

Moving Beyond the Limitations of Traditional Replacement Rates

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Abstract

Replacement rates have historically been a tool to determine the adequacy of retirement income to maintain an individual's standard of living. The concept of a replacement rate is intuitively appealing. Numerous conceptual and methodological issues lie, however, beneath its simple exterior. The purpose of this paper is to examine these underlying issues for the benefit of retirement security stakeholders, particularly public policy makers, pension plan sponsors, advisors, financial product providers, and individuals planning for retirement.

We find that conventional gross replacement rate targets are not adequate in their traditional role as a tool for retirement planning or evaluating the retirement preparedness of a population owing to the limitations that we review in this paper. To illustrate how poorly they perform, we show that the empirical distribution of "real-world" target gross replacement rates is very wide; consequently, any one target rate fits relatively very few individuals.

Consequently, although the conventional gross replacement rate measure continues to have a role in evaluating the general performance of a defined benefit pension plan scheme, or as a descriptive population statistic to show trends over time, such measures are unsuitable for assessing an individual's ability to maintain his/her standard of living after retirement. Fortunately, with the emergence of better data and superior methodologies, the replacement rate literature is becoming more sophisticated. This paper reviews past literature, examines the conceptual and measurement issues when building replacement rates, performs original analysis, and provides guidance on building replacement rate measures.

A Introduction

One of the generally accepted goals of retirement is explicitly a relative one: that retirees should not experience a markedly reduced standard of living (or economic welfare) upon retirement.

Interest in this goal has led to widespread use of "replacement rate" measures, typically calculated by dividing some measure of retirement income by some measure of working-life income. These measures are used, often for different purposes, by a number of actors with interests in the retirement income system, including:

1. by researchers and policy-makers to describe and evaluate retirement income systems, and examine population trends over time,
2. by employers, unions and actuaries in the design of employee benefit programs, and
3. by individuals and financial planners to plan for retirement and make retirement savings decisions.

There is no consensus on the best approach to estimate replacement rates within any of these roles and the conceptual grounding of the measures developed has often been weak. Replacement rates have consequently been calculated in widely-different manners that have depended not only on their purpose but also on the availability of data, human and technological resources.

As will be discussed in Section B, there has been widespread use of “rules of thumb” that suggest that individuals with a gross replacement rate of 70-80% will be able to continue their standard of living in retirement. In the past, efforts have been exerted to produce more “accurate” target gross replacement rates – ones that are based on a consistent methodology and actual data (e.g. Dexter (1984) and Palmer (1988)). These initiatives were innovative for their time, but were encumbered by limited data and inferior computer technology. Although the developers were quite clear in documenting many of the limitations, the end users were generally unaware. In recent years, much of the literature acknowledges that “rules of thumb” based on gross income are inaccurate indicators of retirement adequacy for many individuals and families (e.g. Scholz and Seshadri, (2009)). This realization has been accompanied by the availability of better data.

We begin with a review of the replacement rate concept in Sections B through D, including its application in previously published literature. Specifically, Section B provides a general background, Section C examines the conceptual and measurement issues when building replacement rates, and Section D provides some guidance towards better replacement rates. To demonstrate the issues outlined in the paper, Section E empirically shows the inaccuracy of traditional target gross replacement rates by calculating the *individualized* target gross replacement rate for a large sample of Canadians. This section employs a state-of-the-art dynamic population microsimulation model developed by the Canadian federal statistical agency, Statistics Canada, which draws on many Canadian data sources to model the lifecourses of individual Canadians. Section F discusses research gaps and future work, and thereafter we summarize our findings.

B Background

The “replacement rate” is the conventional measure used to evaluate the extent that individuals are able to replace their pre-retirement earnings with other sources of income in retirement. An individual’s replacement rate is simply the fraction of his/her pre-retirement income replaced by retirement income:

$$\text{replacement rate} = \frac{\text{retirement income}}{\text{pre-retirement income}} \quad (1)$$

Theoretically, a *target* replacement rate is the replacement rate necessary for an individual to maintain his/her standard of living after retirement.

In most uses, replacement rates are used in an attempt to establish whether, or to what degree, individuals are able to continue their pre-retirement standard of living after ceasing employment (Moore and Mitchell, 1977) (Munnell and Soto, 2005) (Moore et al., 2010) (MacDonald et al., 2011) (Wolfson, 2011). An appropriate indicator of an individual's standard of living is consumption, which is the value of the flow of goods and services consumed over a given time period. Within the replacement rate framework, therefore, a retiree who maintains smooth consumption over the pre- and post-retirement period is considered to have maintained his/her pre-retirement standard of living.

The ideal approach to measuring whether an individual's consumption falls after retirement is to employ longitudinal expenditure data - data that tracks the expenditure of an individual (or preferably, a household) over time. Such microdata are, however, extremely scarce¹. For practical purposes, therefore, analysts often measure expenditure indirectly using the following formula²:

$$\text{Consumption} = \text{gross income} - \text{taxes} - \text{savings} + \text{dissavings} \quad (2)$$

Here, "dissavings" refers to the drawdown of savings or the accumulation of debt. Equation (2) captures consumption indirectly by assessing the funds used to support a household's standard of living – the basic needs (food, shelter, transportation, medical, clothing, etc) and any additional voluntary expenses (travel, entertainment, etc). Especially when averaged over a substantial period, equation (2) is a reasonable proxy for consumption. Even this proxy, however, is difficult to measure since longitudinal microdata on savings and dissavings are particularly limited (such as savings in housing and non-registered financial investments).

Replacement rate studies have used different techniques to cope with the divergence between the concept that they are implicitly evaluating (consumption), and their available data³. The most common approach in the literature has been to:

- determine
 - gross (i.e., before-tax) income in the first year of retirement (usually at age 65) and
 - gross pre-retirement final earnings,
- calculate:

¹ Some studies, such as LaFrance and LaRoche-Cote (2011), have used a synthetic cohort approach to examine average cohort consumption across different years of a cross-sectional survey.

² Although a proxy for consumption, we will refer to equation (2) as measuring consumption for simplicity throughout the rest of this paper.

³ Current-year earnings data are generally readily available. For instance, current year earnings is commonly collected in public surveys; a client who visits their financial planner typically brings his/her income tax return for the current year; and employers who sponsor a pension plan have the current year payroll for their employees.

$$\text{gross replacement rate} = \frac{\text{gross retirement income}}{\text{gross pre-retirement employment earnings}}$$

- and set the target replacement rate for successful consumption-smoothing between work-life and retirement at less than 100% to recognize that retired individuals will generally pay lower taxes, not be saving for retirement, no longer need to support children, and typically have paid off their mortgage. It is also sometimes recognized that retirees will no longer have to pay work-related expenses, although other expenses may increase after retirement (Palmer, 1988).

The percentage of earnings that is identified as the target gross earnings replacement rate is essentially a proxy for the retirement income needed to achieve a 100% replacement of pre-retirement consumption.

One widespread approach has been to use a universal and soft "rule of thumb" to signal adequate consumption replacement following retirement. In much popular use, individuals whose gross retirement income is at least 70-80% of their gross pre-retirement earnings are considered to have successfully maintained their working-age standard of living in retirement. For instance, TD Economics (2010) assumed a target gross replacement rate at 70% when assessing the ability of future retiring Canadians to maintain their standard of living. Such an approach is also a "staple of web-based financial planning products" (Scholz and Seshadri, 2009). In addition, many defined benefit occupational pension plans provide benefits that, after 35 years of service, are equal to 70% of an individual's final earnings.

Rather than use rules of thumb, some studies estimate average target gross replacement rates using survey data. This includes Palmer (1988, 2008), who produced universal target gross replacement rates for workers classified by earnings level, region, and family configuration⁴ by implicitly employing equation (2) as a proxy for consumption. He estimated its components for subgroups of workers using data from the Consumer Expenditure Survey, and also to match workers and retirees with similar disposable incomes in the survey year. To provide a basic overview of his approach using the "consumption" framework given by equation (2), for each subgroup of workers, he:

- A. determined the subgroup's average income, taxes, savings and dissavings.
- B. calculated the subgroup's average pre-retirement consumption according to equation (2) using the averages from step A.
- C. determined the average post-retirement savings less dissavings for retirees with similar disposable income.
- D. solved for **post-retirement gross income and taxes** (post-retirement gross income and taxes were solved simultaneously since one affects the other) by setting:

⁴ The methodology underlying Palmer's empirical measure of target gross replacement rates was first developed in Dexter (1984). For an illustration and additional explanation of the conceptual model of building target gross replacement rates, see McGill et al. (2010, Chapter 7).

Post-retirement consumption = Pre-retirement consumption from B,

where:

$$\text{Post-Retirement consumption} = \text{Post-retirement gross income} - \text{Post-retirement taxes} \\ - \text{Post-retirement savings} + \text{dissavings (from C)}$$

He then estimated the target gross replacement rate for the sample:

$$= \text{Post-retirement gross income} / \text{Pre-retirement gross income.}$$

Palmer further produced a second set of replacement rate targets, which incorporated the impact of period-specific expenses that do not exist in both pre- and post-retirement, such as those associated with employment and senior aging (see Section C.4).

Mitchell and Moore (1998) and Munnell et al. (2006) took conceptually similar approaches to estimate target gross replacement rates, but they further evaluated whether current workers (future retirees) appear to be on track to achieving them.

When, as is typical in the literature, target rates are computed using survey averages like the above approach rather than calculating the target rates individual by individual, the analyst is implicitly assuming that everyone in that subgroup has identical employment earnings, savings, retirement income and tax rates before and after retirement⁵. Such averages are likely to represent few, if any, real individuals. A practical issue arising from this type of methodology is that many users are generally unaware of what the target rates represent. In addition to these conceptual and practical issues, there are many measurement issues that are reviewed in Section C.

Brady (2010) and Schieber (2004) also estimated gross replacement rate targets in the above manner, but for a handful of heavily-stylized illustrative individuals. As with average measures, this approach is problematic since so few illustrative individuals were examined, and any one of them is unlikely to represent a real person owing to the simplicity of the stylized life courses compared to the actual diversity and complexity of real-world lives. The problems associated with stylized individuals has been discussed by a number of researchers, such as Steuerle et al. (2000).

Some of the applied replacement rate literature has taken an explicitly descriptive approach when measuring and analyzing replacement rates, thus avoiding any direct judgments about target replacement rates (that is, what level of replacement rate is necessary for an individual to maintain his/her lifestyle in retirement) (Boskin and Shoven, 1987) (Smith, 2003) (Butrica et al., 2003) (LaRochelle-Cote, Myles and Picot, 2008) (Ostrovsky and Schellenberg, 2010). Often loose references are made to

⁵ More specifically, it is being assumed that working-age consumption and net post-retirement taxes and savings are identical across the individuals in the subgroup.

conventional rules of thumb for context, without necessarily endorsing them (for instance, Butrica et al. (2003) wrote, “The financial planning literature often recommends having enough postretirement income to replace 70 percent to 80 percent of pre-retirement income” (pg.1)). This type of approach is common when examining descriptive trends, such as replacement rates over time. In most of the literature, however, replacement rates are used as a tool to make judgments about consumption before and after retirement, rather than remaining purely descriptive – that is, they are used in an attempt to directly determine the extent that individuals have “adequate” retirement income by evaluating whether they are succeeding or failing to meet target gross replacement rates.

Instead of employing gross replacement rates and gross replacement rate targets, Moore et al. (2010), MacDonald et al. (2011), and Wolfson (2011) estimated individuals’ *consumption* replacement rates (post-retirement consumption as a fraction of pre-retirement consumption), with a rate of 100% indicating full continuity of consumption. They were able to estimate equation (2) year by year for each individual by integrating large amounts of data through large-scale, complex dynamic microsimulation modeling (see Section D.2). By calculating annual consumption directly in this manner, they sidestepped the need to construct universal (and inaccurate – see Section E) gross replacement rate targets.

C Replacement Rate Building Blocks: Conceptual and Measurement Issues

Replacement rate studies commonly determine target replacement rates, and/or calculate the historical or projected replacement rates of individuals in a sample. Such studies employ methodologies and data sources that vary significantly, as do their findings. This section discusses these differences – in the unit of analysis, in the numerator, in the denominator, and in the assumed age- and employment-related changes in consumption. Each of the following subsections follows a similar pattern – we first discuss the issues underlying each of these building blocks and then illustrate the issues using examples of previously published studies.

1 Unit of analysis/adjustments for family size

Economic welfare is likely best evaluated at a household level rather than at the level of the individual. This recognizes that families serve as a mechanism for the pooling and sharing of income and consumption. More than just the sharing of resources between spouses, it acknowledges the impact of supporting dependent children on an individual’s personal consumption. A core insight is that parents need less income in retirement to maintain their pre-retirement standard of living than childless individuals with similar pre-retirement income. As expressed by Skinner (2007, pg.69), “parents are already used to getting by on peanut butter, given that a large fraction of their pre-retirement budget

has been devoted to supporting children, so it's not difficult to set aside enough money to keep them on peanut butter through retirement." It also enables the analyst to account for the economies of scale enjoyed by couples relative to single individuals. For instance, the cost of living for a couple is not twice the cost for a single with the same standard of living, since a couple shares their housing, a phone line, etc. To capture the income pooling and economies of scale that individuals experience within a household, analysts often apply equivalency scales. An example of an equivalence scale is the square root of family size (Buhmann et al., 1988), i.e., if two individuals had the same level of consumption ($\$X$), but one was single and the other fully supported a spouse and two children, then the family-adjusted consumption of the first would be $\$X$, while the second would be $\$X/\sqrt{4}$.

The replacement rate literature is diverse in terms of unit of analysis. Some replacement rate studies have used individuals (VanDerhei, 2006) (Ostrovsky and Schellenberg, 2009), while others use households or families (Mitchell and Moore, 1998) (Munnell et al., 2006). Some studies have used individuals as the unit of analysis, but calculate per-capita income at the level of couples (Butrica et al., 2003) (for example, if the consumption of one spouse is \$100,000 and the other zero, each spouse would be assumed to have consumed \$50,000).

Increasingly, there has been explicit recognition in the replacement rate literature that couples enjoy economies of scale in consumption, and that this has implications for replacement rates. Some studies acknowledge this by separating households according to marital status (Munnell et al., 2006). Studies that use longitudinal data have to contend with the fact that marital status changes through time. For example, it is not obvious whether a man who marries in the year leading up to his retirement should be considered married or single for the purposes of computing his replacement rate. Smith (2003) discussed these issues (including transitions to widowhood) between pre-retirement and post-retirement, and adjusted replacement rates accordingly by using an equivalency scale, as did Larochelle-Cote, Myles and Picot (2008).

Recent academic literature has highlighted the impact of raising children on the pre-retirement consumption and savings of parents (Scholz and Seshardri, 2008a). A number of replacement rate studies (Scholz and Seshardri, 2008b) (Moore et al., 2010) (MacDonald et al., 2011) have responded by constructing replacement rate measures where pre-retirement consumption is explicitly reduced to reflect the costs of supporting dependent children.

2 Replacement Rate Denominator

2.1 Components of pre-retirement income/consumption

This section discusses the various elements that determine pre-retirement consumption: employment earnings, other sources of income (such as government transfers), imputed rent, taxes, and savings.

It is universally agreed that employment earnings is a component of pre-retirement income and all of the cited studies include earnings in their replacement rate denominator. In fact, replacement rates are commonly conceived of as *earnings* replacement rates. Strictly speaking, it is not earnings that are most specifically of interest, however, but rather the consumption that is financed in the pre-retirement period by earnings.

Other sources of income, especially those that are substitutes for employment earnings, could also be included in a replacement rate measure. These include pre-retirement transfers from government such as social assistance, employment insurance and child benefits. Investment income generated by financial wealth could be included in a replacement rate denominator (if any portion of the investment income is saved rather than consumed, however, that portion should then be subtracted from the denominator). Studies that incorporated these other components of pre-retirement income include Smith (2003), LaRochelle-Cote, Myles and Picot (2008) and MacDonald et al. (2011). Munnell and Soto (2005) and Munnell et al. (2006) did not include pre-retirement government transfers, but did include pre-retirement investment income in the replacement rate denominator.

“Imputed rent” is another source of pre-retirement consumption that is increasingly being incorporated in replacement rate studies (Munnell and Soto, 2005) (Munnell et al., 2006) (Moore et al., 2010) (MacDonald et al., 2011)(Wolfson, 2011). Imputed rent can be considered a form of investment income – the return from savings that are held in the form of real property, rather than in financial assets. Including imputed rent in the replacement rate denominator recognizes that homeowners who have some equity in their homes are enjoying a flow of services that should be considered a source of pre-retirement consumption (Brown, Feng and Lafrance, 2010).

All of the cited studies that assessed “replacement adequacy” incorporated income and payroll taxes into their calculations, although with different approaches.

As might be expected given data limitations, studies are diverse in their handling of pre-retirement savings. Palmer (1988) developed target gross replacement rates using a measure that reasonably captured most forms of savings, but appeared to omit the savings represented by paying down one’s mortgage. The target gross replacement rates developed by Mitchell and Moore (1998), Munnell et al. (2006) and Brady (2010), on the other hand, did include savings through the reduction of mortgage principal. In the consumption replacement rate literature, Moore et al. (2010) and Wolfson (2011) incorporated pre-retirement savings in the form of employer-sponsored pension plans, registered retirement savings plans, and paying down mortgages. MacDonald et al. (2011) took a somewhat more comprehensive approach by also measuring non-registered wealth and debt accumulation (including financial assets/debts, real-estate investments and equity in businesses owned). While MacDonald et al. (2011) lumped financial wealth and debt into one item, the accumulation and reduction of financial debt is a source of consumption that likely deserves separate treatment.

Another aspect of defining the denominator is how to account for the fact that it will be measured at a different time than the numerator (the former is before retirement and the latter is after retirement). Most studies express the numerator and denominator in constant dollars using the consumer price index. An alternative method is to use wage indexation, which is the approach traditionally taken by the U.S. Social Security Administration (SSA, 2004) in its calculation of social security replacement rates, and was also used by Butrica et al. (2003) and Wolfson (2011). Using a consumer price index compares an individual's retirement income to the absolute level of pre-retirement consumption he/she actually experienced, while using a wage index also incorporates a comparison to the consumption of currently working generations. For most purposes, replacement rates are used to evaluate whether retirees' own consumption falls after retirement, rather than to make intergenerational comparisons, and for this reason, some form of price indexation is appropriate.

2.2 Measurement period for pre-retirement standard of living

One of the most substantive methodological issues in designing a replacement rate measure is the choice of measurement period for the denominator.

As we explain in Section B, the fundamental "replacement adequacy" goal is the preservation of pre-retirement consumption, but this leads to the question: pre-retirement consumption measured over what period? Much of the consumption literature finds that the average shape of consumption over an individual's life has a distinct "hump" shape (Gourinchas and Parker, 2002) (Fernandez-Villaverde and Krueger, 2007). On average, annual consumption early in an individual's career closely tracks earnings and typically rises at a relatively rapid pace. After an individual reaches their "prime" working years, however, annual consumption increases much more gradually or even levels off completely. Consumption tends to peak in late middle-age, and starts declining gradually thereafter, even as annual earnings remain flat or continue to increase.

There is no obvious choice for the most appropriate measurement period for pre-retirement consumption. For some purposes, consumption immediately before retirement might be the most attractive benchmark since this would imply no discontinuity of consumption as workers transition into retirement. Another alternative is peak life-course consumption, such as an individual's best five years, or a broader "career-average" measure, which averages an individual's consumption across his/her entire career⁶.

The most important complications arise, however, because replacement rate denominators are typically calculated using gross earnings and not consumption. For instance:

1. Although annual earnings tend to reflect a life-cycle pattern when averaged across a population, it has considerable year-over-year variation (Morrison, 2000), which

⁶ Section E employs alternative pre-retirement consumption measurement periods for calculating individualized gross replacement rate targets and finds that this factor has a significant impact on results.

- creates very complex and diverse earnings histories across individuals. Many individuals exhibit tremendous “earnings mobility”⁷, and consequently occupy quite different rankings in the distribution of earnings over the course of their careers (Finnie, 1999) (Beach and Finnie, 2004). In addition to such medium-term variability, an individual’s earnings can also vary tremendously in the short-term. This is particularly true of earnings leading up to retirement, as individuals transition from employment into retirement in a variety of manners. Overall, it cannot be assumed that any narrow measurement period is “representative” of earnings since it will reflect different things for different individuals.
2. If earnings are acting as a proxy for consumption, it becomes unclear what the denominator is measuring since it depends on the relationship between the age profile of consumption and that of earnings. For example, if the desired benchmark is consumption shortly before retirement, does this correspond to “final earnings” or earnings averaged over some other period? Much of the theoretical literature relating to life-cycle income and consumption suggests that the relationship between an individual’s standard of living (consumption), and his/her earnings measured over any particular short-term period may be quite weak (Modigliani and Brumberg, 1954). This literature suggests that individuals prefer a relatively consistent standard of living, so they smooth their consumption over long time horizons, such as their entire lifetimes, rather than making current consumption decisions based primarily on current income (ibid). Increasingly, the literature has acknowledged that an individual’s pre-retirement standard of living is often more strongly linked with broader measures of average earnings than with earnings measured over any particular short-term period (Biggs and Springstead, 2008).
 3. The measurement period used to calculate pre-retirement earnings can have an enormous impact on the resulting replacement rate. For instance, replacement rates calculated using a peak or final measure of earnings can be half the size of those calculated using earnings averaged over an entire career, leading to quite different conclusions about replacement adequacy.⁸

In the applied replacement rate literature, there is tremendous diversity in the measurement periods used to calculate the pre-retirement denominator. As we discuss below, this diversity applies both to the part of the life-course chosen, and the number of years averaged in the calculation.

Some studies use only one year of data. For example, Palmer’s work (1988) (2008) relied on a single cross-sectional year of data with individuals between ages 50 and 64, whom he averaged across to produce the denominator. Mitchell and Moore (1998) essentially used final earnings, but the denominator was calculated deterministically by taking a

⁷ “Earnings mobility refers to changes in the relative earnings of individual workers through time” (Beach and Finnie, 2004, pg. 5).

⁸ These findings are based on the authors’ own analysis of individual Canadians over the course of this study. Other studies that support the important impact of the measurement period choice include Biggs and Springstead (2008), Munnell and Soto (2005) and Boskin and Shoven (1987).

single year of data (an individual's earnings in 1992) and assuming constant real wage growth until retirement. Munnell et al. (2006) similarly began with data on a household's pre-retirement income in a single year, 2003, and projected it forward to retirement age according to an average earnings profile. Using only one year of data, and projecting any remaining years from this one observation in a highly stylized manner, completely ignores the substantial variation in many individuals' earnings.

Brady (2010) calculated average career earnings from ages 30 to 67, but relied on a handful of illustrative individuals with very stylized earnings histories.

Using longitudinal earnings data, Smith (2003), LaRochelle-Cote, Myles and Picot (2008) and Ostrovsky and Schellenberg (2009) all averaged the earnings of each sampled individual from ages 54 to 56, which were characterized as "peak" and "permanent" earnings. Given the substantial variability in employment and earnings across many individuals' life-courses, average earnings for this age range will represent neither peak nor permanent earnings for a significant number of individuals (Finnie 1999) (Morissette, Zhang and Frenette, 2007) (Finnie and Gray, 2011).

Munnell and Soto (2005) used approximately forty years of longitudinal micro-data on individual earnings to calculate both career-average and final average (best 5 of final 10) measures for the denominator. Boskin and Shoven (1987) similarly used 23 years of longitudinal earnings microdata to calculate career average and final average (best 3 of final 10) measures. The impact of the chosen measurement period had a substantial impact in both studies.

Studies that use large-scale, dynamic microsimulation models have nearly complete flexibility in measuring the denominator (see Section D.2). In these models, each individual's entire earnings history is modeled in great detail, typically incorporating age and cohort effects, as well as the realistic individual variability in earnings that occurs over the course of an individual's career. Butrica et al. (2003) averaged pre-retirement income from ages 22 to 62. Moore et al. (2010) averaged the top fifteen years of each individual's pre-retirement consumption from age 35 to 65, and MacDonald et al. (2011) calculated average pre-retirement consumption from age 35 to retirement. Biggs and Springstead (2008) compared the different results that follow from using various measurement periods for earnings, including a variety of career-average and final average earnings measures.

3 Replacement Rate Numerator

3.1 Components of post-retirement income/consumption

This section discusses the various elements that determine post-retirement consumption: employment earnings, government transfers, employer-sponsored pension plan benefits, withdrawals from individual savings or wealth (including home equity), imputed rent, taxes, and savings.

Arguably, the very concept of a “replacement rate” effectively precludes including “post-retirement” employment earnings in the numerator since its purpose is to evaluate the extent that employment earnings have been replaced after retirement (where retirement is the cessation of employment). For some purposes, such as examining the general standard of living of the elderly, post-retirement earnings could be included but the resulting measure would more appropriately be called an “income stability rate”, for example, rather than a replacement rate.

Replacement rate studies are divided on the issue of employment earnings in the replacement rate numerator. In most of the literature, earnings are expressly excluded on conceptual grounds (Mitchell and Moore, 1998) (Munnell et al., 2006) (Biggs and Springstead, 2008) (Moore et al., 2010) (MacDonald et al., 2011). In other studies, earnings are either purposely included in the numerator, or are included in a broader “total income” variable (Boskin and Shoven, 1987) (Smith, 2003) (Larochelle-Cote, Myles and Picot, 2008).

Replacement rates can be used to evaluate a specific form of retirement income, such as Social Security, in which case the analyst can omit all other sources of retirement consumption. For studies that intend to provide a more global assessment of “replacement adequacy”, however, all sources of post-retirement consumption should be included in the numerator, including income from public and private pensions, as well as the consumption available from other forms of individual savings or wealth. The flows from these latter sources should not be limited to “income” in a strict accounting sense, but also assume the drawdown or “dissaving” of accumulated assets over the course of retirement.

In principle, this includes equity in an owner-occupied home. Many argue that homes are a special case, however, and that an assessment of the replacement adequacy of the retirement income system should not assume that retirees sell their homes or otherwise deplete their home equity (see MacDonald et al. (2010) for a discussion). Excluding this asset class, which in many cases is the single largest net asset of retirees (Brown, Feng and Lafrance, 2010), clearly distorts important differences in financial security between homeowners and renters, and between homeowners with very different amounts of home equity.

In principle, there does not seem to be a strong argument against including imputed rent (the flow of housing services that homeowners receive from their homes) both before and after retirement (see Section C.2.1). Given that the cost of shelter is the largest expenditure from among a healthy senior’s basic costs of living (MacDonald et al., 2010) and that seniors are more likely to own their home than any other age group (Turcotte et al., 2006), replacement adequacy studies should recognize the consumption flow from this valuable asset.

Wealth from inheritances and other transfers from family members are likely best excluded from the replacement rate numerator for the purposes of policy analysts and

employers, since such wealth is not related to pre-retirement earnings and arguably should not be viewed as a component of the retirement income system. For the purposes of individual financial planning, however, it might be quite central for a person who is confident that he/she will receive a large inheritance.

Income taxes should be subtracted from gross post-retirement income. This is done directly in the numerator for each individual if consumption replacement rate measures are being employed (such as in MacDonald et al. (2011)). Otherwise, if averages are used to determine target gross replacement rates (see Section B), differentials in income taxes pre- and post-retirement need to be incorporated into the target gross replacement rates.

Replacement rate studies most often evaluate post-retirement consumption possibilities (the resources available to retirees) rather than what they actually consume – that is, although we are interested in actual pre-retirement consumption for the denominator, we are generally interested in potential consumption for the numerator. For example, retirees could realistically do anything with their personal retirement savings, from spending the entire sum in their first year of retirement to leaving it as a bequest to their heirs. Researchers commonly assume, however, that retirees will consume such wealth systematically over their retirement (such as through the purchase of an annuity in MacDonald et al. (2011), Munnell et al. (2006), and VanDerhei (2006)). If the focus is potential consumption in retirement, rather than actual consumption, then any post-retirement savings should be ignored.

Literature over the past twenty years has progressively included more and more of the various sources of post-retirement consumption. The earlier literature tended to restrict the included sources to those found in income data (Boskin and Shoven, 1987) (Palmer, 1988), and this approach continues in studies that rely exclusively on this data source (Smith, 2003) (Larochelle-Cote, Myles and Picot, 2008) (Ostrovsky and Schellenberg, 2009). Although some sources of retirement income are adequately captured in traditional income data or administrative data, others are not. For example, the drawdown or dissavings of assets, such as savings held in bank accounts, bonds, mutual funds, stock markets, and certain annuities, is not captured in traditional income data sources; typically only the annual yield on such capital is identified as “income”. For savings in the form of home ownership, neither the imputed rent nor the consumption represented by its drawdown is visible in such data. Increasingly, replacement rate studies are employing methodologies and using new data sources so as to include these various sources of wealth and build more comprehensive measures of retirement consumption possibilities.

Munnell and Soto (2005) and Biggs and Springstead (2008) included the drawdown of all financial assets in their numerators. Moore and Mitchell (1997) and Munnell et al. (2006) explicitly included the drawdown of all housing wealth in addition to financial assets. Moore et al. (2010) included both imputed rent and the drawdown of registered assets, and also explored the impact of drawing down different proportions of home equity. MacDonald et al. (2011) included imputed rent and the drawdown of registered and non-

registered wealth (with the exception of home equity, which they assumed is not consumed in retirement).

3.2 Measurement period for post-retirement standard of living

Many sources of retirement consumption, such as income from public pensions and employer pension plans, tend to be quite consistent over the course of an individual's retirement since they often take the form of a guaranteed level income (either inflation-indexed or nominally fixed). This suggests that the choice of measurement period for the numerator matters less than for the denominator, since pre-retirement earnings can display tremendous variability over time at the level of the individual or family (see Section C.2.2).

There are, nevertheless, several important issues related to the measurement period used for post-retirement consumption. If a study uses couples or families as the unit of analysis, the two spouses could withdraw from the labour force or take up their retirement income in different years. Consequently, assessing their replacement rate with a single annual snapshot of retirement income becomes problematic. In addition, some sources of retirement income can be variable over time. If an individual has pension income that is not indexed to inflation, such as some employer pensions or most private annuities, the real value of this income can fall substantially over the course of an individual's retirement, which can span up to 40 years or longer. Similarly, many individuals experience marital transitions during their retirement years, especially to widowhood, and this often has an impact on their retirement consumption. Further, given the increasing shift from DB type pension to individual savings, the volatility in retirement consumption could potentially increase since there is a high level of aversion to voluntary annuitization (Brown, 2009).

All of these reasons suggest that a broad "retirement average" measurement period should be preferred for post-retirement income or consumption, rather than a narrow measurement period (such as the first year after retirement).

Most of the literature has used a single, cross-sectional snapshot of post-retirement income (Smith, 2003) (Ostrovsky and Schellenberg, 2009)(Palmer, 1988). Conventionally, replacement rate studies have tended to look specifically at income in the first year of retirement (GAO, 2001).

Some researchers have applied adjustments to contend with the short post-retirement measurement period of one year in conventional replacement rates. For example, Steinberg and Lucas (2004) suggested increasing conventional targeted replacement rates by 10 to 15 percentage points to account for the lack of inflation indexing in many retirement benefits (the lower range would be for low-income seniors, who rely largely on inflation-indexed Social Security benefits). Alford, Farnen and Schachet (2004) made similar adjustments.

Some studies have taken snapshots of replacement rates at several different ages post-retirement (Biggs and Springstead, 2008). MacDonald et al. (2011) used a “lifetime” measure of retirement consumption, averaging consumption from retirement to death. Larochelle-Cote, Myles and Picot (2008) stands out in this regard, as it used longitudinal data to follow individuals and couples through their retirement years, from ages 55 to 80, with a particular focus on the evolution of their replacement rates over time and the stability of their retirement income.

4 *Period-Specific Consumption*

This paper has so far worked from the premise that replacement rates are concerned only with the replacement of pre-retirement consumption in post-retirement. There can be, however, period-specific consumption that does not need to be replaced in post-retirement and/or new post-retirement consumption that does not occur in pre-retirement. Consequently, an individual with an unchanging standard of living before and after retirement could in fact have different consumption levels owing to the effects of aging and the cessation of employment.

For example, expenses associated with employment generally cease after retirement (such as professional development fees, commuting to work costs, and the expense of special clothing). Further, retirees are better able to “stretch their dollar” owing to senior discounts and greater time for home production, consequently a dollar of retirement income could be more valuable than a dollar while working – for instance, it has been observed in both Canada (Brzozowski and Lu, 2006) and the U.S. (Aguilar and Hurst, 2005) that retirees spend less on food but still maintain the same quality of diet owing to more efficient shopping and cooking more at home. On the other hand, medical expenses are likely to rise with age, particularly those associated with a chronic health condition (see MacDonald et al. (2010) for a further discussion).

The question becomes whether this period-specific consumption should be incorporated in the study of retirement income adequacy. The answer is very muddled for a variety of reasons. For instance, necessary expenses (such as medical) and voluntary expenses (such as gift-giving) likely deserve separate treatment, and therefore the analysis becomes necessarily subjective. Further, the “working-age” and “retirement” stages of life can both be lengthy, and making any definite statement regarding the net difference in consumption levels from one to the other is a complex task since there can be extreme diversity among and across the life-courses of individuals.

It would seem that from among the possible drivers of retirement-specific consumption, the cost of medical is likely the most material since it is both a necessary cost and a potentially significant one depending on the public/private nature of the health care system and the coverage afforded by the retiree’s employer. This is particularly true at advanced ages when the likelihood of suffering from acute and chronic health conditions is much higher. For instance, for those who need it, the expense of home care is a great concern in both the U.S. (Russells et al., 2006) and Canada (MacDonald et al., 2010)

since the onset of a chronic illness can be sudden and beyond the individual's control, and the out-of-pocket cost can become quite substantial.

Analysts have the option to either integrate period-specific consumption (all components or those that are deemed most important) or to treat them as a topic outside of a replacement rate framework. For instance, new and significant retirement expenses (notably medical) could be investigated separately such as through a precautionary saving, or insurance type analysis. Alternatively, period-specific consumption could be built into a replacement rate analysis by being subtracted from the consumption proxy (equation (2) in Section B).

In past replacement rate literature, the topic of period-specific consumption has been either not addressed, or done so very loosely in a wide variety of manners. For instance, Dexter (1984) included all components as a one-off net change in consumption requirements at retirement when developing target replacement rates. Building on Dexter (1984), Palmer (1988) defined this variable as:

$$\text{Work-related expenses} + \text{Net Change in Age-Sensitive Expenditures} \quad (3)$$

Palmer then developed two sets of target replacement rates – those with and without age- and work-related changes in consumption. McGill et al. (2010) took a similar approach, but modeled these two categories of expenses using regression analysis.

More recently, some of the literature has highlighted the cost of medical expenses after retirement when assessing the adequacy of retirement resources, and has integrated these expenses into replacement rate analysis. Steinberg and Lucas (2004), Alford, Farnen, and Schachet (2004), and Schieber (2004) used a conceptually similar approach as Palmer (1988) and subtracted net retiree medical costs from post-retirement income in the conventional gross replacement rate calculation. VanDerhei (2006) explicitly modeled medical expenses over the lifetime of the retiree to assess the adequacy of conventional gross replacement rates. As noted above, however, most replacement rate studies do not address period-specific consumption.

5 Post-Retirement Risks

Typically, replacement rate measures have not explicitly accounted for important risks of retirement that can affect a senior's financial well-being – namely, the risk of accelerating inflation, the death of a spouse, divorce, insurer default, low investment returns, annuitization rates, longevity, developing a health condition that generates significant out-of-pocket expenditures, increase in public taxes, and changes in retirement benefits by government and private plan sponsors (such as reductions in pension income, retiree medical benefits, pension cost-of-living adjustments, and other plan design features⁹). A

⁹ See Mills and Young (2004) for a discussion of such changes over the past decade in U.S. employer pension plans.

challenge for future researchers will be to decide whether these various risks should be handled outside of the replacement rate framework, or if they should be a component of the study of replacement rate adequacy.

There has been acknowledgment in recent literature that retirement income adequacy measures should recognize post-retirement risks. For example, Schieber (2004) wrote that “singular rules of thumb for replacement rates are naive and that estimates should take into account the unforeseen risks that individuals face” (abstract). How to incorporate these risks is unclear, however, particularly for conventional replacement rate measures where the typical post-retirement measurement period is the first year of retirement (see Section C.3.2). Choosing average or median costs is problematic – for example, an individual either has a major health condition or he or she does not, and therefore incorporating the median cost of any particular illness in a replacement adequacy measure will be insufficient for half of the sample and cause the other half to unduly reduce their pre-retirement standard of living in order to save for an event that does not occur. The VanDerhei (2006) study offers one possible approach – he explicitly modeled the risk of catastrophic medical expenses, low investment returns, and longevity, and used microsimulation to simulate the distribution of possible future outcomes in order to demonstrate the uncertain financial impact of each contingency on retirement income adequacy targets. VanDerhei explained that the individual could choose the target that most appropriately fit his or her level of risk aversion (for example, a highly risk-averse person might choose the target replacement rate providing a 90% likelihood of maintaining a specified standard of living in retirement).

D Towards Better Replacement Rates

1 Guidelines

Although the replacement rate can be used to simply describe the general relationship between pre- and post-retirement income, its most common purpose is to evaluate whether individuals are able to maintain their pre-retirement consumption after retirement. Without high quality, longitudinal expenditure data to measure consumption directly, analysts must comprehensively incorporate all of those elements of income, savings, taxes and dissavings that define an appropriate proxy (see equation (2)) if they wish to perform a robust evaluation of replacement adequacy.

Some of these elements were completely absent in the data underlying early studies. The most commonly omitted components have been the income, savings, and potential dissavings outside of formal retirement savings vehicles. Although the more recent literature is still uneven in this regard, data availability has improved, and some researchers have employed methodologies aimed specifically at increasing the comprehensiveness of their replacement rate measures to include these missing components (see Section C.3.1).

It is important that replacement rate methodology adequately responds to the diversity across an individual's life-course. The tremendous complexity and diversity within many individuals' life-courses bears directly on their consumption – including earnings, taxes, savings, marital status, health status, and the size of dependent families. Too often, studies have used replacement rate methodologies that rely on the comparison of a very limited cross-sectional snapshot before and a single snapshot after retirement (often of completely different individuals), and this is assumed representative of permanent states (see Section C). Such snapshots are poor proxies for broader lifetime outcomes – not only do they ignore the diversity among and across the life-courses of individuals, but age and cohort effects are un-differentiable.

In addition to the substantial diversity across an individual's life-course, there is even more life-course diversity across the individuals in a population. Replacement rate studies generally ignore this diversity by employing one year of data and assuming that the lifecourses of the sampled individuals unfold in an identical manner (see Section C). This diversity includes differences in:

- the distribution of consumption across the life-course,
- the relationship between pre-retirement earnings and pre-retirement consumption, and
- the relationship between retirement income and retirement consumption.

For instance, taxation is one important reason that the relationship between income and consumption will not be the same among individuals, either before or after retirement.

This arises due to differences such as:

- the size of total income,
- tax deductions and tax credits according to personal circumstances,
- the composition of income by source,
- the distribution of income across spouses,
- location (since taxes vary by province/state - in the U.S., particularly, people tend to move to states with lower or no income taxes (like Florida) after retirement),
- and the forms that savings take. For instance, the consumption and saving implicit in home ownership are completely untaxed (or even subsidized¹⁰), whereas there is substantial complexity and diversity in the taxation of other forms of savings and consumption.

Finally, other significant components of individual diversity relating to consumption include differences in:

- the evolution of marital status over the life-course (including widowhood),
- the number and timing of dependent children or other dependents across the lifecourse,
- large and unexpected expenses (particularly those associated with health and aging), and
- the age of retirement for the individual and the spouse.

¹⁰ This could arise if the interest portion of mortgage payments are tax deductible or when low income social programs do not consider housing wealth while determining eligibility.

Replacement rates methodologies should ideally be based on data that observes individuals through substantial portions of their careers and retirements (see Sections C.2.2 and C.3.2). Otherwise, a replacement rate measure may completely misrepresent whether an individual is experiencing a reduced standard of living after retirement.

In the replacement rate denominator, published literature has made progress by increasingly shifting away from heavily stylized earnings histories towards actual or realistic ones, and by using longer measurement periods. With some exceptions (LaRochelle-Cote, Myles and Picot, 2008) (MacDonald et al., 2011) (VanDerhei, 2006), less progress has been made in the numerator to realistically incorporate the diversity across an individual's retirement period. The largest obstacle continues to be the availability of appropriate data.

When *future* socio-economic outcomes are being evaluated, there tends to be even less recognition of the diversity among and across individual life-courses. Studies are often concerned with the retirement preparedness of future retirees and, whereas it is possible that detailed historical life-course data might be available, no such data is available for the future. Studies that aim to evaluate the replacement rates that current workers will receive in retirement, consequently, have typically made simple, deterministic, average assumptions to project forward individuals' earnings, savings and wealth at retirement age, without any variability between individuals (Mitchell and Moore, 1998) (Munnell et al., 2006). Much preferable is an approach that allows projections to produce a realistic diversity of lifecourses, such as the microsimulation modeling used in Butrica et al. (2003), Moore et al. (2010), MacDonald et al., (2011), and Wolfson (2011) (see Section D.2).

Replacement rate analyses should also determine the sensitivity of the results to any projection assumptions. This was of particular concern in VanDerhei (2006) and Holmer (2009), which developed measures that explicitly incorporated uncertainty regarding future trends. VanDerhei (2006) expressed target replacement rates in terms of the likelihood that they produce different results given the uncertainties about future rates of return, medical expenses, and mortality trends. Holmer (2009) employed five hundred different macroeconomic projection scenarios to produce expected, risk-adjusted replacement rates. A more conventional approach to understanding the impact of any projection assumptions (such as trends in interest rates, pension plan participation and mortality) is through more limited sensitivity analysis – for instance, Wolfson (2011) investigated the sensitivity of his results to the projected financial market rates of return assumption by testing the impact of several alternative future economic scenarios.

Given the tremendous diversity across individuals, a universal “rule of thumb” gross replacement rate target is inadequate for making judgments about whether an individual is able to maintain his/her standard of living in retirement. The common approach of using a small number of average gross replacement rate targets, differentiated by income level and possibly marital status (see Section B), is an improvement but only a small step towards a robust assessment of replacement adequacy.

At the population level, gross replacement rates can be useful in describing general trends over time, but are unsuitable for making specific assessments of outcomes such as “How many individuals or what proportion of a cohort has or will be able to maintain their consumption after retirement?” or “How many individuals are experiencing severe declines and what are their characteristics?” These evaluations require that replacement rates, and replacement rate targets, be determined at the level of the individual and be responsive to the individual-specific life-course. Otherwise, the resulting replacement rates could represent very few real-life individuals, and possibly none at all, but nevertheless adversely influence important public policies and the general retirement planning of individuals. A recent study in the microeconomics literature (Scholz and Seshadri, 2009) underlined this point. It determined the “optimal” consumption in retirement for households using data from the *Health and Retirement Study* and a sophisticated life-cycle consumption and savings model. The study then re-expressed these results in terms of target gross replacement rates based on final earnings. It found that the resulting target gross replacement rates covered a very wide range. Although the median target gross replacement rate was 68%, their distribution was not concentrated in the ranges conventionally used. Only fifteen percent of the households had target gross replacement rates that fell between 65% and 90%. Almost half of households had target gross replacement rates below 65%. VanDerhei (2006) is a second study that found that “a simple one-size-fits-all replacement rate will not work for most Americans” (pg.5). After simulating 1,000 life-paths of stylized 65-year-old retirees and testing the adequacy of gross replacement rate targets, he concluded that “the huge variation in the range of replacement rate targets—depending on the individual's income, degree of annuitization for initial retirement wealth, and the asset allocation of the post-retirement investments—call into question whether the use of a single rule-of-thumb measure is realistic to use in the retirement planning process” (pg.5). Our findings in Section E further support the case against universal gross replacement rate targets – there we show that the empirical distribution of individualized target gross replacement rates span a substantial range.

Few replacement rate studies have evaluated population retirement income adequacy by making evaluations at the level of individuals. Among the few exceptions are Moore et al. (2010), MacDonald et al. (2011), and Wolfson (2011). These three studies employed very similar methodologies to directly calculate each individual's consumption replacement rate, and then determine the number of Canadians projected to experience a substantial fall in consumption at retirement.

The ongoing usefulness of gross replacement rates and gross replacement rate targets is largely dependent on the user. For instance, social scientists or policy analysts could continue to have some use for descriptive replacement rates and crude, universal target replacement rate methodologies when examining trends across time, although it is crucial that these users fully appreciate the limitations of such measures.

Employers are likely less interested in the comprehensive adequacy of retirement financial resources for individual employees, than in the broader performance of their benefit scheme and its competitiveness with the pension plans of rival employers.

If employers wish to assist individual employees to determine how well their standard of living will be maintained after retirement, however, it would be best done on a case by case basis. In the assessment of retirement income adequacy, there is no substitute for individual knowledge since only the individual will have the necessary information about expenditure, savings, retirement expectations, sources of retirement income, etc.

The target gross replacement rate is the least useful at the individual level – in fact, it can be quite misleading (see Section E). It is likely better to estimate desired expenditure/consumption levels in retirement, and work backwards from there, updating regularly and making adjustments when necessary (such as saving more or less). This is the conventional advice of financial planners, but it also has its shortcomings - for instance, if the desired level is too high or too low, it could produce a consumption disruption at retirement (Kotlikoff, 2006). Further, this approach in practice often underestimates large and irregular post-retirement financial expenses (such as divorce, the death of a spouse, and medical expenses), as well as the potential risks associated with non-annuitized wealth (such as longevity, inflation¹¹ and investment-rate risk). Another approach would be to employ software that comprehensively coordinates the individual's pre- and post-retirement income sources, the government's tax and transfer system, and post-retirement financial risks to determine the optimal savings, insurance and investment advice according to the goal of the individual (such as smooth consumption before and after retirement or maximum lifetime consumption). Currently, ESPlanner (Kotlikoff, 2006) and Ballpark E\$timate (VanDerhei, 2006) in the U.S., and Ruthen (currently under development by Avery and Morrison (2009)) in Canada are available microsimulation software explicitly designed to fulfill the retirement planning needs of the individual.

2 *Microsimulation*

Large-scale, complex, dynamic microsimulation models are increasingly becoming the international gold standard for assessing retirement income adequacy, as well as a variety of other analyses. With microsimulation modeling, the analyst can manage many of the measurement issues outlined in Section C. For example:

- These models can largely overcome the limitations of data by providing a means to integrate and extend existing data sources to give the most comprehensive picture of consumption sources, in a way that is not possible with any single data source.
- The analyst has nearly complete flexibility in his/her methodology – for instance, he/she can create any measurement period before or after retirement.
- The results can reflect the realistic complexity and diversity within life-courses, and across individuals.
- It can also explicitly model the uncertainty of the future and show the distribution of possible future outcomes.

¹¹ This would also be a risk for nominally-fixed annuity income.

As described in Section D.1, personal dynamic microsimulation models are also beginning to emerge for individual financial planning purposes (such as ESPlanner, Ballpark E\$timate and Ruthen).

While large-scale microsimulation models endeavor to capture the realism of actual individual lives, this is done at the expense of simplicity since such models can be extensive and complex. This complexity creates an obstacle for analysts wishing to employ large-scale microsimulation modeling in their research, as well as a barrier to outsiders wishing to comment on the output.

E The Proof is in the Pudding

"The proof of the pudding is the eating."

- Miguel de Cervantes Saavedra (Don Quixote. Part ii. Chap. xxiv.)

Listing and expounding on the theoretical and practical issues underlying target gross replacement rates are unlikely to create a paradigm shift since alternative measures, such as a life-course analysis, require a substantial amount of time and resources. To illustrate the deficiencies of traditional target gross replacement rates, therefore, this section will calculate the *individualized* target gross replacement rate for a large sample of Canadians. If these target replacement rates are widely distributed, then one target rate will fit very few actual individuals. Consequently, we could conclude that universal target replacement rates are inaccurate and, as a result, relying on them when evaluating retirement income adequacy could be misleading. This exercise is made possible through the use of Statistics Canada's LifePaths – a state-of-the art microsimulation model of the Canadian population that we describe briefly at the end of the following section (Section E.1).

1 Methodology

As given by its original definition in Section B, the target gross replacement rate should maintain a worker's standard of living after retirement. We arrive at "real-world" target gross replacement rates by working backwards – we first identify the individuals from our sample who maintained their standard-of-living after retirement and next calculate the gross replacement rate for each of these "successful" individuals. To do this:

1. We first decide how to measure standard of living.
2. We next define what it means to "maintain" one's standard of living after retirement.
3. Lastly, we calculate the traditional gross replacement rates of those individuals from our sample who satisfied #2. These replacement rates are, as a result, the sought-after "real-world" target gross replacement rates.

All results have been expressed in constant 2010 dollars, using the total (all item) consumer price index.

The details underlying each of these steps are as follows:

1. We use average, lifetime consumption as the indicator for an individual's standard of living. We measure consumption using equation (2) over the lifetime of the individual at the household level and adjust each year for family size and inflation (that is, each year's consumption is in constant 2010 dollars). Pre-retirement consumption includes:

- pre-retirement gross income (wages¹², self-employment income, investment income, government transfers and other money income, such as alimony and severance pay);
- plus
 - imputed rent (depending on homeownership)¹³;
- minus
 - contributions to employer pension plans, Registered Retirement Savings Plans (RRSPs), Canada/Quebec Pension Plan (C/QPP), and non-registered savings (non-registered financial wealth and owned businesses);
 - mortgage payments;
 - personal income taxes and federal payroll taxes.

Retirement consumption includes:

- government retirement benefits (income from Old Age Security (OAS), Guaranteed Income Supplement (GIS) (both federal and provincial top-ups), Spousal Allowance (SPA) and C/QPP (retirement, survivor and death benefits));
- plus
 - employer pension plan benefits (retirement, survivor and death benefits);
 - withdrawals from RRSPs, Registered Retirement Income Funds (RRIFs) and non-registered savings;
 - imputed rent;
- minus
 - mortgage payments;
 - personal income taxes.

The extent that individuals experience a change in their standard of living at retirement cannot be reasonably assessed without comprehensive longitudinal data (i.e., life-course data). Since the longitudinal data that would be necessary for this study are not available, we rely on LifePaths - a dynamic longitudinal

¹² While only partly achieved in this exercise, wages should ideally include the value of supplementary labour income, such as employer contributions to benefit plans.

¹³ For this exercise, we do not assume that homeowners consume their housing equity after retirement.

microsimulation model of individuals and families developed by Statistics Canada¹⁴.

LifePaths is among the large-scale, complex, dynamic microsimulation models described in Section D.2. This highly advanced model integrates many different Canadian data sources from Statistics Canada to model the synthetic life histories from birth to death that successfully reproduce the diversity and history of the Canadian population. The LifePaths model contains core modules implementing rich life-course modeling of individual-level fertility, mortality, education, employment, earnings and other sources of income, marital unions, inter-provincial and international migration, registered pension plans, RRSPs, and Canada's tax and transfer systems (including public pension benefits). With LifePaths, we can simulate millions of realistic life-paths for Canadians - in essence, we are synthesizing the data-that-might-have-been had longitudinal surveys always existed.

Our use of LifePaths and the methodology employed builds extensively on the work done in MacDonald et al. (2011). We direct interested readers to that paper for further details of LifePaths and the consumption modeling used in this study.

2. We assume that a worker's standard of living is maintained if average consumption before retirement (age 50 - 65) does not change by more than $\pm 10\%$ once retired (age 65 to death). This assumption remains neutral on the debate of whether age and retirement has a generally positive or negative effect on the cost of lifestyle maintenance (see Section C.4)¹⁵. In our analysis at the end of the next section, we also investigate the effects of using a career-average measure of pre-retirement consumption (age 25-65) and a peak measure (best five years between ages 50-65).
3. For each individual from our sample who maintains his/her standard of living according to #2, we calculate his/her replacement rate using the following traditional definition:

$$\frac{\text{Gross retirement income in the first year of retirement at age 65}}{\text{Gross final five-year average earnings (adjusted for inflation) (age 60-65)}} \quad (4)$$

where gross retirement income includes benefits from the Canadian public retirement income system (OAS¹⁷, C/QPP and GIS), employer pension plan

¹⁴ For a general overview of LifePaths, visit <http://www.statcan.gc.ca/microsimulation/lifepaths/lifepaths-eng.htm>. A public version of the model can be downloaded from the Statistics Canada website at <http://www.statcan.ca/english/spsd/LifePaths.htm>.

¹⁵ An area for future work would be to model health and the associated expenses (see Section C.4).

¹⁶ The data is produced by calendar year, therefore we average earnings over the four full calendar years between the individual's 60th and 65th birthdays. Similarly, the numerator uses the gross retirement income in the first full calendar year after age 65. The denominator is price-indexed to the year that the numerator is measured using the total (all-item) consumer price-index.

income, and income from RRSP and RRIF (assumed to be annuitized at retirement over the retiree's expected lifetime at 6% interest). We use age 65 not because it is when people should or do retire, but because it is the standard "normal retirement age" for C/QPP benefits, as well as most employer pension plans (and consequently the benefits are mature at this time).

Our sample population is Canadian baby boomers (born between 1951 and 1966) who will soon begin making the transition into retirement. We have put several limitations on our sample population since the traditional replacement rate would be a meaningless measure for some. For instance, the traditional replacement rate for a person without employment earnings is infinite. Similarly, if someone was unemployed during any of the final five years in the gross replacement rate denominator, then his/her replacement rate would be exaggerated. Consequently, we exclude individuals who were unemployed for more than three months between ages 60 and 65, as well as individuals whose average earnings during this period is less than the Canadian minimum wage. This latter filter excludes self-employed workers with low (or even negative) average earnings. Minimum wage varies by province so we assume the approximate current average across Canada (\$20,000 per year in 2010 dollars).

Further, an age 65 replacement rate target would not make sense for someone who, if judging by sources of income, is evidently delaying retirement past age 65 or choosing to phase into retirement before age 65. We therefore exclude individuals whose working income surpasses their retirement income at age 66. In addition, a person could choose not to take up their C/QPP retirement benefits by age 65 – consequently, we also narrowed our sample to those who have taken these benefits. To exclude people who transition into retirement before age 65, we filter out individuals whose average gross income from retirement income sources exceeds \$10,000 between ages 60 and 65.

A final obvious limitation on our population is that we only include individuals with measurable gross replacement rates and therefore who live at least one fiscal year past age 65. We incorporate this by only examining individuals who die after age 67.

Although additional refinements to the filters are arguably applicable, we did not go further since the eligible criteria set out above already reduced the population to less than 1% (our originally simulated population is 3 million).

Our findings are subject to various limitations, including our definition of consumption, LifePath's capacity to model each of these items (which includes our projection assumptions)¹⁷, the choice of filters put on the population sample, and our approach to determining if consumption is maintained - that is, $\pm 10\%$ of pre-retirement household-adjusted consumption, averaged from ages 50-65 (as noted, we assess the impact of

¹⁷ We reduce the OAS benefit by the income-tested clawback.

¹⁸ See MacDonald et al. (2011) for a description of the first two limitations. The principal author takes full responsibility for the assumptions underlying the projection scenario used.

alternative pre-retirement consumption measurement periods at the end of the next section).

2 Results

As Section E.1 explains, we capture “real world” target replacement rates by identifying the replacement rates of those individuals from our eligible population who maintained their standard of living after retirement. We consider that an individual maintains his/her standard of living if average household consumption, adjusted each year for family size and inflation, does not vary by more than 10% after retirement – in other words, if the consumption replacement rate falls between 90 to 110%:

$$90\% < \frac{\text{Post-retirement average consumption (age 65 to death)}}{\text{Pre-retirement average consumption (age 50 to retirement)}} < 110\% \quad (5)$$

To graphically illustrate our procedure of identifying target replacement rates, we begin by showing the consumption replacement rates of the eligible population (those who satisfied the employment criteria given in Section E.1). From our simulation, approximately 23,000 synthetic Canadian baby boomers qualified as being eligible, and Figure 1 shows the distribution of their projected consumption replacement rates (all of the histograms in this section have a common maximum for the vertical axes of 12%).

Interestingly, the consumption replacement rates are somewhat bell shaped around 100%, which is the goal of the standard of living preservation, with 46% of the eligible sample falling below 100% and 54% above. The bars that lie between 90% and 110% make up approximately a fifth of the eligible sample – these are the individuals whose standard of living was maintained after retirement according to our definition. Consequently, the gross replacement rate for each of these “successful” synthetic life courses qualified as a “target” gross replacement rate. The distribution of these target gross replacement rates is given in Figure 2.

Figure 3 shows the target replacement rate results from Figure 2 by three earnings groups, where an individual is categorized according to his/her final five-year average earnings (the denominator of the replacement rate formula given in equation (4)). For clarity, we trace each histogram. The three categories, in 2010 dollars, are:

- \$20,000 – 35,000
- \$35,000 – 80,000
- \$80,000 +

Figure 1: Consumption replacement rate distribution of eligible sample.

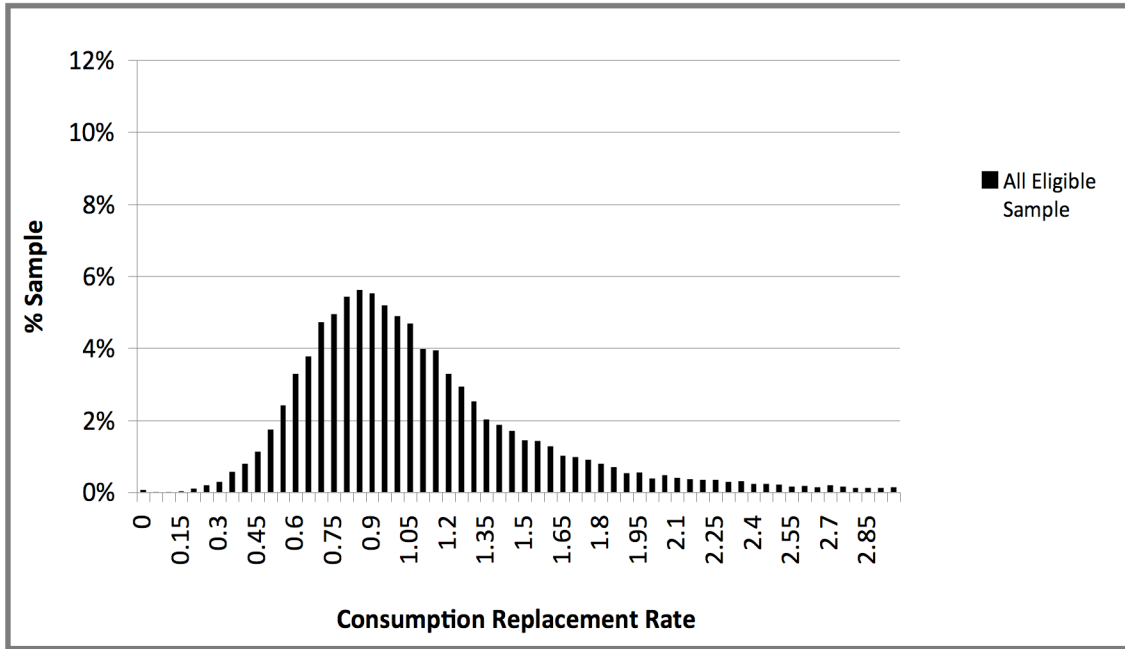


Figure 2: Target gross replacement rate distribution.

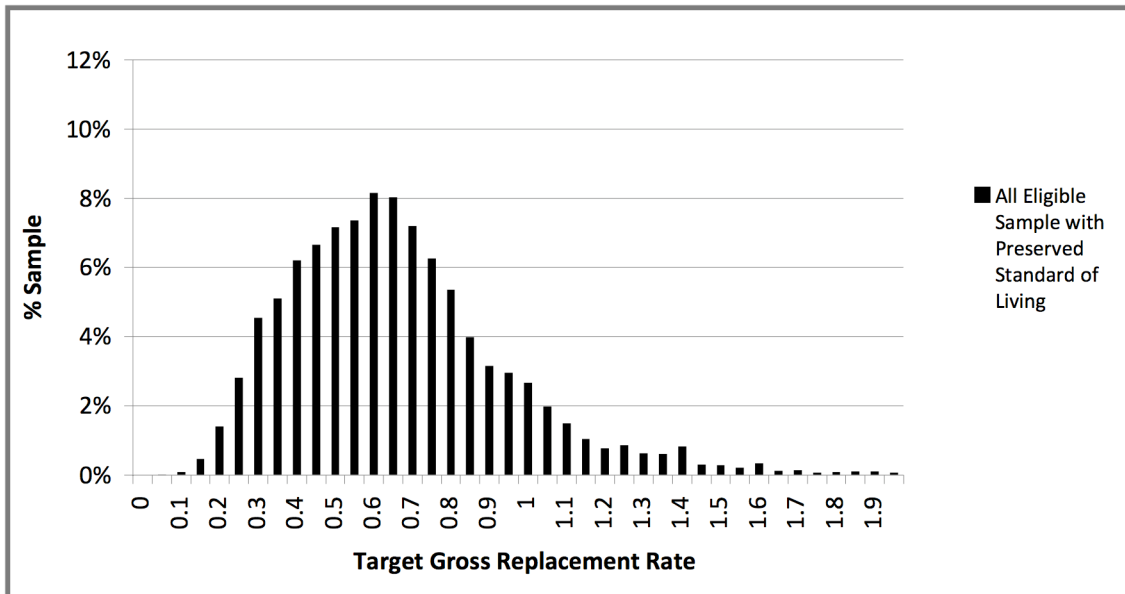
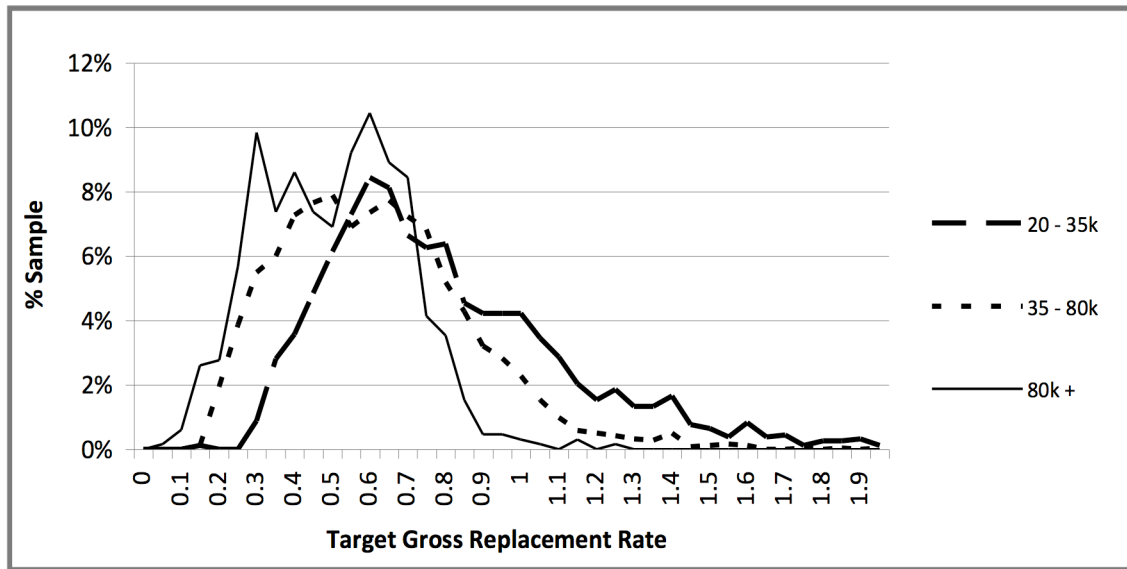


Figure 3: Target gross replacement rate distribution by three earnings groups.



Before discussing the findings, Figures 2 and 3 can be better interpreted with some examples of synthetic individuals taken from our results (note that we describe only a small number of the details behind the life-courses in each).

(1) We first present a synthetic male Albertan who was born in 1966, married at age 22 to a woman his age, and had three kids within the next ten years. Both spouses worked most of their lives, although the husband was employed the entire time between ages 50 and 65, while his wife worked on and off throughout this period. The husband's gross earnings were relatively steady between ages 50 and 60, usually between \$70,000 and \$80,000 and always over \$50,000. In his 60th year, his gross earnings reduced to approximately \$40,000 and, after age 61, it dropped substantially further to approximately \$15,000 per year. During this time, his wife continued to work on and off (earning an average of \$30,000 per year). The value of his gross retirement income suffered a small, but steady, decline over his retirement since, although the majority of his retirement income was made-up of CPP and OAS benefits, which are both indexed to inflation, he had converted his RRSP wealth to a nominally fixed annuity and his accumulated RPP benefits were also not indexed to inflation. Consequently, the value of his retirement income began at approximately \$41,500 and reduced slightly each year until it reached approximately \$35,000 in the year of his death at age 80. His wife's gross retirement income was made-up of only public sources and remained at approximately \$15,000 throughout this time. Together, they maintained their pre-retirement standard of living after age 65, although his gross replacement rate was very high at 1.93 owing to his drop in earnings between ages 61 and 65. This gross replacement rate would be in the right tails of Figures 2 and 3.

(2) We next consider an Ontario woman born in 1965. She married at age 26, separated at age 46 and divorced at age 47. She then formed a common-law union at age 48, which turned into a second marriage at age 55. She separated from her second husband at age 62 and divorced a year later. There were no children from either marriage. While her first

spouse never earned employment income, her second spouse earned a relatively stable income during the length of their union (approximately between \$40-\$55,000 per year). She rotated between paid employment and self-employment throughout her career, and was unemployed multiple times although always for very short durations. For instance, she was unemployed four times between ages 50 and 60, but the total time off work was less than two years. When she did work, her income was generally substantial, although volatile. While employed between ages 50 and 60, she earned approximately \$80,000 per year. She had no unemployment periods between ages 60 and 65, and her gross income averaged approximately \$100,000 per year. Throughout her retirement, her CPP and OAS benefits were just over \$13,500 and \$6,000 per year, respectively. None of her employers sponsored a pension plan and she did not take major advantage of RRSPs during her career - her RRSP wealth amounted to approximately \$24,000 at retirement, which she converted to a nominal annuity. She had, however, made substantial financial investments while employed that were not registered, which amounted to over \$300,000 at age 65. Further, she had purchased a house at age 35 that was also valued at over \$300,000 at age 65. These two forms of savings consequentially reduced her consumption while working, and augmented her retirement income. The overall effect was balanced consumption before and after retirement, although her gross replacement rate was merely 22.5% since it only accounted for the conventional sources of retirement income (public and private pension benefits, and RRSP income). This gross replacement rate would be found in the left tails of Figures 2 and 3.

Figure 2 would seem to lend some support to the notion of a “target” replacement rate because there is somewhat of a peak (that is, a range of replacement rates that “work” for a higher number of people than rate ranges before or after – we will refer to this as the “best” target replacement rate range). The distribution is still, however, considerably wide. Consequently, even the best 10% range of target replacement rates (60% to 70%) works for just under a mere sixth of the sample, and the best 20% range (55% to 75%) covers 31% of the sample.

Target gross replacement rate values are commonly constructed by earnings groups (see Section B), reflecting the belief that universal gross replacement rate targets exist for workers who share the same pre-retirement salary. Figure 3 confirms that target replacement rates do vary by earnings level, but it also demonstrates that there is a high level of variability within earnings groups. Even when differentiated for various earnings levels, therefore, universal targets continue to be inadequate. We also looked at other classifications, such as the distribution of target replacement rates of spouses versus singles, and came to the same conclusion.

In Figure 3, the lower earnings group’s distribution has a thick right tail. From this group, there will be more individuals whose final five-years average earnings is much lower than their lifetime earnings. In these situations, gross retirement income is defined by an individual’s entire career and therefore reflects the higher level of consumption before age 60. The overall result is abnormally large replacement rate targets (for an illustration, see example (1) of the Albertan man given above).

Figure 4: Target gross replacement rate cumulative distribution function by three earnings groups.

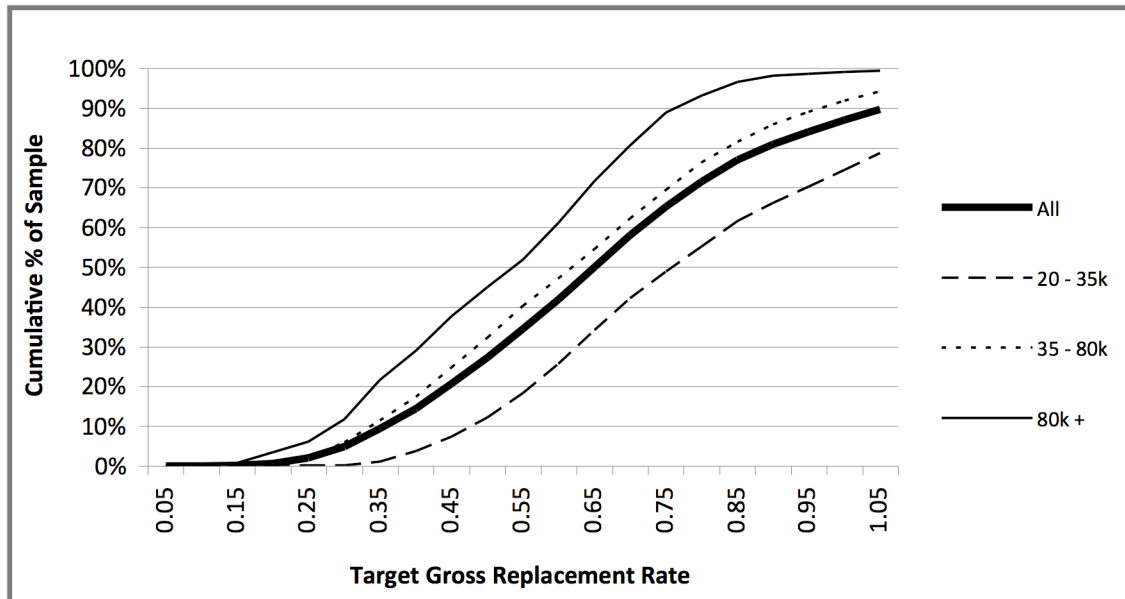


Figure 4 shows the cumulative distribution function of the target replacement rates from Figures 2 and 3. It is conventionally understood that lower-income groups require higher target gross replacement rates (for instance, see McGill (2010)), and our results continue to support this as the distribution of target replacement rates for the bottom earnings group falls to the right of those for the mid and high earnings groups. The primary reason underlying the higher targets is that there is a much lower tax and savings wedge between consumption and gross income for lower income earners. This wedge progressively increases with income. To illustrate with a simplified Canadian example, suppose person A earns \$100,000 gross income and, after savings (in both RRSPs and non-registered savings) and taxes (payroll and income), the amount remaining for consumption is \$55,000. After retirement, such an individual would require \$62,000 in gross income to derive the same level of consumption (assuming that \$5,000 comes from non-registered savings and a 20% average tax rate). The target gross replacement rate is 62.5%. Person B earns a gross income of \$25,000, saves nothing and is left with \$21,000 after taxes for consumption. If this individual has a gross retirement income of \$21,000 and pays no taxes (this would not be unusual), then he/she would continue to have \$21,000 for consumption in retirement. This produces a gross target replacement rate of 84%.

The pension benefits under a traditional DB plan generally take the form of an earnings replacement rate (such as 2% of the average final five years of earnings for every year of service). According to Figure 4, if individuals were able to replace 70% of their average last five years of earnings over a 35 year career, then this would meet or exceed the target replacement rates for approximately 58% of our entire “successful” sample, particularly when combined with other sources of retirement income, such as C/QPP, OAS, and individual savings.

Nevertheless, the main thrust of our results is that any single target will be too much for some, good for others, and not enough for the rest. We emphasize that a 70% target is not appropriate for individual use. For example, a target between 65-75% maintains the standard of living of approximately 15% of our successful sample according to Figure 2. However, targeting this replacement rate would result in roughly 35% of our sample experiencing a drop in their standard of living after retirement, and in "over-saving" by the remaining half of the sample. Such over-saving might appeal to highly risk-averse individuals who place a high value on contingency income, as well as individuals wishing to leave bequests. For others, however, it could produce unnecessary "scrimping and saving" during young and healthy years when the welfare of children is possibly involved, and excess wealth during more advanced ages that is not necessarily enjoyed¹⁹.

The best 10% target replacement rate range in Figure 2 is slightly lower than the traditional target replacement rate rule of thumb (its value is generally set between 70-80% - see Section B). Although interesting, this finding is not very relevant as the critical thrust of this section is to illustrate the wide range of individualized target gross replacement rates. We do not wish to endorse any particular gross replacement rate target. In fact, we can shift the distribution to the right by choosing a peak pre-retirement consumption period as representing pre-retirement standard of living for step #2 in Section E.1, such as the best 5 years of consumption rather than average consumption from ages 50-65. Such a shift would occur because people who are able to maintain their peak pre-retirement consumption after retirement will generally have higher gross replacement rates. We can similarly move the distribution to the left by choosing a career pre-retirement consumption period when determining whether individuals maintained their standard of living after (such as ages 25-65). We show these two new pre-retirement consumption measurement periods in Figure 5, where the distribution of target replacement rates is clearly impacted. The downward shift in the target replacement rates when using career-average consumption and the upward shift when using peak are perhaps more clearly illustrated by the cumulative distribution functions in Figure 6.

Figure 5: Target gross replacement rate distribution for three pre-retirement consumption measurement periods – ages 50-65 (baseline); ages 25-65 (career-average); and best five

¹⁹ Empirical evidence indicates that retirees consume their personal savings at a very slow rate – in fact, in the Smith et al. (2009) study, the personal wealth of the upper income quintile actually continued to accumulate after retirement. This suggests that many retirees who build a relatively large retirement nest do not benefit from their greater wealth after retirement.

years between ages 50-65 (peak).

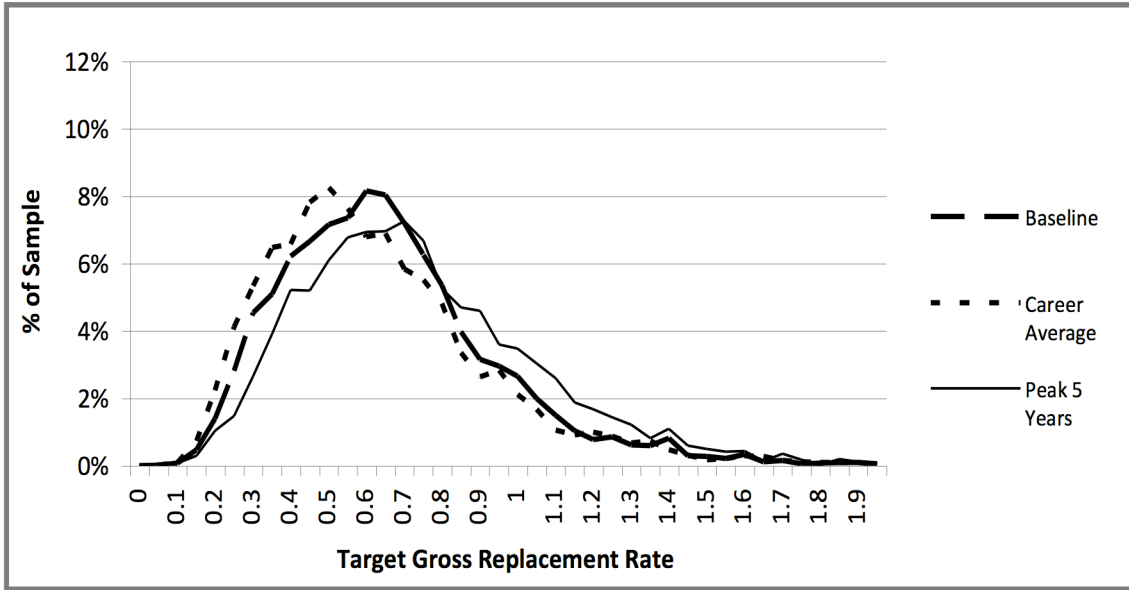
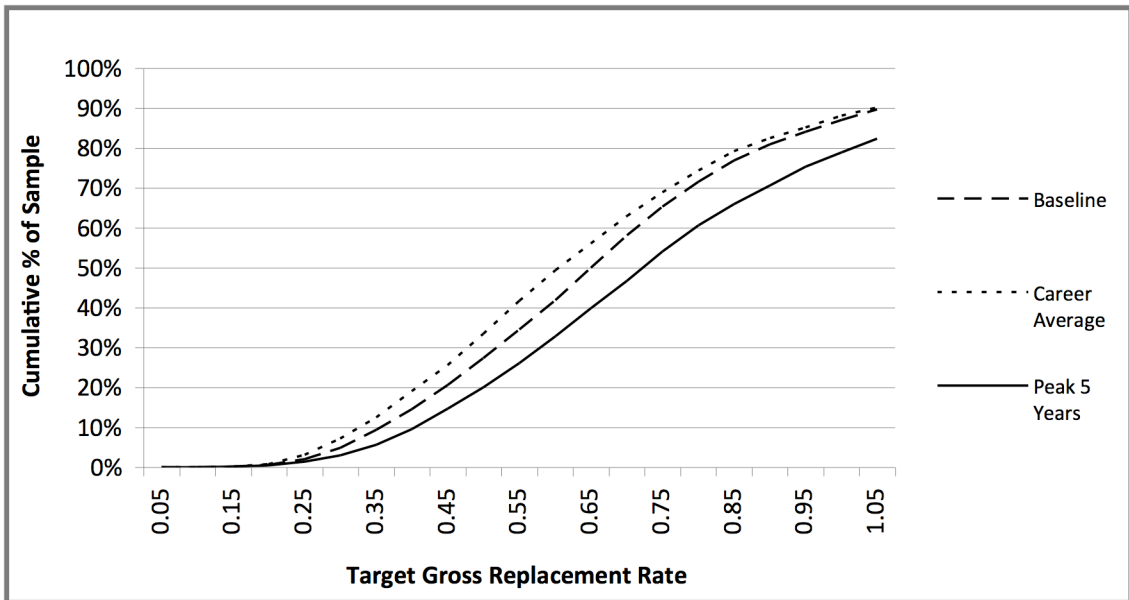


Figure 6: Target gross replacement rate cumulative distribution function for three pre-retirement consumption measurement periods – ages 50-65 (baseline); ages 25-65 (career-average); and best five years between ages 50-65 (peak).



The results shown in this section naturally give rise to a number of questions concerning the most significant driving forces underlying the inaccuracy of universal gross replacement rate targets, such as:

- In the numerator, is gross earnings averaged from age 60 to 65 not representative of pre-retirement gross earnings? Would averaging from age 50 to 65 generate better results?

- Or, are individual gross earnings in general not representative of household-adjusted consumption? Would averaging both spouses' gross earnings be a better approach?
- Similarly, in the denominator, is one year of post-retirement income not representative of post-retirement gross income? Or, is it also not a good proxy for household-adjusted consumption in general?
- How significant is the heterogeneity of savings across the pre-retirement period on the target replacement rate?

By drawing on the conceptual and measurement issues outlined in Section C, many more reasons and possible solutions could be offered. Testing these hypotheses is outside the scope of this study, whose objective was to discuss the underlying issues in replacement rates. Unraveling and disentangling the reasons behind the wide range of target gross replacement rates illustrated in Figures 1 - 6 so as to provide further guidance on the practical use of replacement rate measures is a topic that will be investigated in future work (see Section F).

F Research Gaps and Future Work

The biggest obstacle in the study of consumption smoothing before and after retirement is likely to be data - there is limited longitudinal data on measuring consumption directly (expenditure data), or on the components necessary to estimate consumption indirectly (data on income, savings, dissavings, and wealth) (see Section B). Existing measures and models of consumption tend to be based on cross-sectional data, and pieces are often missing (such as non-registered wealth). High quality, longitudinal data on the components of consumption over the life-cycle would offer many important insights into the determination of adequacy. One of these is the profile of individuals' consumption over their retirement period since most replacement rate methodologies measure the numerator at the beginning of retirement and stop.

A possible avenue of further study would be to develop alternatives to the available universal target gross replacement rates. A possible approach would be to identify the characteristics of an individual's lifecycle that are most responsible for the wide range of target gross replacement rates in Section D.1 (characteristics such as family size, household income, taxes, government transfers, the volatility of pre-retirement earnings) and incorporate them directly into the replacement rate formula. This would significantly narrow the range of real-world target gross replacement rates in Figure 1 and more satisfactorily capture an individual's standard of living without resorting to a more complex lifecycle analysis.

In future work, we hope to continue to move beyond gross replacement rates altogether and promote the development of consumption replacement rates in the study of retirement income adequacy, with an emphasis on integrating all forms of retirement savings and wealth.

Conclusion

Replacement rates are commonly employed to evaluate whether individuals are able to maintain their pre-retirement living standards after retirement. This paper examined their underlying conceptual and measurement issues. We found that the methodological and data requirements to produce reasonable replacement rates are very formidable, and that much of the existing literature exhibits significant limitations.

First, many important sources of pre- and post-retirement consumption have often been left out of the numerator and denominator. In the post-retirement period, researchers traditionally neglect the consumption available from accumulated wealth sources outside of formal retirement savings vehicles such as non-registered financial wealth/debt, home-ownership, and other assets. In the pre-retirement period, analysts typically ignore government transfers (such as unemployment insurance, child benefits and social assistance), investment income, non-registered financial savings and, for homeowners, mortgage payments and imputed rent.

Second, analysts frequently use cross-sectional data from a single year, which drives them to make various simplifying assumptions, including:

- short pre- and post-measurement periods for the numerator and denominator (typically one year) although gross income exhibits substantial volatility over many individuals' lifecourse (particularly pre-retirement earnings), and the link between annual income and consumption can be very weak; and
- projections using highly stylized and simplistic assumptions that do not at all capture the realistic variability of income across and among the lifecourses of individuals.

Third, studies traditionally have not captured the household-level differences in consumption due to family size. The pre-retirement standard of living of a single-earner spouse with children is much different than that of a single person with the same income. In addition, parents are much less likely to be supporting dependents after retirement, and this should be explicitly reflected in replacement rate methodology.

Another issue in past literature is that analysts have often compared gross replacement rate measures with universal targets. This paper argued that such conventional target gross replacement rates do not exist, even when classified by earnings level and family configuration - according to our analysis, the empirical distribution of "real-world" target gross replacement rates is incredibly wide; consequently, any one target rate fits very few individuals.

A practical issue associated with traditional universal target replacement rate measures is that end-users generally do not understand their limitations. This is particularly a concern when financial planners endorse a "rule of thumb" target to their clients, although it is similarly problematic when policy analysts evaluate a country's retirement income system by comparing the projected retirement income sources of a sample of citizens to such universal targets.

With the emergence of better data and methodologies, the replacement rate literature is becoming more sophisticated, and capable of providing better guidance. Many studies are modeling pre- and post-retirement consumption more comprehensively, and are employing longitudinal data and broad measurement periods that are more representative of individuals' living standards. Dynamic microsimulation models have facilitated these improvements by integrating many different data sources and making the complexity and diversity of individuals' life courses more visible and tractable. The literature is also increasingly incorporating the impact of family size in its assessments of consumption. Recent literature recognizes that universal target gross replacement rates cannot accurately assess retirement income adequacy.

The guidance available from the replacement rate literature will continue to improve as better data becomes available and methodologies progress. Currently, however, there is a considerable gap between the insights of the existing literature and the “rules of thumb” or the target gross replacement rates often used by individuals for personal financial planning, or by many others when evaluating retirement income outcomes. There may be a role for the development and dissemination of better alternatives to provide somewhat more refined guidance in the use of replacement rate measures.

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