University of Michigan Retirement Research Center

Working Paper

WP 2009-214

What Replacement Rates Should Households Use?

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MRRC

Project #: UM09-04

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September 2009

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Acknowledgements

This work was supported by a grant from the Social Security Administration through the Michigan Retirement Research Center (Grant # 10-M-98362-5-01). The findings and conclusions expressed are solely those of the author and do not represent the views of the Social Security Administration, any agency of the Federal government, or the Michigan Retirement Research Center.

What Replacement Rates Should Households Use?

Abstract

Common financial planning advice calls for households to ensure that retirement income exceeds 70 percent of average pre-retirement income. We use an augmented life-cycle model of household behavior to examine optimal replacement rates for a representative set of retired American households. We relate optimal replacement rates to observable household characteristics and in doing so, make progress in developing a set of theory-based, but readily understandable financial guidelines. Our work should be a useful building block for efforts to assess the adequacy of retirement wealth preparation and efforts to promote financial literacy and well-being.

Authors' Acknowledgements

We are grateful to our colleague Surachai Khitatrakun for very helpful advice, Mike Anderson for excellent assistance, the National Institute of Aging and the Social Security Administration for financial support, and to the professionals at the University of Michigan, and RAND who developed the HRS data that we rely on.

Introduction

The target replacement rate – the amount of income in retirement needed to maintain pre-retirement living standards – is a workhorse concept in the financial planning literature. Typical advice suggests that replacement rates should be 70 to 85 percent of pre-retirement income. Target replacement rates are thought to be less than 100 percent for three main reasons. First, upon retirement, households typically face lower taxes than they face during their working years, if for no other reason than Social Security is more lightly taxed than wages and salaries. Second, households typically save less in retirement than they do during their working years, so saving is a smaller claim on available income. Third, work-related expenses generally fall in retirement.

Low income households are thought to need higher replacement rates than high income households. Prior to retirement, tax rates are lower for low-income households than they are for high-income households. Their reduction in taxes in retirement, therefore, is smaller than the reduction experienced by high-income households. Moreover, low-income households save less than their higher income counterparts (Dynan, Skinner, and Zeldes, 2004), hence the reduction in saving in retirement will be less substantial for low-income households. The fact that taxes and saving fall less in retirement for low-income households than for high-income households suggests their target replacement rate should be higher.

Financial planners and scholars calculate replacement rates in a conceptually straightforward manner. The numerator requires analysts to calculate an income flow that would be available from retirement resources. Calculating a retirement income flow is easy to do for assets that provide annuity-like payouts such as social security, defined-benefit pension payouts, and annuities. The calculation requires more assumptions for assets held in lump-sum forms, such as bonds, stocks, and account-type pensions. Housing wealth is conceptually trickier still, since one may wish to account for the implicit rental value of owner-occupied housing.[1] Issues also arise in defining the denominator of replacement rates. Typically the denominator is average income over pre-retirement years. But replacement rates are sometimes defined using average income over the last five (or fewer) years of the pre-retirement period, with the idea that living standards may ratchet upwards as people age.

Many studies use target replacement rates as their standard for assessing the adequacy of wealth accumulation and grapple with various methodological complications that arise.[2] The Employee Benefit Research Institute, for example, promotes the American Savings Education Council's Planning and Saving Tool (from ChoosetoSave.org). They suggest a 70 to 80 percent replacement rate goal if "You will need to pay for the basics in retirement, but you won't have to pay many medical expenses… You're planning a comfortable retirement without much travel." They suggest a 80 to 90 percent replacement rate goal if "you will need to pay your Medicare Part B and D premiums … [and any supplemental coverage and] you plan to take some small

[1] See the helpful discussion in Munnell and Soto (2005); also see Venti and Wise (1991, 2002, 2004), Lusardi and Mitchell (2006), Sun, Triest and Webb (2007), Gustman and Steinmeier (1999), Coronado, Maki and Weitzer (2006) all of whom address the proper treatment of housing equity in the calculation of replacement rates.

[2] See Kotlikoff, Spivak and Summers (1982), Bernheim (1993-1997), Mitchell and Moore (1998), Moore and Mitchell (2000), Butrica, Iams and Smith (2003), Steinberg and Lucas (2004), Haveman, Holden, Wolfe and Sherlund (2006), Munnell, Webb and Delorme (2006), Munnell, Webb and Golub-Sass (2007) for applications of replacement rate targets to assess retirement savings adequacy.

Methodological contributions include Boskin and Shoven (1984), Au, Mitchell and Phillips (2004), Social Security Administration (2004), Munnell and Soto (2005), Munnell, Golub-Sass and Webb (2007), Brady (2008).

trips." Moore and Mitchell (2000) and Munnell and Soto (2005) calculate replacement rates with data from the Health and Retirement Study (HRS) and analyze the adequacy of retirement preparation, comparing the empirical distribution of sample replacement rates with the common financial planning targets of at least 70 percent.[3] Munnell, Webb, and Delorme (2006) and Munnell, Webb, and Golub-Sass (2007a, 2007b) make similar calculations for a "National Retirement Risk Index," comparing wealth holdings in the 2004 wave of the Survey of Consumer Finance, augmented with imputations from the HRS, to replacement rate targets. Replacement rates are also a staple of web-based financial planning products.[4]

The rule of thumb that replacement rates should be above 70 percent to maintain living standards in retirement is conceptually flawed. The easiest way to understand this, and a point made in Scholz and Seshadri (2009), is to consider the role of children in the household. Financial planning rules of thumb and the previously mentioned studies that assess the adequacy of retirement preparation use the same replacement rate benchmark for families regardless of their number of children. But the resources needed to equate the discounted marginal utility of consumption in retirement for parents (assuming an intact married couple) is smaller if household resources during the pre-retirement period were devoted, in part, to raising four children than if the couple was childless, holding all else equal (particularly the level and timing

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[3] Haveman, Holden, Wolfe, and Romanov (2007) take a different approach, comparing retirement wealth accumulated by the HRS cohort to the wealth accumulated by an older cohort covered by the New Beneficiary Survey. They focus on measuring the fraction of the population that can sustain a retirement standard of living that exceeds the poverty line.

[4] See, for example, Fidelity myPlan Retirement Quick Check (http://personal.fidelity.com/planning/retirement/retirement_planning.shtml.cvsr), Vanguard How Much Should I Save for Retirement? (https://personal.vanguard.com/us/RetirementSavings), AARP: Retirement Calculator (http://sites.stockpoint.com/aarp_rc/wm/Retirement/Retirement.asp?act=LOGIN), Mass Mutual Retirement Planner (http://www.massmutual.com/planningtools/calculators), MSN Money Central (http://moneycentral.msn.com/retire/planner.aspx), CNN Money Retirement Planner (http://cgi.money.cnn.com/tools/retirementplanner/retirementplanner.jsp).

of earnings, inheritances, education, hours of work, etc.).[5] Put differently, an otherwise equivalent household with many children will have a smaller optimal replacement rate than their childless counterpart. Conceptually, the ages when children are born, due to the interactions of credit constraints and optimal consumption profiles, and the timing of income realizations, will also affect target replacement rates.

A natural alternative to replacement rates can be drawn from the life-cycle model, augmented to account for fundamental factors affecting most households, such as demographic changes and uncertainty about future earnings, medical expenses, and longevity. The drawbacks to the lifecycle approach are that, done correctly, it requires data on annual earnings over individual's lifetimes and considerable computation. But the lifecycle model is the appropriate conceptual benchmark, as lifecycle consumption decisions maximize lifetime well-being, subject to lifetime resource constraints. It is important to emphasize that we do not need to assume that people follow the lifecycle model for it to provide financial targets that are superior to replacement rates. Rather, the lifecycle model provides a rigorous *normative* benchmark – if household wealth equals the lifecycle target, they are on-target for being able to maintain pre-retirement living standards in retirement. Put less intuitively, by meeting the target, the household will be able to equate the discounted marginal utility of consumption across time.

II. The lifecycle model and optimal replacement rates

Two prior contributions examine the implications of the lifecycle model for optimal retirement planning. Gokhale, Kolikoff, and Warshawsky (1999) compare the recommendations from a commercial software package developed by Professor Kotlikoff and colleagues (ES Planner), which implements a restrictive version of the life-cycle model, to the recommendations

[5] This statement depends, to a certain extent, on the precise modeling of children and household scale economies – if children are substitutes for consumption, children would be expected to have a smaller effect on optimal wealth accumulation than would be implied by the equivalence scale used in this paper.

of a leading commercial financial product, the Quicken Financial Planner. They study 24 specific cases, 20 of which examine a couple where the husband is 29, earns $50,000, and has a wife who is two years younger. The 20 cases consider different degrees of demographic or economic complexity. The remaining cases look at a young low-income couple, a middle age upper income couple, an older very high-income couple, and a middle-age, low-income divorcee. They find large differences in the recommendations for saving (and for life insurance) that are driven by the failure of financial planning rules of thumb to fully account for Social Security rules, household demographics and borrowing constraints.

There are two substantial, differences between our work and Gokhale, Kolikoff, and Warshawsky (1999). First, the life-cycle model underlying ESPlanner does not account for critical sources of uncertainty that affect households: uncertainty over earnings, longevity, and health expenses. In Scholz, Seshadri and Khitatrakun (2006) we show that incorporating uncertainty, particularly over earnings, is necessary for our model to match important features of the wealth distribution. Second, it is difficult to assess the representativeness of the 24 cases used to illuminate the ESPlanner and the Quicken Financial Planner differences.

Engen, Gale and Uccello (1999) study the adequacy of wealth accumulation among couples where the husband is employed full-time. They compare distributions of optimal wealth-to-income ratios calculated from a dynamic, stochastic life-cycle simulation model to actual ratios calculated from the Health and Retirement Survey (HRS) and Surveys of Consumer Finances (SCFs). Uncertainty in earnings realizations will lead to a wide distribution of optimal simulated ratios, so they point out that empirical work that focuses on discrepancies of actual wealth relative to a median (or mean) target wealth-income ratios does not provide compelling evidence of under- or over-saving. They then show that actual wealth distributions from the HRS and SCF closely match (or are shifted rightward relative to) the simulated optimal distributions.

A section of their paper compares the implications of their model to popular financial planning advice – namely that optimal replacements rates should be between 65 to 85 percent. They find with a time preference rate of 3 percent, the median replacement rate across different groups, given their lifecycle model, was 72 percent. The median rate was 80 percent with a time preference rate of 0 percent. They conclude that common financial planning rules of thumb may be consistent with the implications of a well-specified life-cycle optimization model.

Our work uses a similar model to Engen, Gale and Uccello (1999) and is fully described in Scholz, Seshadri, and Khitatrakun (2006). The major difference between their work and ours is that they compare the *distribution* of simulated optimal ratios of hypothetical, representative households to actual ratios computed from the Survey of Consumer Finances and the HRS. But each HRS (and SCF) household has an optimal wealth income ratio given a specific life-cycle model and realizations of their lifetime earnings. The fact that actual and simulated wealth-to-earnings *distributions* are similar does not ensure that each specific *household* is achieving its target.

We solve a life-cycle model that incorporates uncertain earnings, health shocks, and uncertain longevity using household-by-household data (including restricted data on earnings realizations from the Social Security Administration) from the Health and Retirement Study. The model gives the *optimal* non-DB-pension, non-social security wealth that the household should hold, given its DB pension and social security entitlements. This level of optimal wealth is sufficient to equate the expected discounted marginal utility of consumption over their lifetime. We focus on two questions in this paper that have received little attention. First, what is the level and distribution of optimal replacement rates, and how do these compare to the conventional financial planning advice of 70 to 85 percent? Second, are there systematic characteristics that are correlated with replacement rates that are higher or lower than the common advice? Or are household circumstances, as reflected in the HRS data, sufficiently idiosyncratic that rules of thumb cannot reasonably capture the implications of an optimizing model?

III. The HRS Data, Economic Model, and Sample

The HRS is a national panel study with an initial sample (in 1992) of 12,652 persons in 7,702 households. It oversamples blacks, Hispanics, and residents of Florida. The baseline 1992 study consisted of in-home, face-to-face interviews of the 1931–1941 birth cohort and their spouses, if they were married. As the HRS has matured, new cohorts have been added. The 2004 version of the data, which we rely on for this paper, includes households from the AHEAD cohort, born before 1924; Children of Depression Age (CODA) cohort, born between 1924 and 1930; the original HRS cohort, born between 1931 and 1941; the War Baby cohort, born between 1942 and 1947; and the Early Boomer cohort, born between 1948 and 1953.

The survey covers a wide range of topics, including batteries of questions on health and cognitive conditions; retirement plans; subjective assessments of mortality probabilities and the quality of retirement preparation; family structure; employment status and job history; demographic characteristics; housing; income and net worth; and pension details.

Our analysis starts with the RAND HRS Data (https://ssl.isr.umich.edu/hrs/files.php?versid=34, the site requires registration with the HRS), which pulls HRS data for respondents and spouses across waves into a single analysis file with consistent variable definitions across waves. We add information to the RAND data and put it on a household basis. This includes adding information on child ages, defined contribution pension benefits from past and current jobs, defined benefit pension coverage from past and current jobs, and we add in the restricted access social security earnings data.

As mentioned earlier, earnings histories are a critical input for the lifecycle model. Unfortunately, earnings data from 1951 through 1977 are potentially censored, that is, the earnings report is not allowed to exceed the social security taxable earnings cap. Beginning in 1978, we have access (on a restricted basis) to uncapped W-2 earnings reports. Among those with positive earnings, 22.5 percent of households have earnings capped in 1971, while 3.2 percent were capped in 1951. We impute earnings above the taxable earnings limit using Tobit regressions in which earnings are the dependent variable and covariates include indicator variables for marital status, census regions, race and ethnicity, birth year, gender, and education group. To add a dynamic element to the earnings imputations, we include variables for the household's position in the aggregate earnings distribution in each of the preceding 4 years. We replace capped earnings in cases where the predicted earnings from the regression exceed capped earnings. The predictions typically exceed the capped amounts for more than 80 percent of the capped observations.

The Economic Model

We assume a household derives utility $U(c)$ from period-by-period consumption in equivalent units, where $g(A_j, K_j)$ is a function that adjusts consumption for the number of adults A_j and children K_j in the household at age j.[6] Let c_j and a_j represent consumption and assets at age j. With probability p_j the household survives into the next period, so the household

[6] Married households in 2004 are modeled as making their lifecycle consumption decisions jointly with their partner throughout their working lives. They become single only if a spouse dies. Similarly, single households in 2004 are modeled as making their lifecycle consumption decisions as if they were single throughout their working lives.

survives until age j with probability $\prod_{k=S}^{j-1} p_k$, where $\prod_{k=S}^{j-1} p_k = 1$ if $j-1 < R$. At age D , $p_D = 0$.

The discount factor on future utilities is β . Expected lifetime utility is then

$$E\left[\sum_{j=S}^{D} \beta^{j-S} g(A_j, K_j)\; U\left(c_j / g(A_j, K_j)\right)\right].$$

The expectation operator E denotes the expectation over uncertain future earnings, health expenditures, and life span.

Consumption and assets are chosen to maximize expected utility subject to the constraints,

$$y_j = e_j + ra_j + T(e_j, a_j, j, n_j),\;\; j \in \{S,...,R\},$$

$$y_j = SS\left(\sum_{j=S}^{R} e_j\right) + DB\left(e_R\right) + ra_j + T_R(e_R, \sum_{j=S}^{R} e_j, a_j, j, n_j),\;\; j \in \{R+1,...,D\},$$

$$c_j + a_{j+1} = y_j + a_j - \tau\left(e_j + ra_j\right), j \in \{S,...,R\},$$

$$c_j + a_{j+1} + m_j = y_j + a_j - \tau\left(SS\left(\sum_{j=S}^{R} e_j\right), DB\left(e_R\right) + ra_j\right), j \in \{R+1,...,D\}.$$

The first two equations define taxable income for working and for retired households.[7] The last two equations show the evolution of resources available for consumption. In these constraints e_j denotes labor earnings at age j. $SS(\cdot)$ are social security benefits, which are a function of aggregate lifetime earnings, and $DB(\cdot)$ are defined benefit receipts, which are a function of earnings received at the last working age. The functions $T(\cdot)$ and $T_R(\cdot)$ denote means-tested transfers for working and retired households. Transfers depend on earnings, social security benefits and defined benefit pensions, assets, the year, and the number of children and adults in

[7]In the baseline model, we define a household's retirement date for those already retired as the actual retirement date for the head of the household. For those not retired, we use the expected retirement date of the person who is the head of the household. The head is defined as being the person with the highest lifetime earnings.

the household, n. Medical expenditures are denoted by m_j and the interest rate is denoted by r.[8] The tax function $\tau(\cdot)$ depicts total tax payments as a function of earned and capital income for working households, and as a function of pension and capital income plus a portion of social security benefits for retired households. Specifically, we model an exogenous, time-varying, progressive income tax that takes the form

$$\tau(y) = a_0\left(y - \left(y^{-a_1} + a_2\right)^{-1/a_1} \right),$$

where y is in thousands of dollars. Parameters are estimated by Gouveia and Strauss (1994, 1999), and characterize U.S. effective, average household income taxes between 1966 and 1989.[9] We use the 1966 parameters for years before 1966 and the 1989 parameters for years after that.

We simplify the problem by assuming households incur no out-of-pocket medical expenses prior to retirement and face no pre-retirement mortality risk. Therefore, the dynamic programming problem for working households has two fewer state variables than it does for retired households. During working years, the earnings draw for the next period comes from the distribution Φ conditional on the household's age and current earnings draw. We assume that each household begins life with zero assets.

We use constant relative risk-averse preferences, so $U(c) = \left\{ \frac{c^{1-\gamma}}{1-\gamma}, \right.$ when $\gamma \neq 1$. In our baseline parameterization, we set the discount factor as $\beta = 0.96$ and the coefficient of relative

[8]Medical expenses are drawn from the Markov processes $\Omega_{jm}(m_{j+1} \mid m_j)$ for married and $\Omega_{js}(m_{j+1} \mid m_j)$ for single households. Medical expenses drawn from the distribution for single households are assumed to be half of those drawn from the distribution for married couples.

[9] Estimated parameters, for example, in 1989 are $a_0 = 0.258$, $a_1 = 0.768$ and $a_2 = 0.031$. In the framework, $a_1 = -1$ corresponds to a lump sum tax with $\tau(y) = -a_0 a_2$, while when $a_1 \to 0$, the tax system converges to a proportional tax system with $\tau(y) = a_0 y$. For $a_1 > 0$ we have a progressive tax system.

risk aversion (the reciprocal of the intertemporal elasticity of substitution) to $\gamma = 3$. We assume an annualized real rate of return of 4 percent.

Our equivalence scale comes from Citro and Michael (1995) and takes the form $g(A_j, K_j) = (A_j + 0.7K_j)^{0.7}$, where A_j indicates the number of adults and K_j indicates the number of children in the household. This scale implies that a two parent family with 3 children consumes 66 percent more than a two parent family with no children. There are other equivalence scales, including ones from the Organization for Economic Cooperation and Development (1982), Department of Health and Human Services (1991) and Lazear and Michael (1980). The corresponding numbers for these equivalence scales in this example are 88 percent, 76 percent, and 59 percent. Our scale lies in between these values.

We model the benefits from public income transfer programs using a specification suggested by Hubbard, Skinner and Zeldes (1995). The transfer that a household receives while working is given by $T = \max\{0, \underline{c} - [e + (1+r)a]\}$, whereas the transfer that the household will receive upon retiring is $T_R = \max\{0, \underline{c} - [SS(E_R) + DB(e_R) + (1+r)a]\}$. This transfer function guarantees a pre-tax income of $\underline{c}$, which we set based on parameters drawn from Moffitt (2002).[10] We assume through this formulation that earnings, retirement income, and assets reduce public benefits dollar for dollar.

We aggregate individual earnings histories into household earnings histories. Earnings expectations are a central influence on life-cycle consumption decisions, both directly and through their effects on expected pension and social security benefits. The household model of

[10]The $\underline{c}$ in the model reflects the consumption floor that is the result of all transfers (including, for example, SSI). Moffitt (2002) provides a consistent series for average benefits received by a family of four from 1960 to 1998. We assume that the parameters for years prior to 1960 and after 1998 are the same as the closest year for which we have data. We adjust (and verify) amounts for different family sizes using equivalence scales.

log earnings (and earnings expectations) is $\log e_j = \alpha^i + \beta_1 AGE_j + \beta_2 AGE_j^2 + u_j$, where $u_j = \rho u_{j-1} + \varepsilon_j$ and e_j is the observed earnings of the household *i* at age *j* in 2004-dollars, α^i is a household specific constant, AGE_j is age of the head of the household, u_j is an AR(1) error term of the earnings equation, and ε_j is a zero-mean i.i.d., normally distributed error term. The estimated parameters are α^i, β_1, β_2, ρ, and σ_ε. Mean (unadjusted) values are -0.29, 0.44, -0.006; 0.72; and 1.4 respectively.

We divide households into six groups according to marital status, education, and number of earners in the household, giving us six sets of household-group-specific parameters.[11] Estimates of the persistence parameters range from 0.69 for one-earner married couples without college degrees to 0.74 for married households with two earners, in which the highest earner has at least a college degree.

The specification for out-of-pocket medical expenses for retired households is given by

$$\log\ m_t = \beta_0 + \beta_1 AGE_t + \beta_2 AGE_t^2 + u_t,$$

$$u_t = \rho u_{t-1} + \varepsilon_t,\ \varepsilon_t \sim N(0, \sigma_\varepsilon^2),$$

where m_t is the household's out-of-pocket medical expenses at time *t* (the medical expenses are assumed to be $1 if the self-report is zero or if the household has not yet retired), AGE_t is age of the household head at time t, u_t is an AR(1) error term and ε_t is white-noise. The parameters to be estimated are β_0, β_1, β_2, ρ, and σ_ε. We estimate the medical-expense specification for four groups of households: (1) single without a college degree, (2) single with a college degree, (3)

[11] The six groups are (1) single without a college degree; (2) single with a college degree or more; (3) married, head without a college degree, one earner; (4) married, head without a college degree, two earners; (5) married, head with a college degree, one earner; and (6) married, head with a college degree, two earners. A respondent is an earner if his or her lifetime earnings are positive.

married without a college degree, and (4) married with a college degree, using eight waves of the HRS. They are available on request.

We solve the dynamic programming problem by linear interpolation on the value function. For each household in our sample we compute optimal decision rules for consumption (and hence asset accumulation) from the oldest possible age (D) to the beginning of working life (S) for any feasible realizations of the random variables: earnings, health shocks, and mortality. These decision rules differ for each household, since each faces stochastic draws from different earnings distributions (recall that the earning expectation parameter, α^i, is household specific). Household-specific earnings expectations also directly influence expectations about social security and pension benefits. Other characteristics also differ across households: for example, birth years of children affect the scale economies of a household at any given age (as determined by the equivalence scale). Consequently, it is not sufficient to solve the life-cycle problem for just a few household types.

Sample Restrictions

Our initial 2004 HRS sample has 8,513 households that match to social security earnings histories. As explained earlier, these earnings histories are a necessary input to our optimal wealth calculations. Besides requiring social security earnings data,[12] we make one additional strong sample restriction. In this paper we examine households in which the primary earner is retired (and the self-reported year of retirement is 2004 or earlier) and at least one adult in the household has at least 30 years of social security earnings. The resulting sample has 2,996 households.

[12] There is some, though limited, evidence from earlier HRS waves that those refusing to allow access to their social security earnings records do not differ in observable characteristics from those who do allow access. Haider and Solon (2000), for example, briefly examine selection issues that arise with the restricted earnings data from the original HRS cohort and conclude "As far as can be told from observable data, the HRS Social Security earnings sample seems to be reasonably representative."

There are two reasons for our sample restriction. Once we have calculated optimal wealth for retired households, it is straightforward (though computationally demanding) to calculate optimal wealth for households prior to retirement. Indeed, we have done so in other work. But these younger households are less useful in our effort to investigate optimal replacement rates, since they have additional years over which they will be accumulating wealth. Moreover, the years prior to retirement are, in many cases, high-saving years, since children are typically out of the house and earnings are often high, relative to their average lifetime levels. Consequently, replacement rates based on optimal wealth for non-retired households will be understated, since they fail to reflect the more-rapid than typical wealth accumulation between the time we observe households in the data and their retirement date. We could forecast earnings for households up to their expected date of retirement (indeed, the model requires households to have expectations over future earnings paths), but these earnings estimates may have substantial error. Instead, we take the simpler approach of simply dropping households if they are not retired.

For many of our calculations, we also require one adult in the households to have at least 30 years of earnings in the social security data. Our assumption is that those who do not meet this condition were much more likely than others to have some period of disability or other sources of income not covered by the social security system. Because we do not have information on transfer payments prior to 1992 (the first wave of the HRS) or on earnings outside the social security system, we will not have good measures of average or late-in-life earnings, and hence our replacement rate calculations will not accurately reflect household's circumstances.

IV. Replacement Rate Results

The model described above, applied to HRS data on family structure and earnings realizations, produces estimates of optimal wealth. Moreover, the earnings realizations and details on DB pensions yield expectations of Social Security and DB pension benefits. These benefits in the model are computed as annual values. When calculating optimal replacement rates, we use these *expected* values rather than their actual values since optimal (non-pension, non-social-security) wealth is computed given these expectations. Given the restricted earnings data from the Social Security administration, our estimates of Social Security benefits are quite accurate.

We annuitize optimal wealth (into annual values) using a standard formula for annuities $Flow = \frac{Stock * r}{(1+r)^{(T-t-1)}}$ where r is an annuitization factor (assumed to be 5 percent real), T is the expected date of death, drawn from life tables for men and for women, t is the year (in this case, 2004).[13] The numerator for the optimal replacement rate, therefore, is the flow value of annual income that can be drawn from the optimal stock of wealth plus expected annual Social Security and defined pension benefits.

The denominators of the replacement rate can be calculated in several different ways. We examine two. In the first, we take the sum of annual household earnings, divided by the maximum of a) the number of years between age 25 and the year of retirement (for the highest earner in the family),[14] or b) the number of years with positive household earnings. We consider the second possibility (total years of positive earnings) because there is clearly some measurement error in the self-reported retirement year, where individuals have years of

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[13] The life tables we use are at http://www.ssa.gov/OACT/STATS/table4c6.html.

[14] If age 25 occurs before 1951, we count the years between 1951 and the year of retirement, since we only have earnings data beginning in 1951.

substantial earnings after retirement. The median value of the first measure is $34,672, the average is $35,341, in real 2004 dollars. Average lifetime income is commonly used when calculating replacement rate targets.[15]

The second denominator corresponds to earnings in the last 5 years prior to retirement, though we make one modification. Typical age-earnings profiles in the HRS data begin falling as households get into their 50s. Moreover, it appears that some households ease into retirement, where earnings immediately prior to retirement fall substantially relative to their average annual levels. Consequently, we take the average of income in the ninth through fifth year prior to retirement. The specific five-year window does not matter much, as long as it is not closer to the actual retirement date. Its median value is $37,288, its mean value is $42,163, again in 2004 dollars.

Optimal retirement resources, of course, do not vary according to the denominator of the target replacement rate. The consequence of altering the denominator, therefore, is to scale the target downward when we use the average of 5 relatively high-earning years, compared to a target replacement rate calculated using average annual income.

We also emphasize that the appropriate treatment of housing is not an issue for this study. We are simply calculating the flow of resources, relative to average lifetime income (or relative to 5 high-earning years) that is needed to equate the discounted marginal utility of consumption over time. *How* households choose to finance that consumption – whether drawing on all, some, or no housing equity to do so – is a topic for another paper.

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[15] See, for example, Boskin and Shoven (1984), Munnell, Webb, and Delorme (2006), U.S. GAO (2007), Brady (2008).

Replacement Rate Results

The median optimal replacement rate target using average lifetime income in the denominator is 0.68, which is consistent with the common financial planning advice that target replacement rates lie between 70 and 85 percent. When the denominator is the average of five high years of income, the median replacement rate is 0.57.

Tables 1 through 3 show the simple bivariate relationship between our two replacement rate measures and household characteristics. In Table 1 we show the relationship between household lifetime earnings decile and optimal replacement rates. Because we restrict our analysis to household with at least 30 years of earnings, we drop many families that end up in the lowest and second lowest lifetime income deciles. Hence we combine the bottom three deciles in Table 1. The pattern with respect to average lifetime income (column 1), which we think are the easiest to interpret, is U-shaped. The optimal median target replacement rate in the bottom 3 deciles is 0.72. It then is 0.58 in decile 4 and rises monotonically with income to its maximum value of 0.76 in the highest lifetime income decile. As will be made clear in the next two descriptive tables, it is inappropriate to focus on the bivariate relationships, as they fail to account for several factors that should affect replacement rates. Put differently, we know, for example, that marital status will affect optimal replacement rates. Life expectancy will be longer for couples, particularly if the male has the highest earnings and is married to a younger woman. Marital status is strongly correlated with lifetime income.

Table 2 shows optimal replacement rates by marital status and educational attainment (of the person with the highest earnings in the household). The top panel shows the optimal median replacement rate for singles is 0.55, while it is 0.75 for married couples. Our result for married couples is nearly identical to the 0.72 result reported in Engen, Gale and Uccello (1999), which is also for married couples with employed husbands. The top panel of Table 2 highlights one major problem associated with conventional target replacement rate advice – single individuals can reasonably have lower optimal target replacement rates. They have lower consumption needs than a two-person household. They likely have a shorter planning horizon, since the expected lifespan of two people is longer than it is for one person, even with identical ages and characteristics.

The second panel of Table 2 shows a monotonically increasing set of optimal target replacement rates with educational attainment (the GED category is relatively uncommon in these data). Optimal target replacement rates increase from 0.57 to those with less than a high school degree to 0.90 for those with a college degree or more. As with the results in Table 1, education is surely correlated with other characteristics that will affect replacement rates, so it would be a mistake to over-interpret the Table 2 thresholds.

Table 3 shows the relationship between children and optimal target replacement rates. As emphasized in Scholz and Seshadri (2009) children are another factor that should affect optimal wealth accumulation. More resources will be needed to equate the discounted marginal utility of consumption in retirement for a married couple with no children compared to an otherwise identical married couple with four children, after the children have left the house. Table 3, however, shows a relatively constant pattern of optimal target replacement rates, except for a very low target replacement rate for households with no children. Again, like the qualifications that accompany the first two tables, the bivariate relationships are difficult to interpret.

The most important result from the first three tables is that there are substantial differences in optimal target replacement rates between single and married households.

A More Nuanced Look at Replacement Rates

The existing literature points to some reasons why we would expect to see variation in replacement rates in a lifecycle framework, even when there is no heterogeneity in preferences that might lead some households to be less willing than others, for example, to consume housing wealth. Replacement rates for a married couple need to be higher than for an otherwise identical single person, both because of couples' greater expected medical expenses in retirement and because of longer expected longevity for at least one partner.

Our discussion at the beginning of the paper repeated the commonly held view that replacement rates of low-income individuals and families would need to be higher than replacement rates for high-income individuals and families, because the reduction (relative to their levels during the working year) in saving and taxes in retirement would be smaller for low-income individuals and families.[16] These features are present in our model as well, and work in the commonly assumed direction. They are dwarfed, however, by two other considerations that have received less attention in the literature.

The first has to do with the pattern of federal taxes over time. It is well-known that federal marginal income tax rates have fallen sharply over time. Average tax rates also fell substantially over the years covered by our data (see, for example, http://www.taxpolicycenter.org/taxfacts/Content/PDF/family_inc_rates_hist.pdf). This reduction in average effective tax rates has a substantial effect on optimal replacement rates. Over the period we study, high-income households needed *lower* replacement rates to equate the discounted marginal utility of consumption over time than low-income households, because of their substantial reduction in average effective tax rates. Of course, the opposite point applies

[16] The magnitude of differences in work expenses between low- and high-income individuals and families is less clear to us. Work expenses are not included in our lifecycle model.

going forward: if one expects future taxes to rise, optimal target replacement rates for high-income households should reflect those expectations.

The second important consideration has to do with the timing of earnings shocks. Shocks to earnings have considerable persistence (as mentioned above, the persistence parameter is estimated to be around 0.7). Consequently, a household that gets a strong positive late-in-career earnings shock would be expected to have replacement rates that are higher than the average of pre-retirement earnings. Similarly, a negative late-in-career shock could cause living standards to be sharply revised downward in retirement. The pattern of earnings realizations is particularly important after the period when children leave the household. Children increase the consumption needs of the household: hence, households will do less retirement wealth accumulation when children are present than they otherwise would do. Earnings shocks from the late 40s to mid-to-late 50s can have a very substantial effect on optimal replacement rate targets.

Medical expenses can also push optimal target replacement rates up for high-income relative to low-income households. A "Medicaid-like" safety net program in the model covers medical expenses for families with health shocks and insufficient private wealth to cover them. Consequently, a low-income household need not accumulate to "self-insure" against out-of-pocket medical expenses. High-income households do self-insure.

These factors combine to result in a very wide range of optimal replacement rates. The 10th percentile target replacement rate is 0.23 using average lifetime income and is 0.20 using five high years of income. Households with very low optimal replacement rates are more likely to be single, have several children, and have negative late-in-career earnings shocks relative to other households. The 90th percentile replacement rate is 2.16 using average lifetime income and is

2.40 using five high years of income.[17] Households in this group are disproportionately likely to be low-income, married, have few children, and have substantial positive late-in-career earnings shocks relative to other households.

What is clear from this discussion is that the substantial variation in optimal target replacement rates presents a challenge for developing sensible replacement rate rules of thumb. Conventional advice may overstate optimal targets by a factor of two, or understate retirement consumption needs by a factor of three depending on the idiosyncratic experiences of households.

To look more closely at the factors that account for the variation in replacement rates, we estimate median regressions, separately for single and married households. We condition on the decile of the lifetime earnings distribution, leaving the bottom four deciles as the excluded category. We condition on cohort of the HRS, with 17 percent of the sample being in the AHEAD cohort, 18 percent in the Children of Depression Age cohort, 59 percent in the original HRS cohort, and the rest from the War Babies and Early Boomer cohorts (there are far fewer households from the latter groups because of our restriction that sample members must be retired). We also include age, gender of the highest earner in the household, indicator variables for race, educational attainment, and number of children (with 0 being the excluded category). We estimate quantile regression models (focusing on the median) to minimize the influence of outliers, given the dispersion discussed above.

Table 4 shows median regression estimates for married couples. There are several striking patterns in this table. First, optimal target replacement rates for married couples are substantially lower in the top 3 lifetime income deciles than they are in the first four deciles, conditioning on

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[17] Caution is needed in interpreting the high five-year income results since we mechanically choose the 9th to 5th years prior to retirement. If earnings were particularly low in those years, the optimal replacement rate will be inappropriately high.

education, race, children and other factors. This pattern is largely driven by the evolution of average effective tax rates experienced by high-income households in our sample. As average effective tax rates decline, all else being equal, high-income households need less to equate the discounted marginal utility of consumption across time.

The second strong correlation in Table 4 is the positive, significant coefficient on age. This is largely driven by the pattern of medical expenses observed in the data. Out-of-pocket medical expenses increase with age. Moreover, these shocks are persistent. Optimal wealth decumulation patterns will reflect this, and life-cycle households (particularly affluent ones) will preserve resources in order to maintain their discounted marginal utility of consumption, given (the higher) expected medical shocks. The positive coefficient on age reflects this phenomenon.

The third strong positive correlation is between the optimal target replacement rates and educational attainment (again conditioning on lifetime income decile, age, and other covariates). Education is correlated with two things that affect replacement rates. The most important is the pattern of earnings shocks. Conditioning on lifetime income decile and other characteristics, the likelihood of receiving a positive income shock is positively correlated with education. Thus, the high education types are more likely to get positive late-career income shocks (holding income decile constant) than those with lower educational attainment. Out-of-pocket medical expenses (and their expectation) also appear to be positively correlated with education.

Once we condition on age, there are no significant differences in replacement rate across HRS cohorts. Married couples where a female is the primary earner have lower optimal target replacement rates than couples where a male is the primary earner. Similarly, black couples have lower optimal target replacement rates. Both factors appear to be driven by patterns of late-career earnings realizations, though other factors related to household demographics and medical expense shocks also contribute to the result. But broadly speaking, these family types are more likely than others to receive negative late-career earnings shocks, which reduce target replacement rates.

In Scholz and Seshadri (2009) we provide a detailed analysis of how children affect optimal wealth accumulation. In addition to model-based results, we show reduced form regression evidence of the effects of children on observed wealth in the HRS data. Those regressions included a detailed set of household characteristics as well as individual earnings histories (and their square). In the more parsimonious specification shown in Table 4, children have an insignificant effect on replacement rates. Our earlier work shows that they matter. As noted earlier, households with many children would be expected to have lower optimal target replacement rates than households with fewer children, all else being equal. But households with many children may have larger positive late-career earnings shocks than others and may have younger partners, which would lead to higher optimal target replacement rates. The net effect of these considerations appears to offset one another when we fail to account for earnings realizations in a detailed way.

Table 5 shows similar results for singles. Incomes for singles are much lower than they are for couples, so few singles are in the top lifetime income deciles. Otherwise, the results for singles are very similar to those for married couples. The only important difference is that the sign on “gender” for the optimal target replacement rates flips and is positive and significant (when measured using average income). This is easily understood – females (coded as “2” while males are coded as “1”) have longer life expectancies and so, conditioning on lifetime income decile, age, education, and other characteristics, must have greater wealth to cover their longer expected lifetimes.

Online Financial Calculators

As documented in footnote 4, a number of online tools exist to help households assess the adequacy of their savings given a retirement income goal. Adequacy in this context is determined through a mechanical application of target replacement rates. The user provides basic financial information such as current income, level of current savings, the expected rate of return on this savings, expected age at retirement and estimates of Social Security benefits, pension income and life expectancy.

The final key input is the percentage of current income that the user would like to maintain in retirement. Typically the calculator provides a user-adjustable default replacement rate ranging from 70 percent (The CNN Money Retirement Planner) to 85 percent (Fidelity myPlan Retirement Quick Check). Besides providing a default value, there is no guidance about how to choose a target replacement rate or the factors upon which the target might depend.

The idea that a single target replacement rate is appropriate for all households is contrary to the implications of the augmented life-cycle model. The model implies that for a given income class, there is a distribution of optimal replacement rates that depend on factors often ignored by online calculators. For example, the savings requirements of two households with the same earnings profile, retirement age and life expectancy would be given an equivalent target by the online planning tools regardless of whether one household raised five children and other had none.

The second concern about online financial planning tools is the variance in target replacement rates. Since these targets are developed from rules of thumb, the user is left to their own judgment as to which calculator provides a more accurate goal. The difference in the final assessment between calculators can be significant. For example, consider an individual who is

50 years old in 2009, has an annual income of $55,000, who plans to retire at age 65 (in 2024) and live to the age of 87. Using the default replacement rate target of 85 percent, the Fidelity calculator would advise the individual to build up a nest-egg of $858,787 (in 2024 dollars). The CNN calculator, which uses a 70 percent default replacement rate target, indicates optimal wealth is $479,400 in 2024 dollars. The range of implied optimal savings is wide, leaving us to question whether the resulting advice is particularly useful.

V. Conclusions

We examine optimal target replacement rates for a sample of retired households from the Health and Retirement Study. The sample is restricted to those with at least 30 years of earnings. Our measure of optimal replacement rates comes from a life-cycle model that accounts for uncertainty in earnings, health shocks, and longevity. Crucial inputs for our calculations are earnings realizations, beginning as early as 1951, drawn from restricted access social security earnings records. Our calculations are made for 2004.

Common financial planning advice suggests target replacement rates should be between 0.65 to 0.90 of preretirement income. We find a median optimal target replacement rate of 0.75 for married couples (and 0.55 for singles). This similarity does not validate the commonly used rules of thumb, however. At most 15 percent of the households in our sample fall into the 0.65 to 0.90 range. Recall, our calculations indicate the amount of social security, DB pension, and other forms of wealth needed to equate the discounted marginal utility of consumption across time. When considering retirement saving adequacy, of course, errors of “oversaving” are perhaps less consequential than undersaving. But at least 48 percent of our sample have optimal target replacement rates below 0.65, the lower bound of the popular financial planning advice. While these households may be happy to hear that their financial futures might be brighter than conventional wisdom suggests, they may also feel anxiety or have foregone consumption that would increase their wellbeing.

A large number of factors will affect optimal target replacement rates. Optimal rates will be larger for couples than for singles. The evolution of average tax rates will have a substantial effect on optimal replacement rates. The reduction in average tax rates over the period we study, particularly for affluent households, implies that replacement rates for high-income households are lower than they otherwise would be absent the tax changes. Of course, if taxes increase in the future, replacement rates will need to reflect tax increases that will be borne by high-income households. Earnings shocks, particularly those incurred after children have left the household will also have substantial effects on optimal target replacement rates. Shocks to earnings are common and persistent, which makes durable rules of thumb difficult to formulate. Lastly, as shown in Scholz and Seshadri (2009), children will have a substantial effect on optimal replacement rates. Because fertility is so closely integrated with other factors that affect replacement rates, the effect of children in the simple correlations documented here are muted.

Given the range of factors affecting replacement rates and the varied experiences of typical households, we are skeptical of the value of common rule-of-thumb target replacement rates, such as those embodied in many web-based financial planning products. We recognize the value of financial education and further understand that the replacement rate is a simple, teachable concept. We nevertheless think more refined guidance is needed to serve households well. While we have not yet solved the problem of what should replace replacement rates, we hope this work is a first step in a more helpful direction.

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Table 1: Median Optimal Target Replacement Rates by Lifetime Income Decile

Lifetime Income Decile	RR Calculated Using Income: Averaged Over Lifetime	RR Calculated Using Income: Averaged Over Top 5 Earning Years
0 – 30%	0.72	0.73
30% – 40%	0.58	0.50
40% – 50%	0.59	0.56
50% – 60%	0.67	0.55
60% – 70%	0.67	0.59
70% – 80%	0.68	0.57
80% – 90%	0.73	0.61
90% – 100%	0.76	0.53
Population	0.68	0.57

Source: Authors' calculation from Health and Retirement Survey data.

Table 2: Median Optimal Target Replacement Rates by Marital Status and by Education

Marital status	RR Calculated Using Income: Averaged Over Lifetime	RR Calculated Using Income: Averaged Over Top 5 Earning Years
Married	0.75	0.66
Not Married	0.55	0.46
Educational Attainment		
Less Than High School	0.57	0.53
G.E.D.	0.64	0.60
High School Graduate	0.64	0.54
Some College	0.71	0.59
College and Above	0.90	0.67
Population	0.68	0.57

Source: Authors' calculation from Health and Retirement Survey data.

Table 3: Median Optimal Target Replacement Rates by Number of Children

Number of Children	RR Calculated Using Income: Averaged Over Lifetime	RR Calculated Using Income: Averaged Over Top 5 Earning Years
0 Children	0.47	0.43
1 Child	0.70	0.58
2 Children	0.74	0.61
3 Children	0.71	0.59
4 Children	0.63	0.54
5 Children	0.66	0.57
6 or More Children	0.70	0.59
Population	0.68	0.57

Source: Authors' calculation from Health and Retirement Survey data.

Table 4: Median Regression, Married Couples, 2004 HRS Data

Dependent Variable: Optimal Replacement Rate Calculated Using Income Averaged:	Over Lifetime	Over Top 5 Earning Years
Constant	-0.81*	-0.24
	(0.41)	(0.37)
Middle Lifetime Income Decile	-0.02	-0.02
	(0.09)	(0.13)
6th Lifetime Income Decile	-0.02	-0.02
	(0.09)	(0.14)
7th Lifetime Income Decile	-0.07	-0.12
	(0.09)	(0.12)
8th Lifetime Income Decile	-0.17**	-0.29***
	(0.08)	(0.11)
9th Lifetime Income Decile	-0.22***	-0.37***
	(0.08)	(0.1)
Top Lifetime Income Decile	-0.26***	-0.48***
	(0.08)	(0.1)
Children of Depression Age Cohort	-0.04	-0.14
	(0.11)	(0.1)
Original HRS Cohort	-0.12	-0.23**
	(0.1)	(0.1)
War Baby Cohort	-0.09	-0.31**
	(0.13)	(0.12)
Early Boomer Cohort	0.03	-0.16
	(0.16)	(0.15)
Age	0.02***	0.02***
	(0.004)	(0.004)
Gender (Female)	-0.14**	-0.11
	(0.06)	(0.07)
Black/African American	-0.21***	-0.19***
	(0.04)	(0.05)
Race: Other	-0.08	-0.15
	(0.13)	(0.1)
G.E.D.	0.02	0.13
	(0.07)	(0.08)
High School Graduate	0.09**	0.1**
	(0.05)	(0.04)
Some College	0.18***	0.15***
	(0.06)	(0.05)
College and Above	0.46***	0.34***
	(0.08)	(0.06)
1 Child	0.18	0.2*
	(0.11)	(0.12)
2 Children	0.14	0.13
	(0.09)	(0.1)
3 Children	0.14	0.1
	(0.09)	(0.1)
4 Children	0.09	0.09
	(0.09)	(0.1)
5 Children	0.1	0.12
	(0.09)	(0.1)
6 or More Children	0.1	0.09
	(0.09)	(0.1)
Observations	1783	1645
Pseduo R^2	0.06	0.04

Standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%

Table 5: Median Regression, Unmarried, 2004 HRS Data

Dependent Variable: Optimal Replacement Rate Calculated Using Income Averaged:	Over Lifetime	Over Top 5 Earning Years
Constant	-1.76***	-0.55
	(0.52)	(0.48)
Middle Lifetime Income Decile	-0.16***	-0.17***
	(0.05)	(0.05)
6th Lifetime Income Decile	-0.1*	-0.24***
	(0.05)	(0.05)
7th Lifetime Income Decile	-0.23***	-0.28***
	(0.06)	(0.06)
8th Lifetime Income Decile	-0.21***	-0.32***
	(0.08)	(0.06)
9th Lifetime Income Decile	-0.07	-0.21**
	(0.09)	(0.09)
Top Lifetime Income Decile	0.01	-0.23
	(0.18)	(0.18)
Children of Depression Age Cohort	0	-0.07
	(0.08)	(0.07)
Original HRS Cohort	0.11	-0.09
	(0.11)	(0.1)
War Baby Cohort	0.21	-0.06
	(0.16)	(0.15)
Early Boomer Cohort	0.34*	0.01
	(0.2)	(0.18)
Age	0.03***	0.02***
	(0.01)	(0.01)
Gender (Female)	0.16**	-0.01
	(0.04)	(0.04)
Black/African American	-0.1**	-0.11***
	(0.04)	(0.04)
Race: Other	0.04	0
	(0.13)	(0.09)
G.E.D.	0.01	-0.06
	(0.08)	(0.07)
High School Graduate	0.14***	0.08**
	(0.05)	(0.04)
Some College	0.19***	0.11**
	(0.07)	(0.05)
College and Above	0.25***	0.15***
	(0.07)	(0.05)
1 Child	0.09	0.1
	(0.06)	(0.06)
2 Children	0.14**	0.07
	(0.06)	(0.05)
3 Children	0.18***	0.04
	(0.06)	(0.05)
4 Children	0.04	-0.02
	(0.06)	(0.06)
5 Children	0.16*	0.05
	(0.09)	(0.08)
6 or More Children	0.15*	0.06
	(0.08)	(0.09)
Observations	1211	1123
Pseduo R^2	0.07	0.02

Standard errors in parentheses. * significant at 10%, ** significant at 5%, *** significant at 1%