2001)). The high risk of wealth exhaustion has led to its disfavor among analysts over the past decade, although there is continued popular support. A 6% fixed drawdown is considered a more aggressive constant drawdown approach.

If funds run out before life does, then the individual must rely on pension benefits and government social transfers. Note that the real value of payments from "Fixed Drawdown 4%/6% Rule" are only fixed on a pre-tax basis (i.e. the after-tax purchasing power of the income generated from the withdrawals is not necessarily fixed in real terms). By definition, the first year payment (before taxes) is 4% of initial wealth for males and females using "Fixed Drawdown 4% Rule", and 6% using "Fixed Drawdown 6% Rule".

In variable DS "Variable Drawdown to Age 80" and "Variable Drawdown to Age 95", the individual withdraws equal real amounts until age 80 and until age 95. This strategy is similar to the more common "$1/T$ Rule", where if $T =$ 15, then the drawdown amounts at ages 65, 70, 79 and 80 (for example) would be:

- $\text{Drawdown}_{65} = \text{Wealth}_{65}/15$ at age 65 (the denominator is 80 less 65);
- $\text{Drawdown}_{70} = \text{Wealth}_{70}/10$ at age 70;
- $\text{Drawdown}_{79} = \text{Wealth}_{79}/1$ at age 79; and
- $\text{Drawdown}_{80} = 0$ for ages 80 and above.

The "1/T Rule" has the advantage of simplicity, but it fails to account for anticipated future real portfolio returns, and therefore creates payments that generally increase over time. The formula for the variable DS (see Appendix A) is explicitly designed to account for future expected real portfolio returns so as to target level, inflation-indexed payments that exactly exhaust the portfolio at the end of the chosen horizon. That is, the drawdown amount is only constant in real terms *on average* (each simulation has some variability). If portfolio returns assumed their projected average in each simulation year, the real amount drawn down would be constant. (If real portfolio returns were expected to be zero, then the "Variable Drawdown to Age 80" and the "1/T Rule" described above would render the same drawdown pattern.)

In "Variable Drawdown to Age 95", age 95 is the "lifetime" target for asset exhaustion — the implicit assumption is that after age 95, the individual will depend on Canada's OAS/GIS system plus any available pension benefits. In "Variable Drawdown to Age 80", 15 years is the approximate number of years in full health over which the individual wishes to deplete personal wealth (health-adjusted life expectancy for 65-year-old Canadians in 2001 was 14.4 years for females and 12.7 years for males (Source: CANSIM Table 102–0121)). The first year payment (before taxes) is 6.36% of initial wealth for males and females using "Variable Drawdown to Age 95", and 9.31% using "Variable Drawdown to Age 80".

2.3.3. *Hybrid strategy.* A hybrid, or "mixed", strategy combines annuitization and self-management. The benefits are a guaranteed income stream from the annuitized assets and the flexibility and potential for bequest from the self-managed assets.

In "Hybrid", 25% of the total wealth is used to purchase an annuity, while the remaining is self-managed. We apply the same DS to both tax-assisted and non-tax-assisted wealth in the first five DS. In "Hybrid", however, the subject purchases the annuity first from his/her non-tax-assisted wealth, and then from his/her tax-assisted wealth, until 25% of total wealth is annuitized.

2.4. Tool of analysis and underlying assumptions

Our analysis uses "Ruthen" — a longitudinal dynamic micro-simulation model that explicitly models the Canadian retirement income system when projecting the financial consequences of alternative DS, while accounting for the uncertainty of future financial returns, inflation rates and mortality. Ruthen is a longitudinal dynamic *individual* micro-simulation model. Rather than simulating many separate lives within a population, Ruthen simulates many possible future life-courses for a single subject individual while keeping track of the annual and lifetime consequences of the individual's DS as it interacts with the financial market, inflation and with the set of tax and benefits programs relevant for the individual. In each simulated year, the relevant intra-lifetime measures are tracked, such as each year's discounted utility for each of the income concepts outlined in the introduction.

Figure 1 illustrates the general simulation structure of Ruthen. The top box of Figure 1 represents the personal characteristics of the subject individual, including the chosen DS, that serve as the starting point at the outset of each simulated lifetime. Section 2.4 defines the personal characteristics and financial resources in terms of the tax-assisted and non-tax-assisted portfolio sizes at retirement, and the Canada Pension Plan (CPP) and private (employer) pension benefit levels. Ruthen first determines the various income sources that the person is eligible to receive during the coming year. It then calculates the drawdown amount (using the chosen DS of the six given in Section 2.3). The drawdown amount 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. If the DS is annuitization, then the portfolio level is fixed at zero. 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 repaid as a result of the year's income level, as well as taxes on capital gains.

This process continues until the individual has died within the year, which is determined by comparing a pseudo-random draw against standard mortality table rates. If the person dies during the year, an additional pseudo-random draw determines when the death occurs and the various financial flows are accordingly calculated to reflect a partial year. We assume that life-contingent payments are payable through the month of death (from government-administered programs (OAS, GIS and CPP), from the private pension, and from any annuities purchased as part of the DS).

The instantiation of a particular individual terminates once he/she dies. Ruthen records the relevant information for the particular lifetime, and moves on to the next instantiation. Each run generates one million independent instantiations of the subject individual for the analysis that we report in this paper.

When simulating the drawdown of wealth over the individual's retirement, we use the following:

- 2007 gender-specific Canadian population mortality rates (The Canadian Human Mortality Database, 2007).
- 2011 Canadian Government tax/benefit values assuming that 2011 rules, including those for indexation, extend into the future;
- 2000–2007 average industry prices to estimate the cost of purchasing a gender-specific single premium immediate life annuity whose payments are not indexed for inflation (see Appendix B for our methodology in pricing the cost of annuitization). Specifically, we assume that a 65-year-old male could purchase a life annuity with an average monthly payout of \$697 with a premium of \$100,000 (\$631 for a female).

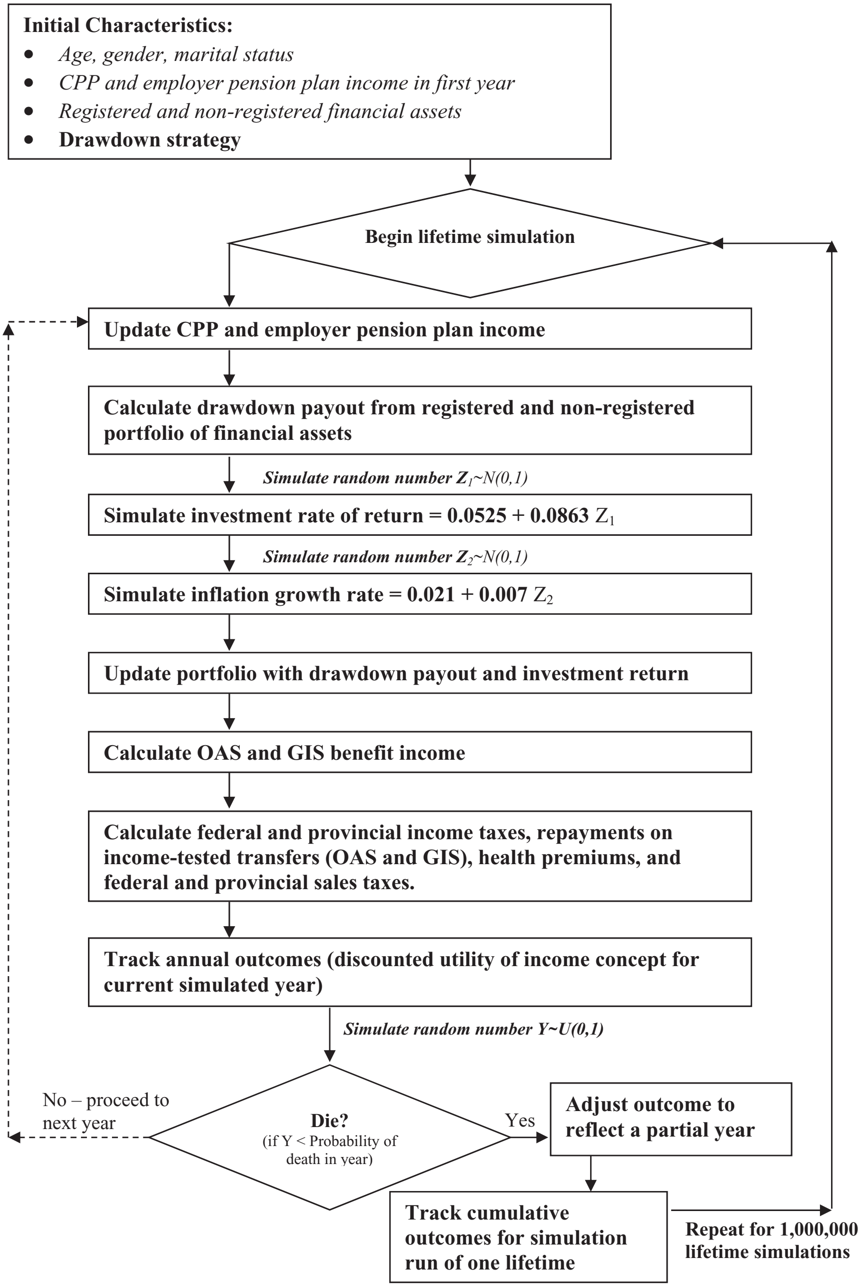

FIGURE 1: General simulation structure of "Ruthen" longitudinal dynamic micro-simulation model. Note: Earlier version of this flow chart appeared in Avery and Morrison (2009: 6; 9).

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- Self-managed portfolio asset portfolio modeling: We assume that financial assets are invested 60% in equities and 40% in bonds. The stochastically simulated annual real returns of the investments are independently and identically normally distributed from year to year with a mean of 5.25% and standard deviation of 8.63% (based on historical data for 2000–2007 so as to match available annuity data, although these values also match long-term historical averages — see Appendix B). We assume dividends and interest income are a constant 3.15% proportion of the funds under management, and that management expenses equal the value that the fund manager adds to the fund performance beyond the rate of return modeled. We assume a buy-and-hold investment strategy where capital gains are realized only on withdrawal.
- 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 from 1995 to 2011 (see Appendix B for additional details).

2.5. Example Canadians

Our example cases assign empirically representative levels of retirement resources corresponding to a newly retired 65-year old with positive financial assets. In 2005, 78% of 60–70 year old Canadians had net financial savings (more than $0 in net financial assets, based on the 2005 Statistics Canada's Survey of Financial Security (SFS) Public Use Microdata). Financial assets are defined as the sum of tax-assisted financial assets (in Canada, these are registered retirement savings plus registered retirement income funds) and non-tax-assisted financial assets, less non-mortgage debt. Non-tax-assisted financial assets consist of deposits held in chequing and savings accounts, term deposits, guaranteed investment certificates, bonds, mutual funds, trust funds and other miscellaneous financial assets. Total non-mortgage debt consists of amounts owing on credit cards, secured and unsecured loans (including lines of credit from banks and other institutions), car loans and other unpaid bills.

In this paper, we restrict our attention to single Canadians, whose financial profiles are much lower than their couple counterparts — for example, in 2005, median total income was $26,200 for 55–64 year old unattached Canadians and $21,800 for unattached Canadians aged 65 and over, compared to $75,300 and $47,600 for families with two or more people (Source: Cansim Table 202–0404). Single Canadian seniors are a minority (19% of male 65-year olds were single in 2007 and 33% of females, and 26% were single overall) — nevertheless, government taxes and transfers are much more complex to model for couples, and single Canadians serve our purpose to investigate whether the consideration of pensions, government taxes and transfers can affect the most rankings of DS. (Note that "single" represents single, divorced or widowed. See CANSIM Table 051-0010).

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Table 1 lists the representative C/QPP, employer pension plan income and financial savings (tax assisted and non-tax assisted) for "representative" single 65-year-old Canadians entering retirement with

- low income (10th percentile of the income distribution);
- median income (50th percentile of the income distribution); and
- high income (90th percentile of the income distribution).

The purpose of Table 1 is to present the case studies' financial characteristics, as well as to illustrate the Canadian pension system in terms of actual income cash flows.

Our sample population of low, median, and high income is made up of Canadians whose "total after-tax income" falls within ten percentiles of the 10th, 50th and 90th percentile, respectively, and who are fully retired, which is defined as having neither earnings from paid employment (wages and salaries) nor self-employment. "Total after-tax income" is defined as the sum of wages, salaries, net income from self-employment, investments, government transfers, pensions and other incomes such as alimony, minus federal and provincial income taxes.

Within the low-, median- and high-income criteria, we estimate income flows from C/QPP and defined benefit employer plans using the 2008 Survey of Labour and Income Dynamics (SLID), employing the median values of 66–70 year old single Canadian respondents. We estimate the wealth stock of tax-assisted financial assets and net non-tax-assisted financial assets (total financial assets less total non-mortgage debt) using the 1999 and 2005 SFS, employing the median values (averaged across the two surveys) of 60–70 year old single Canadian respondents who hold any financial assets (note that the wider age range is for the purpose of having an adequate sample size while still being centered on the targeted age of 65). Finally, the income flows from taxes and social transfers (OAS and GIS) generated in the simulation use 2011 published Canadian government values and rules for future indexation (the maximum annual benefits in 2011 were \$6,368.25 and \$8,634.84). We assume that the individuals have met the full residency requirement for OAS/GIS benefit eligibility and reside in the province of Ontario.

While some high-income Canadians are, for example, employed professionals with defined benefit pension plans, other high-income Canadians (e.g. small-business owners) will depend on defined contribution plans and their private financial wealth in retirement. The choice of DS choice is likely most relevant to affluent individuals with a high level of personal savings and a low level of expectable secure pension income, and hence we also build a stylized high-asset-no-pension (i.e. no employer pension plan) individual. We use CPP, OAS and GIS levels from the high-income example case Canadian in Table 1, set the employer pension benefit to zero and assume financial savings are \$400,000 (\$240,000 tax assisted and \$160,000 non-tax assisted). We note that \$400,000 in financial savings is far from representative of Canadian seniors in general. In 2005, among Canadians between 60 and 70 years old, 25% held over \$100,000 in financial savings, 16% held over \$200,000, 11% held over \$300,000 and only

TABLE 1

ESTIMATED RETIREMENT INCOME RESOURCES FOR FOUR EXAMPLE CASES OF 65-YEAR-OLD SINGLE CANADIANS AT THE START OF THEIR RETIREMENT: LOW-, MEDIAN-, HIGH-INCOME AND HIGH-ASSET-NO-PENSION INDIVIDUAL (2011$).

Income Group	CPP/QPP (in First Year)	Private Pension* (in First Year)	Tax-Assisted Financial Assets (at Age 65)	Non-Tax-Assisted Financial Assets (at Age 65)	OAS** (in First Year)	GIS** (in First Year)
Low (10th Percentile of Income Distribution)	1,156	0	0	1,500	6,368	8,027
Median (50th Percentile)	7,093	2,207	0	16,000	6,368	3,606
High (90th Percentile)	9,195	34,677	59,500	33,000	6,368	0
High-Asset-No-Pension	9,195	0	240,000	160,000	6,368	0

*We assume that employer pension benefits are indexed at 50% of inflation per year.

**OAS/GIS benefit flows are income tested and are calculated year by year in the simulation according to 2011 published Canadian government values and rules for future indexation. This table presents the simulated values in the first year of retirement for each 65-year-old example case Canadian under the 4% Rule drawdown strategy of private savings.

Notes: Author's calculations using the 1999 SFS, 2005 SFS and the 2008 SLID. Consumer price index (annual rates, 1992 = 100; 1999 = 110.5; 2005 = 127.3; 2008 = 135.8; 2011 = 142.7).

6.5% held over $400,000. Within each of these wealth groups, 37%, 42%, 43% and 46% had no employer pension. (Based on the 2005 SFS weighted data, we divide the household values reported in the SFS by the square root of the number of household members to arrive at adult-equivalent values. We deem that someone does not have an employer pension plan if the actuarial value of all employer pension plans is less than $100.)

Using the four example cases and our tool of analysis (Ruthen), Table 2 demonstrates the flows in the first year of retirement under each income concept (columns) for each DS (rows).

3. Analysis

While analysts often look at income flows in the first year of retirement (such as in Table 2), we get a better measure if we extend the timeframe to look at the entire retirement. To do this, we calculate the annual CEI — see Section 2.3. This section demonstrates three primary findings (all of which we will analyze and discuss below).

1. Including pensions, taxes and government transfers can impact the optimal DS rankings. These other components of retirement consumption also affect the rankings of DS *differentially* for our example case Canadians across the income distribution, as well as between males and females and between different levels of risk aversion.
2. Second, we find that relying on a restricted income measure of gross withdrawals from financial savings, in isolation, generates the same ranking of the six DS for all the example case Canadians — in other words, seniors across the income spectrum have the same rankings of DS. A common criticism of conventional financial advice is that it is too universal and simplistic — that is, workers are given the same drawdown advice regardless of financial circumstances. This suggests that limiting the drawdown decision analysis to restricted income measures can (incorrectly) lead to the same advice for all.
3. Third, considering only the drawdown of savings provides no indication of the relative importance of the drawdown decision. We find, however, that the choice can in fact bear enormously on the financial welfare of some seniors, and nearly none on others, once pensions, taxes and transfers are accounted for. As most Canadians have relatively low levels of savings, their DS choice has little effect on lifetime welfare when other income sources of retirement consumption are introduced. This is because the more comprehensive income concepts contain retirement income flows that are much larger than the withdrawals from private savings, their inclusion is more important to lifetime financial welfare than the chosen DS. The DS choice matters, however, at the top end of the income distribution. Here, we find that lifetime welfare is appreciably impacted by the drawdown choice, and that the ranking of DS can change when the income concept is altered (when we

TABLE 2

FIRST-YEAR FLOWS ($2011) FOR FOUR INCOME CONCEPTS UNDER SIX DRAWDOWN STRATEGIES.

Income Group	Savings	Savings + Pension	Savings + Pension − Taxes	Savings + Pension − Taxes + Transfers
Low (10th Percentile of Income Distribution)				
Annuitization	125	1,281	1,787	15,281
Variable Drawdown to Age 95	95	1,251	1,759	15,253
Variable Drawdown to Age 80	140	1,296	1,803	15,290
Fixed Drawdown 4% Rule	60	1,216	1,723	15,223
Fixed Drawdown 6% Rule	90	1,246	1,753	15,248
Hybrid (Annuity and Variable to Age 80)	76	1,232	1,739	15,229
Median				
Annuitization	1,338	10,638	10,881	19,688
Variable Drawdown to Age 95	1,018	10,318	10,665	19,367
Variable Drawdown to Age 80	1,490	10,790	11,081	19,767
Fixed Drawdown 4% Rule	640	9,940	10,333	19,049
Fixed Drawdown 6% Rule	960	10,260	10,615	19,319
Hybrid (Annuity and Variable to Age 80)	814	10,114	10,470	19,148
High (90th Percentile)				
Annuitization	7,733	51,605	39,098	42,822
Variable Drawdown to Age 95	5,883	49,755	38,014	41,736
Variable Drawdown to Age 80	8,612	52,484	39,864	43,588
Fixed Drawdown 4% Rule	3,700	47,572	36,575	40,259
Fixed Drawdown 6% Rule	5,550	49,422	37,790	41,513
Hybrid (Annuity and Variable to Age 80)	4,708	48,580	37,428	41,030
High-Asset-No-Pension				
Annuitization	33,440	42,635	35,165	39,306
Variable Drawdown to Age 95	25,440	34,635	30,426	34,567
Variable Drawdown to Age 80	37,240	46,435	39,017	42,828
Fixed Drawdown 4% Rule	16,000	25,195	23,159	27,724
Fixed Drawdown 6% Rule	24,000	33,195	29,397	33,539
Hybrid (Annuity and Variable to Age 80)	20,360	29,555	26,490	31,212

Notes:
1. The first two income concepts use averages from the first year of retirement and therefore can be directly calculated from Table 1. Owing to the unusual taxes payable on the realization of the capital gains for non-tax-assisted funds that occur only in the first year when annuitizing, we use taxes and transfer levels from the second year of retirement in the third and fourth column, which are a better representation of the overall flows in the case of annuitization and the hybrid strategy.
2. The difference between the third and fourth income concepts is less than the OAS/GIS benefits, since these benefits bring with them additional income taxes and sales tax.
Source: Authors' calculations.

compare affluent individuals with different mixes of pension entitlements and private financial savings). For example, affluent Canadians with no private pension plan are better off annuitizing their savings, while those with an employer pension plan should self-manage their savings.

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TABLE 3

DRAWDOWN STRATEGY RANKINGS ACCORDING TO DISCOUNTED UTILITY ACROSS FOUR INCOME CONCEPTS FOR LOW-, MEDIAN- AND HIGH-INCOME CANADIAN (RELATIVE RISK AVERSION = 1.5).

Income Group	Savings	Savings + Pension	Savings + Pension − Taxes	Savings + Pension − Taxes + Transfers
Low (10th Percentile of Income Distribution)				
Annuitization	2	2	2	1
Variable Drawdown to Age 95	4	3	3	3
Variable Drawdown to Age 80	1	1	1	2
Fixed Drawdown 4% Rule	6	6	6	6
Fixed Drawdown 6% Rule	3	4	4	4
Hybrid (Annuity and Variable to Age 80)	5	5	5	5
Median				
Annuitization	2	1	1	2
Variable Drawdown to Age 95	4	3	3	3
Variable Drawdown to Age 80	1	2	2	1
Fixed Drawdown 4% Rule	6	6	6	6
Fixed Drawdown 6% Rule	3	4	4	4
Hybrid (Annuity and Variable to Age 80)	5	5	5	5
High (90th percentile)				
Annuitization	2	1	1	2
Variable Drawdown to Age 95	4	3	3	3
Variable Drawdown to Age 80	1	2	2	1
Fixed Drawdown 4% Rule	6	6	6	6
Fixed Drawdown 6% Rule	3	4	4	4
Hybrid (Annuity and Variable to Age 80)	5	5	5	5
High-Asset-No-Pension				
Annuitization	2	1	1	1
Variable Drawdown to Age 95	4	2	2	3
Variable Drawdown to Age 80	1	4	4	2
Fixed Drawdown 4% Rule	6	6	6	6
Fixed Drawdown 6% Rule	3	3	3	4
Hybrid (Annuity and Variable to Age 80)	5	5	5	5

Source: Authors' calculations.

Table 3 gives the ranking associated with the six DS. Although the differences between strategies are not large for lower income Canadians (as we show below), rankings of DS can change depending on the income concept underlying the analysis — in particular, we note that for both the median and high income example, annuitization is *not* the preferred strategy when the "*Savings+ Pension − Taxes + Transfers*" income concept is used (being dominated by the "Variable Drawdown to Age 80" strategy).

The first column of Table 3 shows that using the conventional gross-income concept (Savings), DS rankings are the same across all example case

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Canadians — and that the variable DS to age 80 (which aims at equal payments in real terms that exhaust the portfolio through the first fifteen years of retirement) is the highest rank for all four example cases. This is because any DS examined is a function of initial wealth and therefore generates a CEI value that is in constant proportions between example case Canadians with the same utility function specifications and simulation assumptions (for example, the ratio of the simulated expected present utility value for the low-income example case ($1,500 savings) and for the high-income example case ($92,500 savings) is $(1{,}500/92{,}500)^{(1-\alpha)}$).

In Table 3, the rankings of DS can change for each example case Canadian between income concepts. For example, for the median-income Canadian, the ranking of the four most optimal strategies re-order between the third income concept and the inclusion of pension income in the fourth income concept. This indicates that calculating the most optimal DS choice under one income concept does not necessary translate into a "universal" top ranking across all income concepts.

Are these results being driven by the assumed level of individual risk aversion? Not particularly — Table 4 examines the DS rankings for the high-asset-no-pension case male at higher levels of risk aversion ($\alpha = 2$ and $\alpha = 5$). In both Tables 3 and 4, we find that the strategy "Variable Drawdown to Age 80" appears like the best option, if risk aversion is on the lower side ($\alpha = 2$ and $\alpha = 1.5$) and if pre-tax income from savings alone is being considered — but annuitization dominates for all risk aversion levels for the fuller measures of incomes, including pensions, taxes and transfers. For all three levels of risk aversion, the underlying income concept used for analysis affects the ranking of the DS — for example, the ranking of the top four DS under the first income concept "Savings" are re-ordered under the fourth (consumption proxy) income concept.

Although annuitization is not always the best strategy once other income sources are taken into account, it does often rank at the top, particularly for higher levels of risk aversion in Table 4. A driving force behind its general success is the design of the conventional utility framework that underlies the evaluations in this analysis. The utility framework was chosen for consistency with literature in this line of research (see Section 2.2), although its design favors the qualities of annuities and places no value on some of the important advantages of self-managed strategies. As explained in Section 2.3, the value of annuitization is that it provides payments that are stable, guaranteed until death, and augmented by the mortality premium (members who live longer will profit from the invested capital of those who die earlier, creating a "mortality premium" that is added to the investment return and can become quite substantial at advanced ages). Correspondingly, the utility framework favors high, stable income flows that come sooner than later. This utility framework can lead to reasonable conclusions — for example, Table 3 shows that annuitization is preferable for an affluent Canadian with no private pension plan, as it provides needed stability, while a self-managed strategy that draws income quickly (before age 80) is more valuable to affluent Canadians with adequate secure employer pension benefits.

TABLE 4

DRAWDOWN STRATEGY RANKINGS FOR A "HIGH-ASSET-NO-PENSION" MALE ACROSS FOUR INCOME CONCEPTS AT ALTERNATIVE LEVELS OF RELATIVE RISK AVERSION ($\alpha = 2$ AND $\alpha = 5$).

Income Group	Savings	Savings + Pension	Savings + Pension − Taxes	Savings + Pension − Taxes + Transfers
Relative Risk Aversion = 2				
Annuitization	2	1	1	1
Variable Drawdown to Age 95	3	2	2	2
Variable Drawdown to Age 80	1	6	5	3
Fixed Drawdown 4% Rule	6	5	6	6
Fixed Drawdown 6% Rule	4	3	3	4
Hybrid (Annuity and Variable to Age 80)	5	4	4	5
Relative Risk Aversion = 5				
Annuitization	1	1	1	1
Variable Drawdown to Age 95	4	3	3	3
Variable Drawdown to Age 80	3	6	6	6
Fixed Drawdown 4% Rule	5	4	4	5
Fixed Drawdown 6% Rule	6	5	5	4
Hybrid (Annuity and Variable to Age 80)	2	2	2	2

Source: Authors' calculations.

But the overwhelming support for annuitization by the conventional utility framework conflicts with the fact that voluntary annuitization is extremely rare in the real world, which has led to a great deal of study on the topic (for summary, see MacDonald *et al.* 2013). The fundamental barrier to purchasing traditional annuities from the private market is that people do not want to lose the flexibility and control over accessible funds, for often very good reasons: using savings to pay off debt, covering medical expenses, leaving a legacy, or maintaining a contingency fund to cover renovations or other unanticipated financial expenses (when a bank loan is not possible or desirable). These advantages of self-managed strategies receive no value under the conventional utility framework. Considering the underlying bias in the evaluation framework, therefore, the instance where purchasing annuities is not the best choice is a compelling evidence to the importance of employing a comprehensive income concept since, if using a more balanced metric for evaluation, the impacts to financial outcomes could be much more severe.

Table 5 examines the impact of gender for the high-asset-no-pension case for a female with relative risk aversion of 1.5. In this analysis, gender affects the annuity price and mortality modeling. (Note that both genders have the same income and wealth levels at retirement in Section 2.5 — this is for illustrative purposes, and we do not pretend that men and women actually have equal income and wealth.) Table 5 shows changes in the DS rankings from one income concept to the next, and between male and female at each income concept (for

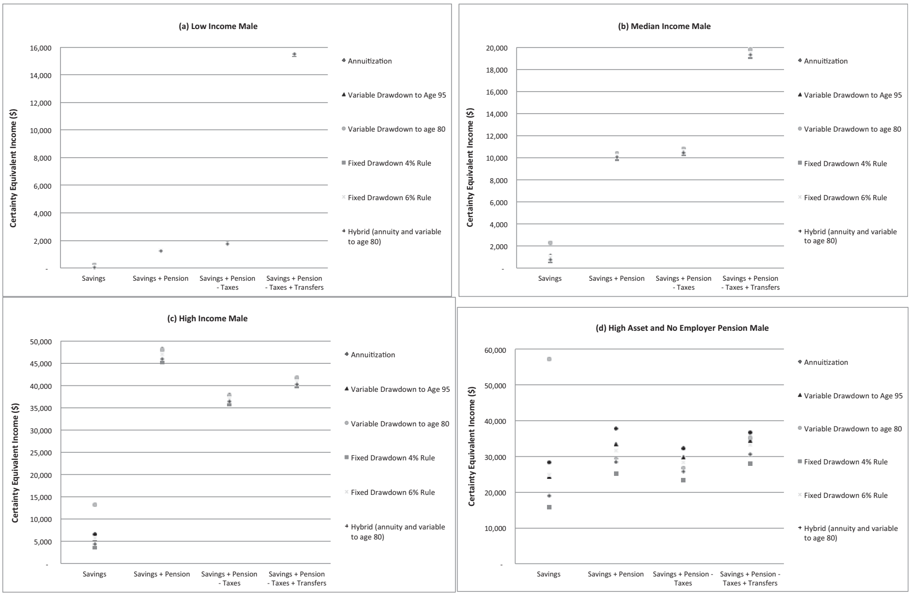
TABLE 5

DRAWDOWN STRATEGY RANKINGS OF DISCOUNTED UTILITY FOR A "HIGH-ASSET AND NO REGISTERED PENSION PLAN" FEMALE ACROSS FOUR INCOME CONCEPTS (RELATIVE RISK AVERSION = 1.5).

Drawdown Strategy	Savings	Savings + Pension	Savings + Pension − Taxes	Savings + Pension − Taxes + Transfers
Annuitization	3	1	1	1
Variable Drawdown to Age 95	4	2	2	2
Variable Drawdown to Age 80	1	5	5	3
Fixed Drawdown 4% Rule	6	6	6	6
Fixed Drawdown 6% Rule	2	3	3	4
Hybrid (Annuity and Variable to Age 80)	5	4	4	5

example, at the fourth income concept, "Variable drawdown to Age 80" ranks second for the male in Table 4 but third for the female in Table 5). Annuitization remains the preferred strategy across second, third and fourth income concepts, but its relative value compared to the other DS is reduced for females owing to the higher gender differential in annuity pricing that exists in the population mortality underlying the simulations.

Examining drawdown from savings alone not only distorts the true ranking of DS, but it also ignores the relative importance of the drawdown decision on retirement financial welfare. We next show that not only the ranking can change once pensions, taxes and transfers are accounted for, but so does the weight of the drawdown decision on financial welfare. Figure 2 displays the CEI values (y-axis) produced by the six DS (labeled) for the (a) low-, (b) median-, (c) high-income and (d) high-asset-no-pension example case single Canadians at each of the four income concepts (x-axis), for a male with a constant relative risk aversion of 1.5. Examining the most comprehensive income measure results, the markers are nearly non-differentiable for the low-income single Canadian, and become just somewhat more visible for the median- and high-income single Canadians, which illustrates the relative unimportance of the drawdown decision on general retirement financial welfare for many Canadians once we include other sources of pension income, government taxes and social transfers. This is because the comprehensive incomes are primarily driven by the pensions and social benefits transfer system (particularly for the median and 10th percentile example case studies). Indeed, the value of choosing one drawdown strategy over another is nearly invisible. This is not the case for the high-asset-no-pension individual, and Figure 2(d) suggests that DS choice does matter for Canadians who do not hold employer pensions and have substantial financial savings. The rest of this section is devoted to explaining the tradeoffs that are occurring when moving from one income concept to the next, for the benefit of readers interested in the precise dynamics underlying the results.



Notes:
Savings: Gross withdrawals from financial savings
Savings + Pension: Savings + Pension Income (employer and state)
Savings + Pension – Taxes: Savings + Pension Income – income taxes/sales tax + tax credits
Savings + Pension – Taxes + Transfers: Savings + Pension - Taxes + government social transfers
Source: Authors' calculations.

FIGURE 2: Annual certainty equivalent income corresponding to six drawdown strategies for low (a), median (b), high (c) income and high-asset-no-pension (d) single Canadians using four income concepts (relative risk aversion = 1.5 and 2011). Notes: Savings: Gross withdrawals from financial savings. Savings + Pension: Savings + Pension Income (employer and state). Savings + Pension – Taxes: Savings + Pension Income – income taxes/sales tax + tax credits. Savings + Pension – Taxes + Transfers: Savings + Pension - Taxes + government social transfers. Source: Authors' calculations.

The first income concept (labeled "Savings") in Figures 2(a), (b), (c) and (d) plots the CEI of each DS under the conventional "simple gross withdrawals from retirement savings" concept that is habitually used in this line of research. When withdrawals from retirement savings are the only determinant of consumption, drawdown strategy choice necessarily plays a large role in retirement well-being. When pension income is included in the income concept (*Savings + Pension*), the importance of Canada's pension system to the expected retirement well-being of Canadian seniors is apparent — the CEI value for all six DS rises dramatically and becomes less distinguishable for the first three example case Canadians. Some dispersion between the markers remains, however, for the high-asset-no-pension individual.

Including taxes and tax credits implies that DS' values again move in unison, although the direction and magnitude of the move are different across the four example case Canadians. The relative CEI of the low income and median Canadian senior improves slightly, as such a person does not pay federal or provincial

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TABLE 6

RATIO OF CERTAINTY EQUIVALENT INCOME VALUES FOR FULL ANNUITIZATION OF THE THREE EXAMPLE CASE CANADIANS COMPARED TO THE LOW-INCOME EXAMPLE CASE.

Income Group	Savings	Savings + Pension	Savings + Pension − Taxes	Savings + Pension − Taxes + Transfers
Low (10th Percentile of Income Distribution)	100%	100%	100%	100%
Median	1,067%	813%	610%	127%
High (90th Percentile)	6,167%	3,760%	2137%	269%
High-Assets-No-Pension	26,701%	2,219%	1,605%	183%

Source: Authors' calculations.

income tax or provincial health premiums, and the sum impact of tax credits and sales taxes is positive. However, the CEI of high-income and high-income-no-pension Canadians decrease owing to income taxes and sales tax that exceed government tax credits.

When government transfers are added, all example Canadians increase their incomes, but to varying degrees that reflect the size of the benefit and the relative starting position of the individual. Across the 4% Rule drawdown strategy simulations in Table 2, for example, the low-income Canadian generally receives the maximum OAS and nearly the maximum GIS benefits, the median-income Canadian similarly receives the maximum OAS benefit and approximately 45% of the maximum GIS benefit and the high-income Canadian generally receives the maximum OAS benefit and no GIS benefit. Second, the low-income Canadian moves from virtually no income under the third income concept ($1,723) to $15,223 after government transfers under the fourth income concept (783% increase). At the other end, the high-income Canadian begins with $36,575 in income under the third income concept, which increases to $40,259 by the fourth income concept (a 10% increase). As a result, government transfers are strongly progressive, producing the largest improvement in lifetime welfare for the low-income example case, followed by the median-income and high-income cases.

As Figure 2 shows, the drawdown choice of "typical" low-, median- and high-income single Canadians makes little impact on their retirement financial welfare once we include other sources of pension income, government taxes and social transfers. The financial savings of these example case Canadians ($1,500 for low income, $16,000 for median income and $92,500 for high income) were just not large enough to make the drawdown choice significant relative to other income sources of retirement consumption. Figure 2 also shows the extent that the Canadian tax and social transfer retirement system reduces dramatically the dispersion of CEI among the example cases. Table 6 illustrates how important pensions, taxes and transfers are to retirement financial welfare by showing how tightly they pull the income concept values together. It lists the ratio of CEIs for "Annuitization" of the example case Canadians to the low-income example case.

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The introduction of taxes and government social transfers between "Savings + Pension" and "Savings + Pension – Taxes + Transfers" reduces the proportional gap in CEI between the high-income (90th percentile) Canadian and the low-income (10th percentile) single Canadian senior from approximately 3,760% to 269%, which is a 95% decline [=(3,760% − 269%)/(3,760% −100%)].

4. Conclusion

This paper examines the importance of pensions, taxes and government transfers in the evaluation of alternative strategies for drawing down retirement financial savings. Using as examples single elderly Canadians at the 10th, median and 90th percentiles of the income distribution, we use a lifetime utility framework to evaluate an illustrative set of six popular DS. Our longitudinal dynamic micro-simulation model for Canada incorporates risk aversion, stochastic markets, stochastic mortality and the interactions among sources of retirement income within the complex Canadian tax and social benefit system, enabling us to compare estimates of the expected discounted utility for six commonly advocated DS (market annuitization, four distinct self-managed DS and one hybrid strategy). To show the impact of considering alternative measures of income, we ranked these strategies using four different income concepts as the argument of the utility function:

1. Gross withdrawals from financial savings entering retirement.
2. Gross withdrawals + pension income (employer and CPP) .
3. Gross withdrawals + pension income (employer and CPP) – taxes.
4. Gross withdrawals + pension income (employer and CPP) – taxes + government transfers.

Our primary finding is that consideration of pensions, taxes and transfers does often alter the rankings of drawdown strategies for retirement savings. We find that moving beyond the simple income concept to more comprehensive measures can change the drawdown strategy rankings among the six commonly advocated strategies examined, and the top ranking DS choice under one income concept does not necessary translate into a "universal" top ranking across all income concepts. Notably, and contrary to nearly all the research on this topic, annuitization is not always the best strategy once pensions, taxes and government transfers are modeled. This is particularly significant given that the evaluations are done using a conventional utility framework that, by design, highly values the characteristics of annuitization (which offers income stability until death, where payments are higher than equivalent bond returns owing to mortality credits), and places no value on some of the important advantages of self-managed strategies (including bequest motives and control over accessible funds). Second, including consideration of pensions, taxes and transfers differentially alters the ranking of drawdown strategies — the effects are not uniform between males and females, across people at different points in the income distribution and at different levels of risk aversion. Last, the DS choice can be very important to the retirement financial welfare of some seniors, and nearly inconsequential for others — an issue ignored when only the drawdown of savings alone is considered.

The drawdown decision choice can be very important to the retirement financial welfare for some seniors, and nearly inconsequential for others. When only the drawdown of savings is considered, this critical consideration is ignored. For example, the choice of drawdown strategy choice is especially relevant to affluent individuals with a high level of personal savings and a low level of expectable pension income. Although such individuals are not "typical Canadians", nevertheless, individuals with high levels of wealth and no employer pension plan can be politically important (such as small-business owners) and are more likely to seek out and receive financial planning advice. In a 2006 survey by the Financial Planning Association (the largest association of personal financial planning experts in the United States), for example, 85% of clients served by FPA personal financial practitioners had investable assets of over $100,000, and 48% had investable assets of over $500,000.

Overall, this paper finds that a restricted income concept can lead to misleading advice for individuals where choice can significantly affect their retirement financial well-being.

The most common reaction to this work is that the results are not surprising — that is, ***of course*** pension, taxes and government transfers will affect the optimal drawdown strategy. The question is, therefore, why do papers on retirement savings drawdown nearly unanimously ignore them? This research suggests a strong need for a retirement savings drawdown research to comprehensively model all of the components of retirement consumption, even if it means resorting to more data-driven analysis. More generally, it supports the importance of more research that strives for comprehensive and holistic analysis of retirement financial planning.

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APPENDIX A. DRAWDOWN STRATEGY FORMULAS

This appendix provides the formulas of each drawdown strategy described in Section 2.3. "Drawdown$_x$" is the drawdown amount (payout of drawdown strategy) at age x. These formulas use basic standard "International Actuarial Notation" — see Dickson *et al.* (2009).
Annuitization:

$$\text{Drawdown}_{65} = \text{Wealth}_{65}/\ddot{a}_{65},$$
$$\text{Drawdown}_x = \text{Drawdown}_{65} \text{ for } x > 65.$$

Variable Drawdown to Age 95:

$$\text{Drawdown}_x = \text{Wealth}_x/\ddot{a}_{\overline{95-x}|r} \text{ for } x \in [65,94].$$

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Variable Drawdown to Age 80:

$$\text{Drawdown}_x = \text{Wealth}_x / \ddot{a}_{\overline{80-x}|_r} \text{ for } x \in [65,79].$$

Fixed Drawdown 4% Rule:

$$\text{Drawdown}_{65} = 0.04\,\text{Wealth}_{65},$$
$$\text{Drawdown}_x = \text{Drawdown}_{x-1}(1 + \text{Inflation}_{x-1}) \text{ for } x > 65.$$

Fixed Drawdown 6% Rule:

$$\text{Drawdown}_{65} = 0.06\,\text{Wealth}_{65},$$
$$\text{Drawdown}_x = \text{Drawdown}_{x-1}(1 + \text{Inflation}_{x-1}) \text{ for } x > 65.$$

Hybrid:

25% Annuitization and 75% Fixed Drawdown 4% Rule

where

- Inflation_{x-1} is the rate of inflation between ages $x-1$ and x;
- $\ddot{a}_{65}$ is the actuarial present value of \$1 at the beginning of each future year for the lifetime of a 65-year old (e.g. whole life annuity due):
  - $\ddot{a}_{65} = \sum_{t=0}^{\infty} {}_tp_{65}(1+i)^{-t}$, where ${}_tp_{65}$ is the probability of death for a 65-year-old annuitant between ages 65 to 65 $+t$, and i is the underlying net *nominal* rate of return set by the annuity provider in pricing the annuity.
  - Note that "Annuitization" *is not* a self-managed drawdown strategy, and therefore the underlying life annuity pricing assumption relies on industry values (for annuity pricing details, see Appendix B).
- $\ddot{a}_{\overline{y}|_r}$ is the actuarial present value of \$1 (inflation-indexed) at the beginning of each future year for y years (e.g. inflation-indexed y-year annuity-certain):
  - $\ddot{a}_{\overline{y}|_r} = \sum_{t=0}^{y-1} \frac{(1+m)^{-t}}{(1+n)^{-t}} = \sum_{t=0}^{y-1} (1+r)^{-t}$, where m is the assumed long-term mean inflation, n is the assumed long-term mean total nominal return on assets and r is the assumed long-term mean total *real* rate of return on assets assumption
  - Note that "Variable Drawdown to Age 80/95" *are* self-managed variable drawdown strategies. The actuarial present value factor is re-calculated each year using the mean expected real rate of return on self-managed assets (represented by μ_p and set at 5.25% in Appendix B).

APPENDIX B. MODELING ANNUITY PRICING, INFLATION AND SELF-MANAGED ASSETS RATES OF RETURN

B.1. DATA

We estimate our financial market and inflation models using historical data compiled by the Canadian Institute of Actuaries 2011 report on Canadian financial statistics (CIA, 2012).

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We price our annuity using historical industry prices compiled by The Individual Finance and Insurance Decisions Centre "Payout Annuity Index" http://www.ifid.ca/payout.htm. The underlying data sources are as follows:

- Bond returns:
  - Yield-to-maturity on Government of Canada marketable bonds (10+ years) from 1936 to 2011
  - CANSIM I: B14013; CANSIM II: V122487
- Stock returns:
  - Total return on Canadian Common Stock from 1936 to 2011
  - Prices:
    - Urquhart & Buckley H641 December 1936–December 1946 (Corporate Composite)
    - CANSIM B4202 (TSE Corporates) December 1946–December 1956
    - TSX Total Return Index December 1956–December 2011
  - Dividend Yield, Annual Averages:
    - Urquhart & Buckley H617 January 1951–December 1955
    - CANSIM V122628 January 1956–December 2011
- Inflation rate of change:
  - All-items Consumer Price Index from 1936 to 2011
  - CANSIM V41690973
- Annuity pricing:
  - Fixed Single-Premium Immediate Life Annuity with 10-year guarantee purchased from tax-assisted funds from 2000 onward
  - Cannex Financial Exchanges Limited (CANNEX specializes in providing real-time income annuity quotes offered by insurance companies in Canada and the United States http://www.cannex.com).

B.2. CALCULATING ANNUITY PRICES AND SELF-MANAGED ASSETS RATES OF RETURN AND INflATION MODEL PARAMETERS

A fair comparison among drawdown strategies requires historical data spanning the same period — but historical industry annuity price quotes are extremely limited. We use the "Payout Annuity Index" by The Individual Finance and Insurance Decisions Centre at York University (http://www.ifid.ca/payout.htm), which compiles the weekly average annuity payout quote across a across a range of Canadian insurers since 2000 (these quotes are provided by CANNEX Financial Exchanges Limited). To avoid the large weight of the recent financial crisis, we limit our time period to years 2000–2007 in estimating both the market annuity prices and self-managed portfolio rates of return modeling parameters.

Because the annuity price quotes supplied by IFID are based on average industry quotes of single premium immediate annuities for single 65 year-old male/female with a 10-year payment certain (also known as a 10-year guaranteed period), while the annuity that we require has no guaranteed period, we use the IFID data and calculate the life-only annuity prices from actuarial first principles. Using the Society of Actuaries' annuitant population mortality rates (1996 US annuity 2000 tables with Projection Scale AA) with a 10% margin for error, we then back-out the underlying rate of return within each year from the average cross-industry annuity prices supplied by IFID. We then combine the mortality assumptions with the calculated underlying rates of return to calculate from first principles the annuity prices for 65-year-old males and females without the guaranteed period for each historical year 2000–2007. We finally average the life-only annuity prices over all eight years to arrive at our estimate.

The average payout from the IFID data was \$8,108.33 per year for a \$100,000 premium for 65-year-old male and \$7,436.39 for female. According to our calculations, removing the guarantee increases the payout to \$8,358.76 for male and \$7,576.77 for females. The change in price is relatively small, since insurers assume with high probability (86.5% if male and 90.9% if female) that annuitants will live beyond age 75. For taxation purposes, these annuities are "prescribed" annuities, which enjoy certain tax advantages.

We stochastically simulate future self-managed assets' annual real rates of return assuming that they are independently and identically normally distributed with mean (μ_p) and standard deviation (σ_p). To estimate μ_p and σ_p, we first obtain historical real rates of return for our assumed portfolio assets (60% equities and 40% risk-free assets, assuming a buy-and-hold strategy for long-term bonds) from the above-listed historical data sources. Letting

- p_t^r represents the portfolio total real rate of return,
- b_t^n represents the bond total nominal rate of return,
- b_t^r represents the bond total real rate of return,
- s_t^n represents the stock total nominal rate of return,
- s_t^r represents the stock total real rate of return and
- k_t represents the rate of consumer price inflation

between times t and t+1. Hence,

$$b_t^r = \frac{1 + b_t^n}{1 + k_t} - 1,$$

and

$$s_t^r = \frac{1 + s_t^n}{1 + k_t} - 1.$$

We estimate mean (μ_p):

$$\overline{\mu}_p = 0.6\frac{1}{2007 - 2000 + 1}\sum_{t=2000}^{2007} s_t^r + 0.4\frac{1}{2007 - 2000 + 1}\sum_{t=2000}^{2007} b_t^r = 5.25\%.$$

We assume a buy-and-hold strategy for the bond investment, thereby making it a risk-free asset. We estimate the annual fixed total return ($\overline{b^r}$) using the average real yield-to-maturity on long-term bonds. Hence, we estimate the standard deviation of the portfolio (σ_p):

$$\overline{\sigma}_p = \sqrt{\frac{1}{(2007 - 2000 + 1) - 1}\sum_{t=2000}^{2007} \left(s_t^r + \overline{b^r} - \overline{\mu}_p\right)^2} = 8.79\%.$$

If we estimate these parameters from all historical data (1936–2011), we find that it produces a nearly identical $\mu_p$of 5.34% and a reasonably close σ_p of 10.12%. This suggests that the reduced sample period 2000–2007, which was necessary owing to the limited available annuity price data, is also representative of long-term historical data.

We stochastically simulate future annual inflation rates of return assuming that they are independently and identically normally distributed with mean (μ_k), which we estimate with

$$\overline{\mu}_k = \frac{1}{2011 - 1995 + 1} \sum_{t=1995}^{2011} k_t = 2.0\%,$$

and standard deviation (σ_k), which we estimate with

$$\overline{\sigma}_k = \sqrt{\frac{1}{2011 - 1995 + 1 - 1} \sum_{t=1995}^{2011} (k_t - \overline{\mu}_k)^2} = 0.7\%$$

We use 1995–2011 to estimate future inflation parameters because the Bank of Canada has targeted a stable 2% inflation rate since 1991.

Because taxation on non-tax-assisted assets depends on the proportion of the portfolio's total return that is dividends and interest income, we calculate how much of the stock total return is dividends and how much of the bond return is income. The average 2000–2007 historical annual stock dividend yield was 1.8% (CANSIM v122487: 1936–2011), and the average yield to maturity for 10+ years Government of Canada marketable bonds over this period was 5.15% (CANSIM V122485: 1951–2011). With this, we assume that the proportion of the portfolio returned as dividends and interest income to be 3.15% ($= 0.4(5.15\%) + 0.6(1.8\%)$). (Note that the taxation of dividends and interest income are broadly similar in the Canadian system, though interest income is taxed somewhat more heavily. For simplicity, we assume that both sources are taxed as dividends.)

Finally, as Section 2.4 notes, we assume a buy-and-hold investment strategy where capital gains are realized only on withdrawal. To estimate the proportion of non-tax-assisted savings that is unrealized capital gains at retirement, we assume that non-tax-assisted savings were accumulated evenly over the 10 prior years with 10 end-of-year equal payments in real terms, and that the wealth grew with the assumed mean rate of return using a buy-and-hold investment strategy. This calculation leads to 27% of the portfolio constituting unrealized capital gains at retirement ($27\% = (\sum_{t=0}^{9} (1.0525)^t - 10)/10$).