Income Replacement Ratios in the Health and Retirement Study

by Patrick J. Purcell*

This article describes the income replacement ratio as a measure of retirement income adequacy and identifies several issues analysts must consider when calculating a replacement ratio. The article presents the income replacement ratios experienced by participants in the original sample cohort of the Health and Retirement Study (HRS), who were born between 1931 and 1941. Replacement ratios are shown by the respondent's birth cohort, age when first classified as retired in the HRS, and preretirement income quartile. Median replacement ratios fall as the retirement period grows longer.

Introduction

Income typically falls in retirement, and the timing and extent of that decline concerns policymakers. Social Security benefits and the tax preferences granted to pensions and retirement savings plans represent a substantial commitment of the nation's economic resources to assuring that retirees can maintain a satisfactory standard of living. If income from Social Security, pensions, and savings do not allow retirees to maintain their preretirement standard of living (or a slightly more modest one), they will face difficult and perhaps unexpected choices about reducing or eliminating certain kinds of expenditures. Some retirees might become more dependent on their adult children for financial support. Others might apply for means-tested benefits, placing further strains on a federal budget that already runs substantial annual deficits.

Assessing the adequacy of retirement income is necessarily a subjective process. The federal poverty threshold provides one measure of income adequacy. However, because its primary purpose is to determine eligibility for means-tested benefit programs, the poverty threshold represents only a minimally adequate income.[1] Although the poverty threshold—or a multiple of the threshold—is a useful benchmark for some income analyses, retirement income is more typically viewed in terms of how it compares with income before retirement. Financial advisors often suggest that near-retirees should estimate the fraction of preretirement income they will need to be reasonably comfortable and independent in retirement.

The income replacement ratio—retirement income expressed as a percentage of preretirement income—has become a familiar metric among financial planners and economists for assessing the adequacy of retirement income. If the ratio exceeds a given target, an individual or couple is likely to have enough income to maintain the preretirement standard of living. Exactly what this target ratio should be, however, and which measures of income to include in calculating the ratio, continue to be debated.

The proportion of preretirement income needed to maintain one's standard of living in retirement varies

Selected Abbreviations

CPI-U	Consumer Price Index for all Urban Consumers
HRS	Health and Retirement Study
MINT	Modeling Income in the Near Term
SSA	Social Security Administration

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according to individual circumstances. Lower-income workers typically need a higher replacement ratio than average-income workers because they spend a higher proportion of their income on necessities such as food, clothing, housing, transportation, and medical care. Higher-income workers, too, may need higher replacement ratios to maintain their preretirement standard of living, especially if their retirement plans include substantial spending on recreation and leisure activities. For some households, a replacement ratio of 65 percent may be adequate, while others may require a replacement ratio of 90 percent or more to maintain their desired standard of living. Of course, before one can evaluate the adequacy of any income replacement ratio, it is essential to know which sources of retirement income and preretirement income—the numerator and denominator of the ratio, respectively—will be used to construct the ratio.

Although the income replacement ratio is a relatively simple concept, it can be difficult to construct. For example, because hours of work and total annual earnings can change from year to year, the preretirement income component ideally should reflect average annual income over several years. Financial planners typically focus on the replacement ratio for an individual client, but economists are more interested in the range of replacement ratios across the population and in the mean or median values that indicate the typical replacement ratio among retirees.

Estimating the mean or median income replacement ratio among current retirees requires collecting income data for a representative sample of individuals over a period long enough to approximate their typical preretirement and retirement incomes. Income data from the Health and Retirement Study (HRS) meet those requirements. The HRS is conducted among a representative sample of Americans aged 51 or older, and it collects comprehensive income data from survey participants every 2 years.

This article estimates income replacement ratios for members of the original sample cohort of the HRS, who were born between 1931 and 1941. The members of the original HRS cohort were first interviewed in 1992. The data analyzed for this article are from HRS interviews through the ninth wave of the survey, which was fielded in 2008. Replacement ratios are shown for all HRS respondents who worked full-time (or worked part-time and were not retired) in three consecutive waves of the survey, and whose retirement income was observed in at least one subsequent wave of the survey.[2] Before presenting estimated replacement ratios for retirees in the HRS, the article describes some of the most important issues that arise when calculating a ratio. After discussing these theoretical and practical considerations, replacement ratios are calculated using four alternative measures of retirement income:

1. Household income;
2. Shared household income;
3. Shared household income plus the potential income from using 80 percent of nonhousing financial assets to purchase an annuity; and
4. Shared household income plus the potential income from using 80 percent of all financial assets (including home equity) to purchase an annuity.

Replacement ratios based on shared household income are then analyzed by retiree birth cohort, age at retirement, and preretirement income quartile. A regression analysis then examines the effects of selected demographic and economic variables. The article concludes with a summary of findings and a brief discussion of policy issues.

Constructing an Income Replacement Ratio

Thirty years ago, Alan Fox of the Social Security Administration (SSA) noted that "at first glance, the concept of an earnings replacement rate is simple: it is the ratio of retirement benefits to preretirement earnings. This change approximates the change in living standards at retirement, since for most persons earnings are the primary source of preretirement income, while pension benefits are the primary income source after retirement" (Fox 1982). Constructing an income replacement ratio, however, raises a number of questions. As Fox stated, "debate can arise over virtually every aspect of the replacement rate calculation." For example:

- Which years of income should be included in the denominator?
- Should preretirement income be in nominal dollars, or be price-indexed or wage-indexed to a particular year?
- Should preretirement and retirement income be measured before or after taxes?

Earnings are the largest source of preretirement income for most people. For some purposes, a replacement ratio might include only preretirement earnings in the denominator and pensions and Social Security benefits in the numerator. An *earnings* replacement ratio such as this is especially useful for assessing the

adequacy of income from pensions and Social Security and for illustrating any shortfall that must be filled by savings or other sources of retirement income. Nevertheless, many households have multiple sources of income before and after retirement. Some people work part-time for several years after they retire from full-time employment; for them, earnings continue to be an important source of income. To include only earnings in the denominator of the replacement ratio and only pensions and Social Security benefits in the numerator would give an incomplete picture of the change in total income that follows retirement. In order to provide a comprehensive view of how income changes after retirement, the replacement ratios constructed for this article include all sources of income both before and after retirement, as reported in the HRS.

The Denominator: Preretirement Income

The analyst's judgment and the goal of his or her research play a large role in determining which sources of preretirement income to include in the replacement ratio, and for what period to measure that income. Because this article aims to estimate total income in retirement as a ratio of total income before retirement, all sources of preretirement income are included in the denominator. Nevertheless, because earnings are the largest source of preretirement income for most workers, it is especially important for the replacement ratio to represent a worker's preretirement earnings accurately.

Earnings in the final year of work may not reflect typical earnings because many people cut back on hours of work just before retirement.[3] Like final-year earnings, peak-year earnings may not be representative of a worker's preretirement earnings. For many families, annual earnings peak in the same years that they are paying for their children's college education, boosting their savings rate to prepare for retirement, or both. If workers save a substantial amount of their peak earnings or spend it on their children, peak-year earnings may overstate the income they will need in retirement to maintain their accustomed standard of living.[4]

An annual average of earnings over several years before retirement, rather than final-year earnings, peak-year earnings, or earnings in any single year may be most representative of preretirement earnings. To calculate Social Security replacement ratios for newly retired workers, Grad (1990) averaged workers' earnings over the 5 years prior to claiming Social Security benefits. Scholz and Seshadri (2009), using data from the HRS, included the average of earnings and other income in the ninth through fifth years preceding retirement in the denominator of their income replacement ratio.

Every 2 years, HRS respondents are surveyed about their income in the calendar year preceding the interview. In this article, the preretirement income in the denominator of the replacement ratio is the average of total annual individual or shared couple income in the three waves before retirement. Whether respondents are identified as retired depends on their answers to several questions about their labor force participation. Workers with wage, salary, or self-employment income are classified as retired if they were not working full-time and reported that they considered themselves fully or partly retired.

Indexed or Nominal Income?

One can measure preretirement income in nominal dollars or index it to a particular year, such as the year for which retirement income is counted. Economists often use a price index so that incomes from different years reflect relative purchasing power. Alternatively, some analysts index past earnings to the present using a wage index.[5] For example, Social Security bases retired-worker benefits on the worker's earnings through age 60 indexed to national average wages (earnings after age 60 are counted in nominal dollars). For purposes other than calculating Social Security benefits, however, past earnings are more commonly indexed to prices.[6,7] This article indexes income to 2007 dollars using the Consumer Price Index for all Urban Consumers (CPI-U).

Pretax or After-tax Income?

Analysts also question whether preretirement and retirement income should be measured before or after income taxes have been subtracted. After-tax income may be the more appropriate measure because that is the amount actually available for consumption. Average tax rates usually are lower after retirement, both because income typically is lower and because Social Security and some pensions are taxed at lower rates than are wages and salaries. Therefore, a replacement ratio computed on after-tax income will be higher than one based on pretax income. Smith (2003) estimated that for a median-income household, a replacement ratio computed on after-tax income would be about 20 percent higher than one computed on pretax income. He also noted, however, that data on after-tax income are not widely available. Most household surveys inquire about income before taxes, so studies of income replacement ratios usually measure pretax income.[8] The replacement

ratios estimated for this article are based on the pretax incomes that respondents reported in the HRS.

When Does Retirement Begin?

Constructing an income replacement ratio requires the analyst to determine when a person has retired. This can be difficult, because paid employment does not always end as soon as retirement begins. Munnell and Soto (2005a) observe that because many people who leave full-time employment continue to work part-time for several years before permanently retiring from paid employment, "it is often impossible to define precisely the work/retirement divide."

Because of the difficulty of determining the exact point when retirement begins, some analysts have defined retirement as beginning in the year that an individual first receives Social Security benefits. Others have calculated replacement ratios for subjects at age 67 or 70, by which time most people have retired.[9] This article defines work and retirement according to a methodology developed by the analysts who produced public-use files containing HRS data. The variable that summarizes an HRS respondent's labor force status is described in the methods section of the article.

The Numerator: Retirement Income

Depending on the specific research objectives, the replacement ratio's retirement income component might be limited to pensions and Social Security, or it might be a more comprehensive measure. In this article, both the numerator and the denominator of the replacement ratio represent total household income, as reported in the HRS. This broad definition presents the most complete picture of the change in income that occurs when a worker retires. Retirement income is observed for each wave (through wave 9) in which a respondent was classified as retired in the HRS. Estimating replacement ratios for successive waves of the survey revealed how the ratios changed as the retirement period elapsed. One key finding is that replacement ratios tend to fall in the first several years of retirement. Therefore, replacement ratios observed shortly after retirement might not indicate retirees' longer-term income security.

Previous Research

Over the past 30 years, many economists have studied income replacement ratios using both administrative data and household surveys.[10] A number of studies have estimated the proportion of preretirement income replaced by Social Security benefits (Fox 1979, 1982; Grad 1990; Mitchell and Phillips 2006; Biggs and Springstead 2008). Some analysts have calculated replacement ratios based on both Social Security benefits and pension income (Fox 1982; Grad 1990). A few studies have estimated total income replacement ratios; those ratios attempt to account for all sources of income before and after retirement. However, comparing replacement ratios across studies, even conceptually similar ratios, is difficult because of differences in data and methods.

Estimates of Total Income Replacement Ratios

Butrica, Smith, and Iams (2012) estimated amounts and sources of income at age 67 using the SSA's Modeling Income in the Near Term (MINT) model, which matches Social Security earnings records to results of the Census Bureau's Survey of Income and Program Participation. The authors calculated two replacement ratios based on earnings from ages 22 through 67, with couples sharing earnings in the years they were married. For the first ratio, shared earnings were wage-indexed to age 67; for the second ratio, shared earnings were price-indexed to age 67. For wage-indexed earnings, the authors estimated that the median replacement ratio at age 67 would fall from 95 percent for persons born 1926–1935 to 84 percent for those born 1966–1975. For price-indexed earnings, they estimated that median replacement ratios at age 67 would be nearly the same for the 1926–1935 birth cohort (109 percent) and the 1966–1975 birth cohort (110 percent).

Biggs and Springstead (2008) used MINT data to estimate replacement ratios for individuals aged 64–66 in 2005. Using wage-indexed career-average earnings, they estimated a median total income replacement ratio of 106 percent.

Smith (2003) used data from both the Current Population Survey and the Panel Study of Income Dynamics to estimate total income replacement ratios over the period 1977–1999. He estimated that the average pretax income replacement ratio at age 70 fell from 67 percent in 1977 to 60 percent in 1981 before steadily increasing to 74 percent in 1999. He also estimated that after-tax replacement ratios would be about 20 percent higher than pretax replacement ratios for an average earner.

Munnell and Soto (2005a) used HRS data to estimate replacement ratios based on all sources of income, including imputed rent for homeowners. They found that using a comprehensive measure of income both before and after retirement resulted in average replacement ratios of career-average earnings of 79 percent for couples and 89 percent for single persons. Among those without pensions, replacement ratios were 62 percent

for couples and 63 percent for singles. Replacement ratios based on the highest 5 years of earnings among the last 10 years were about 15 percentage points lower than were those based on career average earnings.

Total Household Income and Shared Household Income

People aging into their late 50s and beyond are likely to experience certain events that could reduce household income. Two such events are retirement—of either the worker or his or her spouse—and the spouse's death. As Smith (2003) observed, "the most salient demographic change between preretirement and postretirement years is changing marital status—largely a consequence of increasing mortality rates with age." Household income also tends to decline as individuals age because they eventually leave the workforce. Many retirees continue to work part-time for a few years, but almost all eventually completely retire from paid employment. In addition, some time after retiring, many people begin to spend the savings that provided them with interest or dividend income. All of those factors—mortality among household members, departure from paid employment, and reduction in income-producing assets—can cause household income to fall. On the other hand, the total income available to the surviving member of a married couple may be more than one-half of the amount that the couple received when both spouses were alive. The shared income of a married couple—their total income divided by two—will often decline by a smaller percentage than total household income upon the death of a spouse. Thus, shared income better approximates the income available to each household member than total income (Getzen 2010). For that reason, after Table 1 presents comparative replacement ratios for both total household income and shared income, subsequent tables focus solely on shared income.

Can Home Equity Provide Retirement Income?

Homeowners who have paid off their mortgages, and thus own their homes outright, benefit from in-kind income in the form of imputed rent—the amount they would have to pay in rent or mortgage payments if they did not own their homes. Some economists have argued that measures of retirement income should include the value of imputed rent realized by homeowners (Munnell and Soto 2005c). If one counts imputed rent as income, it should be included in both the numerator and the denominator of the replacement ratio because homeowners realize imputed rent both before and after retirement.

Estimated values of imputed rent are "very sensitive to the assumption about the rate of appreciation in home prices and rents and the [interest] rate used to discount future rents back to the present" (Munnell and Soto 2005a). That sensitivity is problematic because the period studied in this article included a substantial runup in home prices from the late 1990s through 2006, followed by an unprecedented crash in home prices over the next 2 years.[11] In addition, this period saw long-term interest rates fall to their lowest levels since the 1950s, a condition that may not be sustained if large federal budget deficits eventually begin to exert upward pressure.[12] Consequently, estimates of imputed rent based on recent experience would be highly uncertain. For those reasons, the replacement ratios calculated for this article omit imputed rent.

Homeowners also have the option to convert equity in their homes to income through a reverse mortgage or by selling their homes and using the proceeds to purchase annuities. To date, however, reverse mortgages remain relatively uncommon among retirees, and most retired homeowners remain in their homes rather than "downsizing" to an apartment, at least until advanced age or the death of a spouse makes keeping a house too burdensome.[13] Nevertheless, home equity is an important *potential* source of retirement income. Homeowners who convert their equity into income could achieve higher replacement ratios than renters with the same cash income but no home equity. To illustrate the potential contribution of financial assets and home equity to retirement income, Table 1 includes replacement ratio estimates respectively assuming the use of 80 percent of nonhousing assets and 80 percent of all household assets (including home equity) to purchase an immediate annuity. As noted above, home prices were unusually volatile during 1998–2008, rising swiftly until 2006 and then dropping sharply. Therefore, the estimated replacement ratio effects of annuitizing financial assets including home equity should be interpreted cautiously.

Individual, Family, or Household Income?

Replacement ratio calculations can be based on individual income, family income, or household income. The HRS reports individual income for the respondent and his or her spouse. "Household income" in the HRS is the combined income of married couples, omitting the income of other household members. Panel A of Table 1 shows replacement ratios based on the HRS concept of household income, and panel B shows replacement ratios based on shared income, defined as one-half of the combined income of married couples

while both spouses are alive. If the respondent's spouse dies during the year, all remaining household income is attributed to the respondent for that year. Replacement ratios are based on individual income for unmarried respondents and on shared income for couples because when a spouse dies, household income typically declines by less than half. Using total household income rather than shared income for married couples would tend to overstate the decline in the replacement ratio that occurs with the death of a spouse.[14]

Present Analysis

This article extends previous work on replacement ratios in several respects. First, it uses the most recent available HRS data to calculate replacement ratios for recent retiree cohorts. Second, it exploits the longitudinal design of the HRS to produce estimates of replacement ratios for as many as 5 of the first 10 years of retirement (multiple observations of retirement income reveal how replacement ratios change over time). Third, it estimates the replacement ratio effect of using financial assets and home equity to purchase annuities at the time of retirement. Finally, multivariate analysis examines how birth cohort, age when first classified as retired, year when first classified as retired, and relative position in the preretirement income distribution are related to first-year total income replacement ratios.

What is an Adequate Replacement Ratio?

Opinions vary on how high the replacement ratio must be to provide a retirement standard of living that compares with the preretirement level. Differing expectations about health care expenses, travel and leisure activities, housing arrangements, and financial support of family members may mean that two households with the same preretirement income will have different income requirements in retirement. Most analysts agree, however, that people "need less than their full preretirement income to maintain their standard of living once they stop working" (Munnell and Soto 2005a). There are at least three reasons why households need less income in retirement:

1. Income taxes are lower after retirement because income is typically lower, and because some sources of retirement income, such as Social Security benefits, are taxed at lower rates than earnings.
2. Retirees no longer need to save for retirement or, usually, for their children's education.
3. Work-related expenses are substantially reduced or eliminated altogether.

How much less income retirees need to maintain their standard of living will vary from household to household. Munnell and Soto (2005b) noted that "the range of studies that have examined this issue consistently find that middle class people need between 65 and 75 percent of their preretirement earnings to maintain their life style once they stop working." According to Scholz and Seshadri (2009), "typical advice suggests that replacement rates should be 70 to 85 percent of preretirement income."[15]

Lower-income households typically need higher replacement ratios than middle-income households because they spend a larger proportion of their incomes on necessities. Higher-income households, too, might need higher replacement ratios than middle-income households if they expect to spend substantial sums on recreation and leisure activities. For any given household, however, these generalizations may not hold.

The Data

This article analyzes data from the HRS, a nationally representative survey of Americans aged 51 or older, first fielded in 1992. The University of Michigan's Institute for Social Research developed the HRS with support from the National Institute on Aging and the SSA. Survey participants provide information about their employment, income, assets, pension plans, health insurance, disabilities, physical health, cognitive functioning, and health care expenditures. Respondents are interviewed every 2 years. This study uses data collected from the original HRS sample cohort, whose members were born in 1931–1941, in interviews from wave 1 (fielded in 1992) through wave 9 (2008). The original HRS sample includes 10,376 respondents, of whom 9,814 participated in the first wave of the survey in 1992.[16] Replacement ratios were estimated only for the 2,194 respondents who were observed to be working full-time, or were working part-time and not retired, in at least three consecutive waves of the HRS before the first wave in which they were classified as retired. Because the timing of retirement is crucial to this analysis, the terms "retired" and "retirement" refer specifically and exclusively to the period beginning with the first interview (or wave) in which a respondent is observed (or classified) as retired in the HRS.

In cooperation with the SSA and the National Institute on Aging, the RAND Corporation has produced public-use files that include much of the data collected through the HRS in a format that is easily accessible to researchers and policy analysts. This article is based on the author's analysis of data in the RAND HRS files.[17]

The HRS reports income individually for the respondent and his or her spouse and in total for married couples. In the HRS, household income comprises individual income only for unmarried respondents and the combined income of both spouses in married-couple households; any income of other household members is excluded. The HRS collects information on money income from almost all sources, including earnings; public and private pensions and annuities; unemployment benefits; workers' compensation; veteran's benefits; cash welfare benefits, such as Supplemental Security Income; Social Security benefits; business or farm income; self-employment income; dividends, interest, rent, royalties, and other asset income; alimony; lump sums from insurance, pensions, or inheritances; and income from annuities and regular withdrawals from individual retirement accounts. Income reported on the HRS also includes the cash value of benefits received through the Supplemental Nutrition Assistance Program, formerly the food stamp program. HRS income does not include transfers received from family or friends outside the household or realized capital gains from the sale of stocks, bonds, and other assets.

HRS respondents report income for the calendar year preceding the interview. All income values in this article are indexed to 2007 dollars based on the annual percentage change in the CPI-U. Observations have been weighted using HRS sample weights and are representative of the civilian noninstitutionalized population born in 1931–1941.

Methods

Because the analysis focuses on the change in total income at retirement, the sample was limited to respondents who made the transition from work to retirement after the HRS began. In the original HRS cohort, 5,365 respondents worked in at least one of the first eight waves and were retired in at least one later wave. Because an income replacement ratio should be based on a representative measure of preretirement income, ratios were estimated only for the 2,194 respondents who were observed to be working full-time, or working part-time and not retired, in at least three consecutive HRS waves before the first wave in which they were retired. For members of that sample, replacement ratios were estimated for each wave in which the respondent was retired. For a respondent who worked full-time or part-time in each of the first three waves and reported that he or she was retired in each later wave, retirement income was observed in up to five waves.[18] Respondents' labor force status in each wave was determined by the value of the variable RwLBRF in the RAND HRS data set. RAND derived this variable from respondents' replies to questions about paid employment, disability, and retirement status. In each wave, the respondent was classified as either:

1. working full-time,
2. working part-time,
3. unemployed,
4. partly retired,
5. retired,
6. disabled, or
7. not in the labor force.

In cases of an individual working for pay and also reporting being fully or partly retired, RAND used answers to multiple questions to classify the respondent's labor force status. According to the RAND HRS documentation,

> A respondent can give evidence of working, being retired, and disability alone or in combination with other statuses. RwLBRF attempts to pull information from several sources, and sort through the discrepancies. Working and retirement take precedence in its derivation. If the respondent is working full-time, RwLBRF is set to this status. If he/she is working part-time and mentions retirement, RwLBRF is set to partly retired. If there is no mention of retirement, RwLBRF is set to working part-time. If the respondent is not working but is looking for a full-time job, RwLBRF is set to unemployed. If he/she is looking for a part-time job and mentions retirement, RwLBRF is set to partly retired. If looking for a part-time job and there is no mention of retirement, RwLBRF is set to unemployed. If the respondent is not working and not looking and there is any mention of retirement, RwLBRF is set to retired. If retirement is not mentioned and a disabled employment status is given, RwLBRF is set to disabled. Otherwise, RwLBRF is set to "not in the labor force" (St. Clair and others 2010, 965).[19]

As noted earlier, replacement ratios were estimated only for respondents who were observed to be working full-time, or working part-time and not retired, in at least three consecutive waves before the first wave in which they were retired. Retirement income

was observed in up to five waves for 2,194 HRS respondents, yielding 6,599 observations of annual retirement income, or an average of 3.0 observations per respondent.[20]

For this analysis, preretirement income consists of income observed from all sources in the last three HRS waves in which the respondent worked full-time or worked part-time and was not retired. Because the survey took place every 2 years, these observations in most cases represent 3 of the last 6 years of preretirement income. For example, for a respondent who was employed full-time in the first three HRS waves (1992, 1994, and 1996) and retired in the fourth wave (1998), preretirement income is the average of the respondent's income in 1991, 1993, and 1995 because the HRS asks about income in the year preceding the interview. In some cases, the income reported in the respondent's first wave as a retiree included income from the last year of full-time employment. For instance, if a respondent reported working full-time in wave 4 (1998) and was retired in wave 5 (2000), the income reported in wave 5 (for 1999) could have been from a full year of full-time employment, a partial year of full-time employment followed by retirement, or a full year of retirement. For that reason, 1999 was not counted as a retirement year—and no replacement ratio was calculated—if the respondent reported that he or she worked that year. Instead, to reduce the likelihood of counting income from the last year of full-time work as retirement income during the respondent's first retirement wave, that worker's replacement ratio calculations began with HRS wave 6. Ratios were then estimated for all later waves in which that respondent continued to be retired.

In each interview, HRS respondents report their current labor force status and their income in the year before the interview. A respondent who was not retired in wave *N* and who was retired in wave *N+1* may or may not have been retired in the year between the two waves. Thus, the year of the wave *N+1* interview could have been the respondent's first or second year of retirement. Therefore, in the tables, years of retirement are labeled as "first or second year," "third or fourth year," and so on.

Results

Table 1 shows income replacement ratios at the 75th, 50th (median), and 25th percentiles for members of the original HRS cohort who worked in at least three consecutive waves and were retired in at least one subsequent wave. In panel A, the numerator of the replacement ratio is real total household income in a

Table 1.
Replacement ratios by percentile and year in retirement: Four measures of retirement income

Percentile	First or second year	Third or fourth year	Fifth or sixth year	Seventh or eighth year	Ninth or tenth year
			Panel A: Total household income		
75th	1.013	0.884	0.839	0.789	0.787
Median	0.733	0.635	0.599	0.555	0.537
25th	0.480	0.424	0.401	0.402	0.393
			Panel B: Shared household income		
75th	1.033	0.895	0.855	0.807	0.807
Median	0.735	0.646	0.607	0.580	0.576
25th	0.485	0.433	0.414	0.413	0.408
			Panel C: Shared household income plus annuitized value of nonhousing assets		
75th	1.288	1.155	1.117	1.053	1.052
Median	0.900	0.799	0.774	0.754	0.738
25th	0.610	0.569	0.552	0.545	0.547
			Panel D: Shared household income plus annuitized value of all assets		
75th	1.413	1.281	1.255	1.193	1.207
Median	0.997	0.890	0.869	0.820	0.829
25th	0.679	0.631	0.622	0.627	0.605

SOURCE: Author's calculations using HRS.

NOTE: Ratios are based on CPI-U 2007 dollars.

given year of retirement, and the denominator is the average of preretirement total household income in the three HRS waves before the respondent's first wave of retirement. In panels B, C, and D, the numerator and denominator reflect individual income for unmarried respondents and shared income for married respondents. The replacement ratio in panel C indicates the retirement income effect of using 80 percent of the respondent's household financial assets (excluding home equity) to purchase an annuity. Panel D shows the retirement income effect of using 80 percent of all of the respondent's household financial assets, including home equity, to purchase an annuity.

Panel A shows that the median replacement ratio for total income in the first or second year of retirement was 0.733. One-fourth of households had replacement ratios of 1.013 or higher and one-fourth had replacement ratios of 0.480 or less. Panel A also illustrates how replacement ratios fell over time, especially during the first 7 to 8 years of retirement. The median replacement ratio fell to 0.635 in the third or fourth year of retirement, to 0.599 in the fifth or sixth year, and to 0.555 in the seventh or eighth year. The sharp decline from 0.733 to 0.555 over the first four 2-year intervals of retirement may reflect conditions that are more likely to occur in the earlier years of retirement than in later years. Such conditions could include receipt of lump-sum pension settlements upon retirement, working part-time or working more hours part-time in the first few years of retirement, and the timing of a spouse's retirement relative to the respondent's date of retirement. It is also possible that income from the last year of full-time employment is mistakenly attributed to income in the first wave of retirement in some cases, despite the methodological precaution mentioned earlier.

Results for panel B, in which income of unmarried people is attributed solely to the individual respondent but the income of married respondents is one-half of the couple's income, are similar to those in panel A. Panel B's slightly higher median values in years seven and eight and years nine and ten of retirement do not differ significantly from those in panel A. One reason that replacement ratios for shared income resemble those for total household income even after several years of retirement is that, although household income usually falls after the death of a spouse, it typically falls by less than one-half.

Panel C shows that income replacement ratios (based on shared income for married respondents) would increase if the respondent used 80 percent of the household's nonhousing assets to purchase an immediate income annuity upon retirement. Single respondents were assumed to purchase a level, single-life annuity and married respondents were assumed to purchase a level, joint and survivor annuity with a 100-percent survivor benefit.[21] Because assets used to purchase annuities would no longer generate interest and dividends, the increase in income generated by using 80 percent of nonfinancial assets to buy an annuity was offset in part by a proportional reduction in interest and dividend income. If all of the households in this sample had used 80 percent of their nonhousing assets to purchase income annuities, their median replacement ratios would have been about 15 to 17 percentage points higher, on average, than those in panel B over the first 10 years of retirement.

Home equity is another potential source of retirement income for the four-fifths of US householders aged 65 or older who own their homes (Census Bureau 2012a, Table 15). For many, the equity in their homes is the most valuable asset that they own.[22] Panel D shows the replacement ratio effect of using 80 percent of home equity in addition to 80 percent of household nonhousing assets to purchase immediate annuities. Doing so would raise median replacement ratios over each of the first five HRS waves of retirement to levels about 24 to 26 percentage points higher than those in panel B. Nevertheless, pretax income replacement ratios at the 25th percentile, even using 80 percent of all assets (including home equity) to purchase annuities, would range from just 60 percent to 68 percent.

Most of the median replacement ratios in panels A and B of Table 1 are lower than the minimum ratio of 70 percent that financial planners often recommend. As noted earlier, however, these replacement ratios are based on pretax income. Smith (2003) estimated that for a median-income household, replacement ratios calculated on after-tax income would be about 20 percent higher than ratios based on pretax income. Applying that estimate to panel B would raise the median ratios from 0.735 to 0.882 in the first or second year of retirement and from 0.537 to 0.691 in the ninth or tenth year of retirement.

In both panels A and B, replacement ratios at the 75th percentile exceeded 100 percent in the first or second year of retirement, but fell by 15 to 16 percentage points by the fifth or sixth year of retirement. On an after-tax basis, however, even the lowest replacement ratio at the 75th percentile in panel A (0.787 in the ninth or tenth year of retirement) would be equivalent to a replacement ratio of 0.944. On the other hand, at the 25th percentile, the average replacement ratios over the

observed years of retirement in panels A and B ranged from 0.393 to 0.485. Even after adjusting for taxes, those ratios ranged only from 0.472 to 0.582. Thus, at least one-quarter of retirees had real after-tax income in retirement that was less than 60 percent of their average income in the last several years of full-time work.

Replacement Ratios by Birth Cohort

Because of differences in lifetime earnings, replacement ratios might differ by birth cohort. Table 2 shows replacement ratios separately for HRS respondents born in the 6 years from 1931 through 1936 and those born in the 5 years from 1937 through 1941. The earlier cohort would have entered the labor force mainly in the early to mid-1950s, while most of the later cohort would have entered the labor force in the late 1950s and early 1960s. Both groups would have experienced the rapid growth in incomes of the 1960s and the "stagflation" era of the 1970s during the first half of their careers. However, members of the earlier cohort reached retirement age during 1993–2001—boom years for the economy and the stock market—and members of the later cohort did so during 1999–2006.[23] The latter period included the peak of the "tech bubble" on Wall Street and the decline in stock market values and slower growth in household incomes that followed the collapse of tech stocks. Income replacement ratios for these cohorts might differ because of the differing economic conditions when each group reached retirement age.

Median replacement ratios for retirees born 1931–1936 were higher than those of the 1937–1941 cohort. The difference—about 3 percentage points over the first 10 years of retirement, on average—is not statistically significant. At the 75th percentile, replacement ratios of the earlier cohort ranged from 1.052 in the first or second year of retirement to 0.830 in the ninth or tenth year of retirement. Among the later cohort, replacement ratios at the 75th percentile ranged from 1.019 in the first or second year of retirement to 0.800 in the ninth or tenth year of retirement. At the 25th percentile, replacement ratios for the earlier cohort ranged from a high of 0.508 to a low of 0.407, while for the later cohort they ranged from a high of 0.477 to a low of 0.387.

One of the conditions for selecting the study sample was that a respondent's preretirement income had to be observed in at least three waves, meaning that wave 4, fielded in 1998, would be the earliest in which retirement data could be collected. The youngest age at which the oldest members of the 1931–1936 birth cohort could meet this requirement is 67, and the youngest age at which the youngest members of the 1937–1941 birth cohort could meet it is 57. The slightly lower replacement ratios observed for the 1937–1941 birth cohorts in some cells of Table 2 could be due in part to the age differences brought about by this sample selection process. Respondents in the 1931–1936 birth cohort who retired in their late 50s or early 60s were more likely to be excluded from the sample than respondents in the 1937–1941 cohorts who retired at those relatively young ages.

Replacement Ratios by Age When First Classified as Retired

Age at retirement affects eligibility and benefit amounts for both Social Security and pensions. Although Social Security retired-worker benefits are first available at age 62, benefits claimed before reaching full retirement age are paid at a permanently reduced rate. Many

Table 2.
Replacement ratios by birth cohort and year in retirement

Cohort and percentile	First or second year	Third or fourth year	Fifth or sixth year	Seventh or eighth year	Ninth or tenth year
Born 1931–1936					
75th	1.052	0.928	0.869	0.842	0.830
Median	0.755	0.670	0.613	0.600	0.577
25th	0.508	0.450	0.440	0.419	0.407
Born 1937–1941					
75th	1.019	0.864	0.849	0.754	0.800
Median	0.716	0.622	0.601	0.551	0.574
25th	0.477	0.423	0.387	0.403	0.422

SOURCE: Author's calculations using HRS.

NOTE: Ratios are based on shared income in CPI-U 2007 dollars.

public- and private-sector defined benefit pensions allow early retirement, typically beginning at age 55, although in most cases early retirement triggers an actuarial reduction in benefits.[24] Age at retirement therefore might affect retirement income and replacement ratios. Table 3 shows replacement ratios for respondents according to their age in the first HRS wave in which they were classified as retired. The median replacement ratio in the first or second year of retirement for those who retired before reaching age 62 was 71 percent. In later years of retirement, replacement ratios for those who retired before age 62 ranged from 53 percent to 57 percent. Among those who retired at ages 62 to 64, the median replacement ratio was 74 percent in the first or second year of retirement, 68 percent in the third or fourth year, and between 59 percent and 62 percent in the fifth through tenth years. The median replacement ratios of those who retired at ages 62 to 64 differed little from those who were aged 65 or older, and no variances were statistically significant. This may be because higher-income workers, on average, retire at later ages and have lower replacement ratios than lower-income workers, as discussed in the next section.

Replacement Ratios by Preretirement Income Quartile

Higher-income workers generally have lower income replacement ratios in retirement than middle-income and lower-income workers, in part because of Social Security's progressive benefit formula. Social Security benefits replace a larger percentage of earnings for lower-wage workers, who are less likely to have a pension plan. Although higher-income workers are more likely to have retirement income from sources besides Social Security, their income from these sources is often relatively modest.

Table 4 shows replacement ratios according to the respondent's preretirement household income quartile. Quartiles were determined by averaging household income in the first three preretirement waves for all members in the final sample, then ranking respondents according to their position relative to the average income of all members of the sample. In the first three waves of the HRS, 98 percent of the respondents in the final study sample were working full-time, or were working part-time and were not retired. The remainder were unemployed or temporarily not in the labor force. None were retired in any of the first three HRS waves.

Table 4 shows that in the first or second year of retirement, median replacement ratios differed little by preretirement income quartile. In later years, however, the median replacement ratios in the highest preretirement income quartile were lower than the median replacement ratios in the lowest three quartiles. Comparing the highest and lowest income quartiles, for example, the median replacement ratio in the highest quartile ranged from 59 percent in the third or fourth year of retirement to 51 percent in the ninth or tenth year. In the lowest quartile, the median replacement

Table 3.
Replacement ratios by age at retirement and year in retirement

Age at retirement [a] and percentile	First or second year	Third or fourth year	Fifth or sixth year	Seventh or eighth year	Ninth or tenth year
Younger than 62					
75th	1.006	0.824	0.800	0.754	0.791
Median	0.713	0.554	0.574	0.531	0.548
25th	0.449	0.362	0.372	0.394	0.382
62–64					
75th	0.999	0.911	0.849	0.807	0.807
Median	0.736	0.682	0.615	0.590	0.598
25th	0.488	0.469	0.402	0.445	0.444
65 or older					
75th	1.072	0.899	0.889	0.843	0.862
Median	0.738	0.645	0.628	0.599	0.553
25th	0.493	0.451	0.440	0.414	0.391

SOURCE: Author's calculations using HRS.

NOTE: Ratios are based on shared income in CPI-U 2007 dollars.

a. Respondent's age in the first wave of the HRS in which he or she was observed as being retired. Retirement usually has commenced before the interview date; thus, actual age at retirement is younger in most cases.

ratio ranged from 70 percent in the third or fourth year of retirement to 60 percent in the ninth or tenth year. Differences in median replacement ratios across the lower three quartiles, however, were relatively small, and most were not statistically significant.

The effect of Social Security's progressive benefit formula can be seen in Table 5, which shows the median share of income received from Social Security by retirees in the HRS according to preretirement income quartile. Among the 2,194 members of the sample—including those not receiving Social Security—the median share of income from Social Security in the first or second year of retirement was 23.1 percent. The proportion of total income received from Social Security was lowest for those with preretirement income in the highest income quartile and was highest for those whose preretirement income was in the lowest income quartile. Among those in the highest preretirement income quartile, the median share of income received from Social Security in the first or second year of retirement was only 7.7 percent. Among those in the lowest preretirement income quartile, however, the median share of income received from Social Security in the first or second year of retirement was 44.0 percent. The proportion of household income received from Social Security by HRS respondents whose preretirement income was in the lowest quartile rose substantially in later years of retirement. That

Table 4.
Replacement ratios by preretirement household income quartile and year in retirement

Preretirement income quartile and percentile within quartile	First or second year	Third or fourth year	Fifth or sixth year	Seventh or eighth year	Ninth or tenth year
Fourth (highest) quartile					
75th	1.033	0.854	0.759	0.724	0.800
Median	0.718	0.593	0.524	0.502	0.506
25th	0.478	0.361	0.325	0.338	0.306
Third quartile					
75th	1.001	0.889	0.869	0.789	0.823
Median	0.751	0.664	0.631	0.546	0.610
25th	0.523	0.467	0.451	0.431	0.444
Second quartile					
75th	1.042	0.915	0.855	0.872	0.786
Median	0.730	0.653	0.621	0.631	0.598
25th	0.467	0.462	0.460	0.462	0.464
First quartile					
75th	1.084	0.963	0.957	0.956	0.907
Median	0.738	0.695	0.672	0.687	0.601
25th	0.471	0.490	0.493	0.482	0.458

SOURCE: Author's calculations using HRS.

NOTE: Ratios are based on shared income in CPI-U 2007 dollars.

Table 5.
Median share of household retirement income from Social Security by preretirement income quartile and year in retirement

Preretirement income quartile	First or second year	Third or fourth year	Fifth or sixth year	Seventh or eighth year	Ninth or tenth year
Fourth (highest) quartile	0.077	0.211	0.289	0.288	0.333
Third quartile	0.211	0.365	0.403	0.439	0.422
Second quartile	0.306	0.483	0.526	0.530	0.591
First quartile	0.440	0.663	0.709	0.720	0.778
All respondents	0.231	0.406	0.449	0.480	0.484

SOURCE: Author's calculations using HRS.

NOTE: Ratios are based on shared income in CPI-U 2007 dollars.

reflects the diminishing share of income from earnings as retirees gradually leave part-time jobs and rely more heavily on Social Security benefits.

Multivariate Analysis

This section presents the results of a regression analysis that controls for the effects of the characteristics shown in Tables 2 through 4 and for several other demographic and economic variables. Among the sample of retirees from the HRS, the median replacement ratio for shared income in the first observed year of retirement income was 0.735 (Table 1, panel B). A logistic regression tests the effects of a range of variables on the probability that a respondent's income replacement ratio in the first wave of retirement exceeds the sample's median ratio. The value of the dependent variable is equal to 1 if the respondent's replacement ratio exceeds the sample median of 0.735 and 0 otherwise.

The independent variables in the regression include the respondent's birth cohort, age when first classified as retired, and the calendar year of the HRS wave when the respondent was first classified as retired. The regression therefore controls for the effects of birth cohort, retirement age, and retirement year on replacement ratios. The regression also includes other economic and demographic independent variables, described later. Table 6 presents complete results of the regression.

Table 6.
Logistic regression on median replacement ratio

Independent variable	Marginal effect	Standard error
Birth cohort = 1931–1936 (omitted)		
Birth cohort = 1937–1941	-0.0365	0.0071
Retired before age 62 (omitted)		
Retired at age 62 to 64	0.0330	0.0064
Retired at 65 or older	0.0930**	0.0180
First year of retirement = 1998, wave 4 (omitted)		
First year of retirement = 2000, wave 5	-0.0030	0.0006
First year of retirement = 2002, wave 6	-0.0110	0.0021
First year of retirement = 2004, wave 7	0.0529	0.0102
First year of retirement = 2006, wave 8	0.0945**	0.0183
First year of retirement = 2008, wave 9	0.0351	0.0068
Male	-0.0150	0.0029
Married at retirement	0.0856*	0.0166
White, Non-Hispanic	0.0209	0.0040
High school or less (omitted)		
Some college	0.0021	0.0004
College graduate	0.0321	0.0062
Fourth preretirement income quartile (omitted)		
Third preretirement income quartile	0.0761*	0.0147
Second preretirement income quartile	0.1259*	0.0244
First (lowest) preretirement income quartile	0.2083*	0.0403
Ratio of Social Security to household income	-0.2625*	0.0508
Household had earned income in retirement	0.2413*	0.0467
Household had pension income in retirement	0.1042*	0.0201

SOURCE: Author's calculations.

NOTES: The marginal effect shows the change in the probability based on a one-unit change a given variable, assuming that all other independent variables are held constant at their mean values.

Dependent variable is income replacement ratio in first year of observed retirement income > 0.735.

Observations = 2,194; observations with replacement ratio > 0.735 = 1,097 (50%).

Log Likelihood: -1,320; R^2 = .1675; maximum rescaled R^2 = 0.2233.

Association of predicted probabilities and observed responses: concordant = 73.8%, discordant = 25.9%, tied = 0.2%.

* = statistically significant at the 0.01 level.

** = statistically significant at the 0.05 level.

Table 2 showed that the median first-year replacement ratio for respondents born from 1937 to 1941 (0.716) was about four percentage points lower than the first-year replacement ratio for those who were born from 1931 to 1936 (0.755).[25] In the logit model, the relationship between birth cohort and the likelihood that the respondent's first-year income replacement ratio was greater than the median is not statistically significant.

Table 3 showed that the median first-year replacement ratios for individuals aged 62–64 and 65 or older in their first wave of retirement (0.736 and 0.738, respectively) were slightly higher than those for respondents aged younger than 62 (0.713). The regression estimates in Table 6 show that the first-year replacement ratio for a respondent aged 65 or older in the first wave of retirement was significantly more likely (by 9.3 percentage points) to exceed the median of 0.735 than that of a respondent who retired before age 62. In other words, all else being equal, those who retired at 65 or older had higher income replacement ratios than those who retired before age 62.

Table 4 showed that retirees with preretirement income in the highest income quartile had a lower median first-year replacement ratio than those in the lower three quartiles. The regression results show that, when controlling for the other variables, retirees with preretirement income in the lower three quartiles were more likely to have a first-year income replacement ratio that exceeded the full-sample median ratio than were those in the highest quartile. Compared with an HRS respondent with preretirement income in the highest (fourth) quartile, one in the third quartile was 7.6 percentage points more likely to have a first-year income replacement ratio greater than 0.735. For those in the second and the first income quartiles, the probabilities of having first-year replacement ratios above the median were 12.6 and 20.8 percentage points higher, respectively, than that of a respondent in the top quartile.

The regression included dummy variables indicating the HRS wave in which the individual was first classified as retired. In order to observe at least 3 years of preretirement income, wave 4 (fielded in 1998) was the first in which any members of the sample were observed as retired. Compared with respondents who retired in wave 4 (the omitted category in the regression), only those who retired in wave 8 (fielded in 2006) had a significantly different probability (9.4 percentage points more likely) of having a first-year replacement ratio above the full-sample median.

The model also included three economic and four demographic independent variables. The economic variables were dummies indicating whether the individual had earned income in the first or second year of retirement, whether he or she had pension income, and whether Social Security's share of his or her household income exceeded the full-sample median proportion.

As expected, respondents with earned income in retirement had higher replacement ratios than those without. Those who had wage, salary, or business income were 24.1 percentage points more likely than those with no earnings to have a first-year income replacement ratio above the median. Also as expected, when controlling for other variables, respondents who had income from a pension were more likely (by 10.4 percentage points) than those with no pension to have a replacement ratio greater than 0.735.

Among members of the full sample, the median share of first-year retirement income provided by Social Security benefits was 23.1 percent. Respondents who received more than 23.1 percent of income from Social Security were 26.2 percentage points less likely to have a first-year income replacement ratio above the median ratio of 0.735. For career-long low-wage workers, Social Security replaces about 55 percent of career-average earnings, and earnings represent the great majority of their preretirement income. Retirees who receive a relatively large share of household income from Social Security typically have few other sources of income, and with other things being equal, they are less likely to have an income replacement ratio above the median.

The model's other demographic variables included the respondent's sex, race and ethnicity, marital status at retirement, and education. Of these variables, only the respondent's marital status in the first retirement wave proved to be statistically significant. Compared with single, divorced, or widowed respondents, those who were married in their first retirement wave were 8.6 percentage points more likely to have had a first-year income replacement ratio that exceeded the 0.735 median.

Summary and Discussion

Understanding the change in income after retirement is important to policymakers because if Social Security, pensions, and savings do not provide adequate retirement income, the health and well-being of the elderly population could be at risk. In addition, retired people who cannot support themselves financially might have few options other than to accept financial

assistance from their adult children or to apply for means-tested government benefits. The latter would further strain a federal budget already in deficit.

One widely used measure of retirement income adequacy is the replacement ratio, which expresses retirement income as a percentage of preretirement income. Estimating income replacement ratios for recent retirees requires income data that cover a number of years to provide a representative sample. Because the HRS is a nationally representative longitudinal survey of older Americans and measures numerous sources of income over many years, data from this survey can be used to estimate income replacement ratios in retirement.

This study looked at income replacement ratios among the original cohort of HRS participants, all of whom were born between 1931 and 1941. Replacement ratios were estimated for HRS respondents who worked during at least three consecutive waves of the survey and were retired in one or more subsequent waves through the ninth wave, which was fielded in 2008. Annual retirement income was observed in up to five waves of the survey for each of the 2,194 members of the sample. Based on individual income for unmarried respondents and shared income for married respondents, the median replacement ratio in the first or second year of retirement was 0.735. One-fourth of respondents had initial replacement ratios above 1.033, and one-fourth had replacement ratios that were less than 0.485 in their first retirement wave. The median replacement ratio fell to 0.646 in the second retirement wave and to 0.607 in the third.

The estimated replacement ratios presented here were based on pretax income. Because some forms of retirement income, such as Social Security, are less subject to income taxes than earnings, after-tax replacement ratios are usually higher than pretax replacement ratios. By one estimate, after-tax ratios would be about 20 percent higher than pretax ratios for a middle-income retiree.

For most people, the main sources of retirement income are pensions, Social Security, and, for younger retirees, earnings from part-time employment. More than one-half of persons aged 65 or older also own some financial assets and about four-fifths of older Americans are homeowners. Financial assets provide income in the form of interest and dividends and homeownership provides noncash income in the form of imputed rent. Financial assets and home equity could provide more income, and could raise income replacement ratios, if a greater proportion of those assets were used to purchase annuities.

Relatively few retirees use their financial assets to purchase annuities, and most homeowners continue to live in their homes until increasing frailty or the death of a spouse makes maintaining a house too difficult. Nevertheless, financial assets and home equity represent a substantial potential source of income to many retirees. If, upon retirement, the retirees in this sample had converted 80 percent of their nonhousing assets into immediate annuities, the income from these annuities would have raised the median first-year income replacement ratio from 0.735 to about 0.900. Annuitizing 80 percent of all assets including home equity would have raised the median first-year replacement ratio to almost 1.0, about 26 percentage points above the baseline median replacement ratio of 0.735.

A number of household and individual characteristics appear to influence income replacement ratios in retirement. Other things being equal, retirees in this sample were less likely to have a first-year replacement ratio above the median if they retired before age 62, or if their preretirement household income was in the top quartile. They also were less likely to have a first-year replacement ratio above the median if they received greater shares of their income from Social Security than the median share among the full sample. Those with earnings in retirement, with income from pensions, and who were married when they retired were more likely to have an income replacement ratio above the median than were those with no earnings, with no pensions, and who were unmarried at retirement, respectively.

The replacement ratios estimated for this study included only people who were members of the original HRS cohort, all of whom were born between 1931 and 1941. Members of later birth cohorts are likely to have different lifetime earnings profiles and will probably have somewhat different sources of income in retirement. For example, women born in the 1940s and 1950s had higher labor force participation rates than those who were born in the 1930s. Workers who were born after 1960 will be less likely to retire with a defined benefit pension than those who were born earlier. For those and other reasons, income replacement ratios of later birth cohorts will likely differ from those of the cohort analyzed here.

As the HRS continues to collect information from individuals who are making the transition from full-time work to retirement, analysts will be able to study trends in income replacement ratios and to further investigate the individual and household characteristics that appear to affect this and other measures of retirement income adequacy.

Appendix

Table A-1.
Characteristics of HRS original cohort members: Percentage distributions within three groupings

Characteristic	Full sample	Worked and later retired [a]	Study sample [b]
Birth cohort			
1931–1936	51.3	49.4	42.7
1937–1941	48.7	50.6	57.3
Sex			
Men	47.2	51.0	52.1
Women	52.8	49.0	47.9
Race/ethnicity			
White, not Hispanic	71.3	74.5	76.8
Black, not Hispanic	17.1	15.7	14.7
Hispanic	9.3	8.0	6.7
Other	2.3	1.9	1.9
Education			
College graduate	16.7	19.3	21.9
Some college	18.9	20.2	20.5
High school diploma or equivalent	37.7	38.4	38.5
No high school diploma	26.8	22.1	19.2
Marital status [c]			
Married	73.6	75.0	76.8
Divorced or separated	15.2	15.2	13.7
Widowed	6.5	5.8	5.6
Never married	4.7	4.0	3.9
Labor force status [c]			
Works full-time	55.1	76.4	85.8
Works part-time	10.1	13.9	13.0
Unemployed	2.3	1.9	1.2
Partly retired	3.6	2.2	0.0
Fully retired	13.7	1.8	0.0
Other not in labor force	15.3	3.8	0.0
Number in sample	10,376	5,363	2,194
Median income [d] ($)	57,969	66,900	70,687

SOURCE: Author's calculations using HRS.

NOTE: Rounded components of percentage distributions may not sum to 100.0.

a. Respondent worked in one or more HRS waves and was partly or fully retired in at least one subsequent wave.

b. Respondent worked in three or more consecutive HRS waves and was partly or fully retired in at least one subsequent wave.

c. Reflects status in wave 1.

d. In CPI-U 2007 dollars.

Table A-2.
Percentage distribution of original HRS cohort members by labor force status and HRS wave: Three groupings

HRS wave	Worked full-time	Worked part-time	Unemployed	Partly retired	Fully retired	Other not in labor force	Number of respondents
				Full sample			
1	55.0	10.1	2.3	3.6	13.7	15.3	9,814
2	48.8	9.4	2.0	5.5	21.2	13.0	8,889
3	42.0	7.3	1.2	7.8	27.1	14.6	8,540
4	35.4	6.9	0.7	9.6	32.5	14.9	8,243
5	28.5	6.0	0.5	10.9	38.6	15.4	7,781
6	20.7	5.5	0.3	11.9	47.5	14.1	7,531
7	15.6	4.4	0.2	13.6	55.6	10.6	7,228
8	11.3	3.4	0.0	13.2	63.0	9.1	6,856
9	9.3	2.8	0.1	12.5	67.2	8.2	6,545
				Worked and later retired [a]			
1	76.4	13.9	1.9	2.2	1.8	3.8	5,205
2	66.0	13.4	2.1	5.5	9.3	3.8	4,990
3	54.9	9.7	1.4	9.5	19.3	5.1	4,985
4	42.7	8.8	0.7	12.9	30.0	4.9	5,048
5	31.8	7.5	0.5	15.0	39.3	6.0	4,894
6	20.6	6.6	0.3	16.2	50.6	5.7	4,852
7	13.2	4.9	0.2	18.9	58.9	4.0	4,702
8	6.8	3.3	0.0	18.5	68.1	3.3	4,482
9	4.2	1.8	0.0	17.4	73.6	2.9	4,282
				Study sample [b]			
1	84.4	12.8	1.2	0.0	0.0	1.6	2,154
2	84.7	13.4	0.7	0.0	0.0	1.1	2,135
3	86.0	13.4	0.2	0.0	0.0	0.5	2,157
4	64.8	10.9	0.3	8.9	13.4	1.7	2,179
5	46.6	9.3	0.0	14.4	26.5	3.2	2,158
6	31.1	8.4	0.0	17.9	39.4	3.1	2,109
7	19.4	6.3	0.0	22.4	49.5	2.5	2,062
8	10.1	4.3	0.0	23.8	59.8	1.9	1,985
9	5.3	2.2	0.0	22.2	68.7	1.5	1,877

SOURCE: Author's calculations using HRS.

NOTES: Excludes 562 HRS participants who did not respond in wave 1 of the survey.

Rounded components of percentage distributions do not necessarily sum to 100.0.

a. Respondent worked in one or more HRS waves and was partly or fully retired in at least one subsequent wave.

b. Respondent worked in three or more consecutive HRS waves and was partly or fully retired in at least one subsequent wave.

Table A-3.
Median household income of original HRS cohort members by HRS wave and labor force status: Full sample (in 2007 dollars)

HRS wave and percentile within wave	Worked full-time	Worked part-time	Unemployed	Partly retired	Fully retired	Other not in labor force	All respondents
1st wave							
75th	105,577	90,624	70,385	101,197	70,989	67,968	93,645
Median	68,877	54,374	36,703	61,322	38,538	34,241	57,969
25th	40,970	29,151	16,765	30,208	16,947	12,687	30,208
2nd wave							
75th	109,053	94,140	57,096	91,572	69,943	65,660	93,923
Median	69,816	56,811	28,548	57,096	37,683	32,117	56,168
25th	42,205	27,121	10,957	30,211	16,992	12,316	28,548
3rd wave							
75th	113,736	103,657	69,219	107,372	71,219	61,987	94,238
Median	72,574	55,385	35,827	63,394	40,436	31,684	55,460
25th	43,978	28,434	12,316	33,471	20,489	12,208	28,499
4th wave							
75th	117,499	94,716	75,254	89,033	67,495	53,728	87,767
Median	71,330	54,050	37,202	54,822	39,582	27,828	50,364
25th	41,824	26,464	18,017	32,595	19,399	11,906	25,954
5th wave							
75th	119,624	102,655	113,232	93,786	69,586	54,160	86,954
Median	73,663	53,044	49,971	55,899	41,246	26,782	49,390
25th	42,980	30,538	12,422	32,049	22,076	11,135	25,310
6th wave							
75th	120,043	99,957	53,816	88,496	63,338	51,677	77,151
Median	68,918	57,261	35,058	52,998	36,376	26,818	43,752
25th	42,038	32,118	18,483	30,641	20,131	12,593	23,961
7th wave							
75th	127,656	121,588	90,960	90,152	61,234	52,306	75,285
Median	74,040	57,662	42,096	52,700	35,620	26,611	42,228
25th	44,601	30,719	21,595	32,252	19,628	12,463	22,802
8th wave							
75th	122,138	104,136	--	89,798	58,776	49,981	70,425
Median	69,546	53,510	--	52,915	34,706	25,608	40,213
25th	44,239	32,821	--	31,532	19,111	12,868	21,633
9th wave							
75th	123,368	116,248	--	85,200	57,800	50,076	66,896
Median	68,576	62,900	--	51,584	33,757	26,016	38,488
25th	39,880	41,508	--	32,627	18,578	13,307	21,000

SOURCE: Author's calculations using HRS.

NOTE: -- = not available.

Table A-4.
Median household income of original HRS cohort members by HRS wave and labor force status: Respondents who worked and later retired (in 2007 dollars)

HRS wave and percentile within wave	Worked full-time	Worked part-time	Unemployed	Partly retired	Fully retired	Other not in labor force	All respondents
1st wave							
75th	107,716	94,673	71,504	93,292	90,392	68,281	103,501
Median	72,117	55,239	39,290	66,747	47,475	40,051	66,900
25th	42,963	30,688	20,101	36,025	23,170	16,332	38,498
2nd wave							
75th	107,974	95,868	63,621	92,963	92,127	66,701	105,745
Median	71,041	58,102	34,861	59,293	56,649	37,476	65,364
25th	43,576	29,341	15,339	31,375	28,615	15,978	37,102
3rd wave							
75th	112,201	101,818	77,780	104,355	83,595	68,084	103,153
Median	73,328	54,639	39,121	61,526	49,416	39,807	64,103
25th	44,419	27,796	19,250	33,076	24,777	13,326	35,497
4th wave							
75th	117,567	94,813	--	88,494	73,574	54,682	95,897
Median	72,579	55,474	--	55,881	44,580	29,362	57,417
25th	42,895	26,997	--	34,341	22,681	12,680	31,171
5th wave							
75th	117,278	98,024	--	95,723	72,042	58,879	93,107
Median	73,748	52,881	--	56,444	42,885	26,876	53,548
25th	41,760	31,258	--	32,553	23,661	12,318	28,757
6th wave							
75th	113,797	98,732	--	87,905	67,030	48,357	82,351
Median	68,610	55,004	--	53,600	39,409	25,711	47,400
25th	42,243	31,825	--	31,384	22,594	13,387	26,936
7th wave							
75th	117,441	115,892	--	91,125	64,667	47,316	79,192
Median	72,997	56,341	--	53,232	38,452	23,878	44,888
25th	42,511	32,386	--	32,612	21,407	11,654	25,232
8th wave							
75th	105,092	89,337	--	90,615	61,153	52,332	70,493
Median	61,428	50,196	--	54,122	36,024	21,980	41,106
25th	39,524	31,724	--	31,600	20,585	10,381	23,325
9th wave							
75th	92,943	95,008	--	88,712	58,896	43,572	65,380
Median	52,252	55,852	--	52,684	34,876	25,278	38,760
25th	29,480	39,024	--	33,324	20,064	10,248	22,216

SOURCE: Author's calculations using HRS.

NOTES: Reflects respondents who worked in one or more HRS waves and were partly or fully retired in at least one subsequent wave.

-- = not available.

Table A-5.
Median household income of original HRS cohort members by HRS wave and labor force status: Study sample (in 2007 dollars)

HRS wave and percentile within wave	Worked full-time	Worked part-time	Unemployed	Partly retired	Fully retired	Other not in labor force	All respondents
1st wave							
75th	110,259	95,155	--	--	--	--	107,692
Median	72,499	58,241	--	--	--	--	70,687
25th	45,312	30,963	--	--	--	--	41,688
2nd wave							
75th	112,051	94,208	--	--	--	--	109,767
Median	71,370	57,096	--	--	--	--	69,229
25th	44,101	30,255	--	--	--	--	41,966
3rd wave							
75th	116,065	106,154	--	--	--	--	113,736
Median	74,297	55,385	--	--	--	--	72,642
25th	46,448	30,120	--	--	--	--	43,328
4th wave							
75th	121,862	97,063	--	87,046	89,156	--	111,600
Median	74,439	56,860	--	64,345	54,307	--	68,453
25th	44,724	30,088	--	37,825	28,457	--	39,096
5th wave							
75th	124,220	104,593	--	97,411	77,141	64,306	106,332
Median	77,538	52,997	--	59,005	43,850	26,722	61,489
25th	43,442	31,209	--	35,713	23,855	13,416	33,752
6th wave							
75th	119,162	94,423	--	89,618	69,459	47,211	89,748
Median	69,901	54,534	--	52,419	40,597	28,215	51,535
25th	42,818	30,384	--	33,118	23,839	15,285	29,215
7th wave							
75th	120,273	110,844	--	97,086	68,817	52,465	89,584
Median	72,218	54,333	--	56,394	39,600	24,850	49,619
25th	43,029	32,040	--	35,669	22,734	14,818	28,847
8th wave							
75th	105,754	93,179	--	97,966	66,776	--	78,313
Median	61,065	52,874	--	60,249	38,247	--	45,589
25th	43,330	35,499	--	35,279	22,639	--	27,238
9th wave							
75th	100,300	--	--	103,113	60,000	--	72,000
Median	52,252	--	--	60,900	35,736	--	41,096
25th	28,700	--	--	36,872	21,704	--	24,244

SOURCE: Author's calculations using HRS.

NOTES: Reflects respondents who worked in three or more consecutive HRS waves and were partly or fully retired in at least one subsequent wave.

-- = not available.

Table A-6.
Distribution of retirement observations, by first HRS wave of retirement income and number of waves in which respondent was retired

Number of HRS waves during which respondent was retired	First HRS wave in which respondent is observed as retired (and interview year)						Total
	4 (1998)	5 (2000)	6 (2002)	7 (2004)	8 (2006)	9 (2008)	
1	485	497	435	353	261	163	2,194
2	390	395	365	295	206	…	1,651
3	340	355	316	254	…	…	1,265
4	305	331	273	…	…	…	909
5	278	302	…	…	…	…	580
Total observations	1,798	1,880	1,389	902	467	163	6,599

SOURCE: Author's calculations using HRS.

NOTES: Observations reflect respondents who worked full-time or part-time in three consecutive waves and were partially or fully retired in one or more subsequent waves.

… = not applicable.

Notes

[1] In 2010, the poverty threshold for an individual aged 65 or older was $10,458, while the poverty threshold for an elderly couple was $13,194 (Census Bureau 2012b).

[2] Retirement can be defined according to an individual's employment status, main sources of income, or both. The methods section presents the definition of retirement used for this analysis.

[3] There are exceptions. For example, some state and local government defined benefit pensions are based on final-year earnings, providing a strong financial incentive for workers to boost their final-year hours of work and earnings.

[4] Scholz and Seshadri (2009) suggest that couples and singles with children will have lower target replacement ratios than people without children because much of the preretirement spending of parents did not represent consumption by the parents.

[5] Because of increases in the marginal productivity of labor, wages tend to rise faster than prices in the long run.

[6] Defined benefit pensions often are based on an average of nominal earnings over the last 5 years of work with the employer. Some defined benefit plans average earnings over the participant's entire period of employment with the plan sponsor, again without indexing past earnings to the present.

[7] Biggs and Springstead (2008) argue against using wage-indexed earnings in the denominator of the replacement ratio because "a wage-indexed average … overstates [the] real earnings level in past years." Experts have debated the relative merits of price indexing and wage indexing earnings in the context of proposed Social Security reforms. Some analysts have suggested using a mixture of price indexing and wage indexing known as "progressive price indexing."

[8] In the HRS, household income is counted before income taxes and payroll taxes have been subtracted and after transfer payments—such as Social Security, SSI, unemployment insurance, and workers' compensation—have been received. This measure is sometimes referred to as "pretax, posttransfer" income.

[9] Butrica, Smith, and Iams (2012), for example, used income at age 67 to represent retirement income.

[10] Most studies refer to "replacement rates." This article uses "ratios" rather than "rates;" in the present context, the terms are synonymous. When discussing replacement ratio values, this article uses quotients (to three decimal places) and percentages interchangeably.

[11] From the first quarter of 1998 to the second quarter of 2006, the Case-Shiller home price index rose by 122 percent. From the second quarter of 2006 to the fourth quarter of 2008, the index fell by 27 percent.

[12] The average yield on newly issued 10-year US Treasury Notes, for example, fell from 6.35 percent in 1997 to 3.26 percent in 2009. Other long-term interest rates also fell during that period.

[13] Munnell and Soto (2005a) find that "people do not appear interested in tapping their home equity for non-housing consumption."

[14] Consider a couple with preretirement income of $80,000, retirement income of $50,000 when both are alive and income of $30,000 for the surviving spouse. On a total income basis, the replacement ratio falls from .625 to .375 upon the death of the spouse. Converting all dollar amounts to shared income by dividing by two, the values are $40,000, $25,000, and $30,000, respectively. Upon the death of the spouse, the replacement ratio of shared income increases from .625 to .750.

[15] In both cases, the authors appear to be referring to replacement ratios based on pretax income.

[16] In the Appendix, Table A-1 shows sample characteristics for three groups: the full wave 1 sample; a subsample of respondents who were employed (and not self-reported

as retired) in at least one wave, and were retired in one or more later waves; and the study sample—respondents who were employed in at least three consecutive waves and were retired in at least one later wave. For those same groupings, Table A-2 shows labor force status by wave, and Tables A-3, A-4, and A-5 show median income by labor force status and wave.

[17] For more information on the HRS and the RAND HRS files, see http://www.rand.org/labor/aging/dataprod.html. Complete documentation of RAND HRS Version J, the data file used for this analysis, is presented in St. Clair and others (2010).

[18] For a few respondents who were first retired in wave 4 (1998), retirement income was observable in six waves. However, the wave 9 observation for those individuals was dropped because of the small size of that sample.

[19] RAND classified respondents who worked 35 or more hours per week for 36 or more weeks per year as working full-time.

[20] Appendix Table A-6 shows the number of observations in each wave.

[21] Most retirees do not purchase annuities. These estimates illustrate the income that could be realized if 80 percent of assets were used to purchase an annuity. A level annuity maximizes immediate income, but because the amount of income remains level for life, its value will be eroded by inflation. Annuity income estimates were derived by dividing the value of financial assets at retirement by the annuity factors in effect in December 2010 for single men, single women, married men, and married women by age at retirement (see http://www.immediateannuity.com for annuity factors).

[22] Retirees who sell their homes might have to pay rent if they move to an apartment, reducing the net income they would realize from the sale of the home. Another option is a reverse mortgage (for a detailed description, see http://portal.hud.gov/hudportal/HUD?src=/program_offices/housing/sfh/hecm/rmtopten).

[23] In this analysis, "retirement age" is between 62 (the youngest at which an individual can claim Social Security retirement benefits) and 65 (the minimum age to qualify for full retirement benefits for individuals born before 1938. Full retirement age for those born 1938–1941 ranges from 65 years and 2 months to 65 years and 8 months).

[24] Moreover, relatively few defined benefit plans provide cost-of-living adjustments, so the real value of pension income falls over time.

[25] This difference was not statistically significant.

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