working paper 0109

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FEDERAL RESERVE BANK OF CLEVELAND

Working Paper 01-09 July 2001

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Using data on older workers from the 1992 Health and Retirement Survey along with an elaborate life-cycle planning model, we quantify the extent to which the death of each individual would affect the financial status of his or her survivors, and we measure the degree to which life insurance holdings moderate these consequences. The average change in living standard that would result from a spouse's death is small both in absolute terms and relative to the decline that would occur in the absence of insurance. However, this average obscures a startling mismatch between insurance holdings and underlying vulnerabilities. For many of those with the greatest vulnerabilities, the amounts purchased are surprisingly small, and for many of those with the smallest vulnerabilities, the amounts are surprisingly large. As a result, uninsured vulnerabilities are reasonably widespread. The magnitude of these vulnerabilities, as well as the proclivity to address any given degree of vulnerability by purchasing life insurance, vary systematically with individual and household characteristics.

JEL Classification: D12, D18, G11, G22

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The authors are grateful to two referees and seminar participants at the National Bureau of Economic Research for helpful comments, and to Neva Kerbeshian and Noshua Watson for able research assistance. The National Institute of Aging provided financial support. Economic Security Planner (ESPlanner) is

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1. Introduction

The purpose of this study is to examine life insurance holdings and financial vulnerabilities among couples approaching retirement age. Two separate concerns motivate our analysis. First, there are reasons to suspect that life insurance coverage may be poorly correlated with underlying financial vulnerabilities. A well-known insurance industry adage holds that life insurance is "sold and not bought." Alternatively, households may purchase long-term policies relatively early in life, and subsequently fail to adjust coverage appropriately because of inertia and/or other psychological considerations. Second, households that purchase little or no life insurance may leave either or both spouses at risk of serious financial consequences.

Past studies address the second issue, but provide little evidence concerning the first. Analyzing data gathered during the 1960s from households in middle age through early retirement, Auerbach and Kotlikoff [1987, 1991a, 1991b] found that roughly one-third of wives and secondary earners would have seen their living standards decline by 25 percent or more had their spouses died. Holden, Burkhauser, and Myers [1986] and Hurd and Wise [1989] documented sharp declines in living standards and increases in poverty rates (from 9 to 35 percent) among women whose husbands actually passed away.

This study builds on Auerbach and Kotlikoff's work in four ways. First, we use recent, high quality data drawn from the 1992 wave of the Health and Retirement Study (HRS). Second, we obtain more accurate estimates of survival-contingent income streams through the use of actual social security earnings histories and a highly detailed benefits calculator.[1] Third, to evaluate the financial vulnerabilities of each household, we employ an elaborate life-cycle model that accounts for a broad array of demographic, economic, and financial factors not considered in previous research.[2] These factors include household composition, economies of

[1]Social security earnings histories are contained in a matched, supplemental data set, which we have used in compliance with confidentiality requirements and security restrictions.

[2]The model is embodied in financial planning software, Economic Security Planner (or ESPlanner), which was co-developed by three of this paper's authors. Economic Security Planning, Inc. provides free copies of the

shared living, liquidity constraints, inflexible expenses, and various details of state and federal tax codes. Fourth, we quantify the financial vulnerabilities that would have existed in the absence of insurance, and evaluate the extent to which life insurance holdings addressed those vulnerabilities, particularly for cases in which the potential financial consequences of a spouse's death were severe.

Throughout our analysis, we adopt a concrete and easily understood yardstick for quantifying financial vulnerabilities: the percentage decline in an individual's sustainable living standard that would result from a spouse's death. The use of this yardstick permits us to make apples-to-apples comparisons of vulnerabilities across households, and to investigate correlations between vulnerabilities and insurance coverage. We also compare actual life insurance holdings to a natural benchmark, defined as the level of coverage required to assure survivors of no change in their sustainable living standard. It is worth emphasizing that we do not regard this benchmark as a definitive standard of adequacy or rationality. Rational decision makers may elect to purchase either higher or lower levels of insurance. However, when combined with other evidence on household objectives, comparisons with the benchmark potentially shed light on the adequacy of life insurance coverage.

Averaged across our entire sample, the change in living standard that would result from a spouse's death is small both in absolute terms and relative to the average decline that would have occurred in the absence of insurance (henceforth referred to as the *underlying* vulnerability). However, this average obscures a startling mismatch between life insurance holdings and underlying vulnerabilities. Many older workers required little or no insurance to ensure survivors of undiminished living standards, yet nevertheless maintained substantial coverage. Relative to earnings, individuals with greater underlying vulnerabilities did not, on average, purchase more life insurance. Moreover, the likelihood of having no life insurance protection was greatest for those with the largest exposures. On the margin, life insurance offset only ten percent of the variation in financial vulnerability across all individuals, and virtually none of the variation in financial

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software for academic research. For additional information, consult www.ESPlanner.com.

vulnerability across individuals at risk of reduced living standards. Consequently, among those with serious financial vulnerabilities, differences between benchmark and actual levels of life insurance were substantial. Ignoring life insurance, 33 percent of secondary earners and 6 percent of primary earners would have experienced significant (20 percent or greater) declines in living standards had their spouses died in 1992; 20 percent of secondary earners and 3 percent of primary earners would have experienced severe (40 percent or greater) declines. Only one in three households in these at-risk populations held sufficient life insurance to avert significant or severe financial consequences for surviving secondary earners; for at-risk primary earners, the figure is less than one in six. The magnitude of uninsured financial vulnerabilities, as well as the proclivity to address any given degree of vulnerability by purchasing life insurance, varies systematically with individual and household characteristics.

The paper proceeds as follows: section 2 discusses methods, section 3 describes the data, section 4 presents basic results, section 5 provides sensitivity analysis, and section 6 concludes.

2. A Strategy for Measuring Financial Vulnerabilities

A. Concepts

We clarify our strategy for measuring financial vulnerabilities through an example. Imagine that a husband and wife each live for at most two years (equivalently, they are within two years of maximum lifespan). Both are alive initially, but either may die before the second year. The household's well-being depends on consumption in each year and survival contingency. As discussed further below, we allow for the possibility that some ongoing expenditures are either exogenous or determined early in life by "sticky" choices. We refer to these expenditures as "fixed consumption," and to residual spending as "variable consumption." Let y_1 denote initial assets plus first period earnings net of fixed consumption, and let y_{2s} denote second period earnings net of fixed consumption in state s = W, H, B, where the state identifies survivors (wife, W, husband, H, or both, B). The couple divides first period resources between variable consumption, c_1, saving, A, and

insurance premiums, p_iL_i, i = H, W, where L_i represents the second-period payment to i if his or her spouse dies, and p_i denotes the associated price per dollar of coverage. Assets A earn the rate of return r. The couple faces the following constraints: $c_1 = y_1 - A - p_WL_W - p_HL_H$, $c_{2B} = y_{2B} + A(1+r)$, and $c_{2i} = y_{2i} + A(1+r) + L_i$ for i = W, H, where c_{2i} denotes second period variable consumption in state i (for the moment, we ignore non-negativity restrictions on life insurance and assets) Defining $p_B \equiv (1+r)^{-1} - p_W - p_H$, these equations

$$c_1 + p_B c_B + p_W c_W + p_H c_H = y_1 + p_B y_B + p_W y_W + p_H y_H \equiv Y$$

imply:

We equate living standard with per capita variable consumption adjusted for family composition. To determine each individual's living standard when both are alive, we divide variable consumption by a factor 2^{α}. We assume that $0 < \alpha < 1$; the second inequality reflects economies of scale associated with shared living expenses. To maintain a living standard that is constant across time and states of nature (in other words, one that is undiminished if and when either spouse dies), the couple must spend $2^{\alpha}C$ dollars in every period and state where both are alive for every C dollars in any state where only one survives. From (1), it is apparent that

$$c^* = \frac{Y}{2^{\alpha}(1+p_B) + (p_W + p_H)}$$

the household's highest sustainable living standard is:

The couple can guarantee that spouse j's death will not diminish i's living standard from its highest sustainable level, c^*, by purchasing a life insurance policy with face value $L_i^* = (c^* - y_{2i}) + (y_{2B} - \alpha c^*)$.[3]

We measure underlying financial vulnerabilities by comparing an individual's highest sustainable

[3]In the special case where the household has Leontief preferences (defined over per capita adjusted expenditures), this is also the utility maximizing outcome.

living standard, c^*, with $c_i^n \equiv y_{2i} + A(1+r)$, which represents the living standard he or she would enjoy if widowed, ignoring life insurance. We define the variable IMPACT (ignoring insurance) as $\left(\frac{c_i^n}{c^*} - 1 \right) \times 100$, i = W,H. This is a measure of the percent by which the survivor's actual living standard would, with no insurance protection, fall short of or exceed the couple's highest sustainable living standard. Similarly, we measure uninsured financial vulnerabilities by comparing c^* with $c_i^a \equiv y_{2i} + A(1+r) + L_i^a$, which represents the living standard that the individual would actually enjoy if widowed, based on actual life insurance coverage, L_i^a. We define the variable IMPACT (actual) as $\left(\frac{c_i^a}{c^*} - 1 \right) \times 100$. This is a measure of the percent by which the survivor's actual living standard would, given actual levels of coverage, fall short of or exceed the couple's highest sustainable living standard. The IMPACT variables are based on a concrete and easily understood yardstick for quantifying the consequences of a spouse's death.[4] We also compare actual life insurance holdings, L_i^a, with the benchmark level, L_i^*.

For the preceding example, we implicitly assumed that individuals could borrow at the rate r and issue survival-contingent claims at the prices p_H and p_W. As a practical matter, households encounter liquidity constraints and are typically unable to purchase negative quantities of (i.e. sell) life insurance.[5] In solving for each household's highest sustainable living standard, we take these restrictions into account, smoothing consumption to the greatest extent possible, given the constraints.[6]

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[4]Note that, when actual life insurance is below the benchmark, the intact couple saves on insurance premiums, so its actual consumption exceeds c^*. Hence, the IMPACT variables understate the change in living standard that an individual experiences upon a spouse's death. However, since life insurance premiums typically account for a small fraction of expenditures, the degree of understatement is small.

[5]A non-negativity constraint for life insurance purchases is equivalent to the restriction that life annuities are not available for purchase at the margin. For further discussion, see Yaari (1965), Kotlikoff and Spivak (1981), and Bernheim (1987).

[6]Formally, one can think of the outcome that we identify as the limit of the solutions to a series of utility

Among older workers (such as those surveyed by the HRS), binding non-negativity constraints for life insurance holdings are far more common than binding liquidity constraints. When the life insurance constraint binds, the benchmark living standard for a survivor, c_i^* (where i = H or W), may be greater than the benchmark living standard for the couple while both spouses are still alive, c_B^*. This observation raises the following practical issue: when calculating IMPACT, should we set $c^* = c_i^*$, or $c^* = c_B^*$? Were we to use c_B^*, actual IMPACT would be positive not only for households that depart from the benchmark by purchasing additional insurance ($L_i^a > L_i^*$), but also for constrained households that conform to the benchmark by purchasing no insurance ($L_i^a = L_i^* = 0$). In contrast, the use of c_i^* implies that actual IMPACT is positive when $L_i^a > L_i^*$ and zero when $L_i^a = L_i^* = 0$. Since we wish to use actual IMPACT as a measure of the extent to which a household deviates from the consumption-smoothed benchmark, we therefore select c_i^* rather than c_B^*. As a result, the value of IMPACT ignoring insurance is always non-positive (even though, absent insurance, the survivor's material living standard might actually increase upon his or her spouse's death), and it equals zero whenever the corresponding benchmark insurance level, L_i^*, is zero.

B. Implementation

We actually evaluate each household's financial vulnerabilities using a more elaborate and realistic life cycle model. As mentioned previously, the model is embedded in a financial planning software program, Economic Security Planner (or ESPlanner), developed by three of this papers' authors. Although a complete description of the model would be prohibitively lengthy, it is important to summarize some key features.[7]

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maximization problems in which the intertemporal elasticity of substitution approaches zero. In the limit (the Leontief case), the household is actually indifferent with respect to the distribution of consumption across any years in which its living standard exceeds the minimum level.

[7]The software has many capabilities that we do not make use of here due to data limitations. For example, it can account for a variety of special expenditures (college education, weddings, etc.), plans to change homes, various kinds of state contingent plans (e.g. a non-working wife plans to return to work and spend less on a child's education if her husband dies), and estate plans (including intended bequests).

For our base-case calculations, we assume that each individual lives to a maximum age of 95. We include children as members of the household through age 18. We represent household scale economies as follows: an expenditure of $(N + \beta K)^{\alpha}C$, when there are N adults and K children in the household provides the same standard of living for each household member as does an expenditure of C when there is only one adult in the household (this generalizes the adjustment factor used in our simple illustration). The coefficient β is a child-adult equivalency factor; we set it equal to 0.5.[8] The exponent α captures economies of scale in shared living. We set it equal to 0.678, which implies that a two-adult household must spend 1.6 times as much as a one-adult household to achieve the same living standard.[9]

Insurance needs depend on differences in survival-contingent income streams. Consequently, a careful and thorough treatment of the social security system is essential. In calculating benefits for retirement, survivors, parents, children, spouses, and dependent children, the model accounts for eligibility rules, early retirement reductions, delayed retirement credits, benefit re-computation, the legislated phased increase in the normal retirement age, the earnings test, restrictions on maximum family benefits, the wage indexation of average indexed monthly earnings, and the price indexation of benefits once they are received.

Various characteristics of the tax system, such as rate structure and the treatment of married couples, can alter insurance needs by influencing the distribution of after-tax income across the various survival contingencies. Consequently, a careful treatment of taxation is also critical. The model calculates federal and state income and payroll taxes for each year in each survival contingency. It incorporates wide range of provisions, including federal deductions and exemptions, the decision to itemize deductions, the taxation of

[8] Our child-adult equivalency factor is that used by the OECD (see Ringen, 1991). Nelson's (1992) work suggests a smaller value, but she considers total household expenditures whereas our child-adult equivalency factor applies only to non-housing consumption expenditure; for our base-case results, we treat housing expenditure as inflexible. It appears from Nelson's work that a higher equivalency factor is appropriate for non-housing expenditures.

[9] The OECD uses a value of 0.7 for α (see Ringen, 1991). Williams, et. al. (1998) consider values of 0.5 for both α and β.

social security benefits, the earned income tax credit, the child tax credit, the phase-out at higher income levels of itemized deductions, and the indexation of tax brackets to the consumer price index. In computing federal deductions, it determines whether the sum of state income taxes, mortgage interest payments, and property taxes is large enough to justify itemization. Contributions to tax-favored retirement savings accounts are excluded from taxable income, and withdrawals are included. Though the model determines total saving simultaneously with life insurance, tax-favored saving is specified exogenously.

Choices concerning housing may also affect life insurance needs. Unlike many other expenditures, housing outlays are not easily smoothed. It is difficult to scale mortgage, property tax, and insurance payments up and down with other expenditures. Cost and inconvenience discourage many households from moving or refinancing mortgages; others form psychological attachments to their homes, and resist changing residences prior to death (Venti and Wise, 2000). For the HRS sample, roughly three quarters of respondents reported that they planned to remain in their current home after retirement.[10] Moreover, few households access the equity in their homes through refinancing or reverse annuity mortgages (Caplin, 2000). Consequently, for our base-case calculations, we treat housing as fixed consumption. In effect, we assume that couples and survivors remain in the same home until death, and die with home equity intact. Formally, we subtract housing expenses from income off-the-top, itemizing mortgage interest and property taxes as deductions for federal income tax purposes when it is optimal to do so, prior to smoothing variable consumption.

Several potentially important factors are omitted from our analysis. We do not model uncertainty concerning future income and non-discretionary expenses (e.g. medical care). Since small groups of individuals can share risks to some extent, the adverse effect of uncertainty on living standard is probably greater for widows and widowers than for couples. For this reason, our analysis tends to understate insurance

[10]More specifically, 5,753 said that they planned to stay in their current home after retirement, 180 said that the expected to divide time between their current home and another location, 2,192 said that they planned to move, 41 said that they had already moved, and 679 said that they don't know. In addition, 3,705 households were not asked the question (mainly because they had already retired), and 102 households were asked but did not answer.

needs. We also neglect the possibility that an individual might remarry after a spouse's death. The extent to which remarriage mitigates the financial consequences of a spouse's death depends on one's view of the marriage market.[11] In any case, remarriage is relatively uncommon for the age group we consider (see section 5).

Table 1 summarizes some illustrative life insurance calculations.[12] We begin with a couple consisting of a 54 year-old man earning $45,000 per year, and a 50 year-old woman earning $25,000 per year. The man intends to retire at age 64, the woman at age 63. They have one 18 year old child. The net value of their non-housing assets is $50,000; in addition, they own a $100,000 home, and have an unpaid mortgage balance of $20,000. They expect their real earnings to grow at the rate of one percent per year until retirement. They also expect to earn a real after-tax return of 3 percent on their non-housing investments. According to our model, this couple must purchase $133,500 in term insurance on the husband's life, and no insurance on the wife's life, to ensure each potential survivor of an undiminished living standard. The remainder of the table illustrates the sensitivity of insurance needs to changes in various household characteristics and economic parameters.

C. Interpretation

We do not regard our IMPACT variables as perfect measures of financial vulnerability. Though elaborate, the life cycle model used in our analysis is still an abstraction, and we have imperfect information concerning the economic circumstances of each household (see the Appendix). Nor do we regard the benchmark level of life insurance as an objective standard of adequacy or rationality. Optimal insurance coverage depends on a variety of considerations, including (but not limited to) the manner in which marginal utilities vary across survival states, the weights that households attach to the well-being of each family member, degrees of risk aversion, and load factors (more generally, the degree to which the industry departs from

[11] See Lundberg (1999) for a discussion.

[12] For additional examples, and for comparisons with recommendations generated by Quicken Financial Planner, see Gokhale, Kotlikoff, and Warshawsky (1999).

actuarially fair pricing). Consequently, it is possible to rationalize a wide range of behaviors.

Nevertheless, the absence of a significant correlation between life insurance and financial vulnerabilities (measured by IMPACT, ignoring insurance) would be difficult to reconcile with theories of rational financial behavior. Even if a household places less weight on the well-being of a particular spouse, and even if it must pay actuarially unfair rates, it should still obtain greater insurance protection when the spouse in question is exposed to more severe financial consequences. To explain the absence of a correlation, one would need to believe either that our measure of IMPACT (ignoring insurance) is largely unrelated to underlying vulnerabilities, or that marginal utilities vary in a way that just offsets the differences in measured vulnerabilities. Both possibilities strike us as improbable.

Evidence of widespread and substantial uninsured vulnerabilities (as measured by actual IMPACT or by the divergence of actual insurance from the benchmark) would also be more difficult to rationalize than it might at first appear. Most potential explanations presuppose that households deliberately choose different living standards for survivors. Yet this premise is inconsistent with preliminary findings from a financial planning case study at Boston University, involving (to date) more than 300 subjects. Each of these individuals constructed a comprehensive financial plan using the same financial planning software employed in the current study. Participants hoped to benefit from these sessions, and therefore had strong incentives to provide accurate information. Though the software permits users to specify different living standards for intact couples and each potential survivor, every subject selected the same living standard for each contingency.[13] While it is perfectly rational for individuals to have other objectives, it is irrational for individuals with these objectives to purchase coverage that diverges significantly from our benchmark (assuming, of course, that the benchmark is derived from a model that correctly depicts all important aspects of the household's opportunity set).

[13]Even with risk aversion, such choices are reasonable if load factors are low. For evidence on load factors in the context of life annuities, see Mitchell, Poterba, Warshawsky, and Brown (1999).

3. Data

The 1992 wave of the HRS (fielded between April 1992 and March 1993) surveyed over 7000 households with at least one spouse between the ages of 51 and 61.[14] The data cover health status, income, wealth, pensions, social security benefits, demographics, education, housing, food consumption, family structure and transfers, current and past employment, retirement plans, cognition, health and life insurance, intra vivos gifts, inheritances, and bequests.[15] Despite the survey's thoroughness, it was necessary to impute a number of household characteristics; see the Appendix for details.

Our final sample consists of 2,113 couples. Table 2 provides some descriptive statistics. We excluded couples for the following reasons: a) Social Security earnings records were unavailable for either spouse; b) a spouse provided inadequate information concerning life insurance policies; c) a spouse refused to be interviewed; d) a spouse was unemployed; or e) the couple's reported income and other economic resources were insufficient to support its reported fixed expenditures. Criterion (a) accounted for nearly 80 percent of excluded observations, and criterion (b) accounted for most of the remaining exclusions.

4. Results

According to table 2, average actual life insurance holdings were close to average benchmark levels for husbands and wives. The average benchmark exceeded the average level of insurance on the life of a primary earner by $8,022 (a rather small sum when amortized over the individual's remaining lifespan); for secondary earners, this relation was reversed. In each case, median life insurance surpassed the median benchmark.

In the second-to-last line of table 2b (Δ liv. std., ignore ins.), we tabulate means and medians for IMPACT calculated as if each household held no life insurance. This variable measures underlying financial

[14] The HRS sampled 5,000 married couples in which both spouses responded, 200 married couples in which one spouse refused to answer, and 2,452 single individuals.

[15] Mitchell and Moore (1997a and 1997b) provide excellent descriptions of the HRS, in general, and the wealth accumulation of the HRS sample in particular.

exposure. Without insurance, the average living standards for surviving husbands, wives, primary earners, and secondary earners would have been, respectively, 6.6 percent, 17.6 percent, 3.9 percent, and 20.3 percent below their highest sustainable levels. Since the corresponding medians for husbands, wives, and primary earners are zero, we can infer that more than half of these individuals were not at-risk of a reduction in sustainable living standard. This finding reflects the fact that many older workers have relatively little human capital to protect.

In the final line of table 2b (Δ liv. std., actual), we tabulate means and medians for IMPACT based on actual insurance holdings. This variable measures residual (uninsured) financial exposure. For both husbands and wives, life insurance reduced average IMPACT by nearly 75 percent. The proportional effect is somewhat smaller for surviving secondary earners, who would, on average, have seen their living standards decline by 7 percent. Accounting for life insurance, a surviving primary earner would not, on average, have experienced any decline in living standard.

Based on these initial findings, one might be inclined to conclude that households with older workers generally carry sufficient insurance to protect survivors against significant declines in living standards. However, this conclusion is premature. Underlying financial exposures vary dramatically across households. From an inspection of averages (table 2), one cannot determine whether the distribution of insurance holdings matches up with the distribution of exposures.

Table 3 provides further information on the distributions of both IMPACT variables. As discussed previously, ignoring insurance, IMPACT is never strictly greater than zero. This reflects the fact that we have imposed a non-negativity constraint on life insurance purchases. An individual's living standard may rise upon a spouse's death; however, without life insurance, it cannot exceed the living standard that the he or she would enjoy as a survivor assuming implementation of the (constrained) benchmark financial plan. Note also that actual IMPACT is exactly equal to zero for a substantial fraction of the population. Generally, these are individuals for whom actual and (model-generated) benchmark levels of insurance protection are both zero.

It is readily evident that insurance holdings match up poorly with financial vulnerabilities. Only 47.1 percent of wives, 18.4 percent of husbands, 50.5 percent of secondary earners, and 15.0 percent of primary earners in the HRS sample required insurance protection to avoid reductions in sustainable living standards upon their spouses' deaths (in Table 3, those with IMPACT, ignoring insurance, less than zero). In contrast, life insurance actually protected 78.7 percent of wives, 61.2 percent of husbands, 77.9 percent of secondary earners, and 62.1 percent of primary earners. Overall, 53.6 percent of wives, 52.7 percent of husbands, 50.8 percent of secondary earners, and 55.5 percent of primary earners had strictly positive life insurance protection despite the fact that they would have experienced increases in living standards upon the deaths of their spouses (in Table 3, those with actual IMPACT greater than zero).

If life insurance holdings were sufficient on average to avert significant declines in survivors' living standards, and if a significant portion of this coverage "protected" individuals without serious exposures, then many of those at-risk must have had substantial uninsured vulnerabilities. According to table 3, insurance reduced the fraction of individuals at-risk of severe financial consequences (defined as a decline in living standard of 40 percent or greater) from 16.9 percent to 11.0 percent for wives, from 20.3 percent to 13.5 percent of secondary earners, from 6.4 percent to 5.1 percent of husbands, and from 3.0 percent to 2.6 percent for primary earners. Similarly, insurance reduced the fraction of individuals at-risk of significant financial consequences (defined as a decline in living standard of 20 percent or greater) from 29.0 percent to 20.4 percent for wives, from 33.4 percent to 23.9 percent for secondary earners, from 10.7 percent to 8.0 percent for husbands, and from 6.2 percent to 4.6 percent for primary earners. Roughly speaking, only 25 to 30 percent of households with significant financial exposures held sufficient life insurance to avert significant consequences for survivors.

Thus far, we have measured the consequences of a spouse's death in terms of the proportional change in sustainable living standard. For many individuals, the potential financial consequences of a spouse's death are also severe in absolute terms. Prior to the death of either spouse, sustainable consumption for 8.0 percent

of the couples in our sample fell below the 1992 poverty thresholds published by the U.S. Census Bureau. Taking into account actual levels of insurance coverage, poverty rates would have been 22.5 percent among surviving wives and 14.6 percent among surviving husbands. These findings imply that 64 percent (14.5 of 22.5 percentage points) of poverty among surviving women and nearly 45 percent (6.6 out of 14.6 percentage points) of poverty among surviving men resulted from a failure to ensure survivors of an undiminished living standard through insurance. Ignoring insurance, poverty rates would have been 27.6 percent among surviving wives and 16.0 percent among surviving husbands. Consequently, insurance eliminated only 26 percent of the avoidable poverty among surviving widows (5.1 out of 19.6 percentage points), and only 18 percent of the avoidable poverty among surviving men (1.4 out of 8.0 percentage points).

In table 4, we subdivide the population based on underlying financial exposure, measured by the value of IMPACT, ignoring insurance. For each subgroup, we then calculate the means of both IMPACT variables, as well as summary statistics describing insurance holdings. When we examine the data in this way, it is even more apparent that insurance holdings are poorly correlated with financial vulnerabilities.

Note that the likelihood of having no life insurance protection was greatest for those with the largest exposures. For secondary (primary) earners, 30.1 percent (50.0 percent) of those with severe exposures had no insurance protection, compared with only 19.3 percent (38.5 percent) of those with no financial exposure. In a simple probit regression explaining whether the couple held insurance on the primary earner's life as a function of IMPACT for the secondary earner (ignoring insurance), the slope coefficient was 0.00525 (σ = 0.00097). For a similar probit regression explaining whether the couple held insurance on the secondary earner's life as a function of IMPACT for the primary earner (ignoring insurance), the slope coefficient was 0.00267 (σ = 0.00194). In both instances, the positive coefficient indicates that those with lower vulnerabilities are more likely to have insurance protection.

More generally, those with greater vulnerabilities did not, on average, have greater insurance protection. According to table 4, the average level of protection for secondary earners falls monotonically with

the degree of underlying vulnerability, from $70,645 among those with no exposure, to only $52,835 among those with severe exposures. For primary earners, there is no obvious relation between average insurance holdings and underlying vulnerabilities. For each observation, we computed the ratio of insurance on the primary earner's life to the primary earner's annual wages, and regressed this on IMPACT for the secondary earner (ignoring insurance). The slope coefficient was 0.0261 (σ = 0.0095). In a similar regression of the insurance-to-earnings ratio for the secondary earner on IMPACT for the primary earner (ignoring insurance), the slope coefficient was 0.0491 (σ = 0.0638). The positive coefficients indicate that those with smaller vulnerabilities hold more insurance on average.

The difference between our two IMPACT variables (actual and ignoring insurance) provides another measure of insurance coverage. If couples hold insurance to moderate the financial consequences of a spouse's death, then this difference should be larger for those with greater vulnerabilities. To some extent, the statistics in table 4 confirm this prediction.[16] However, the correlation is rather weak. In simple regressions of IMPACT (actual insurance) on IMPACT (ignoring insurance), the coefficients of the latter variable are 0.918 (σ = 0.018) for primary earners, and 0.874 (σ = 0.018) for secondary earners. In analogous median regressions, the corresponding coefficients are 1.01 (0.018) for primary earners, and 1.01 (0.026) for secondary earners. The OLS regressions suggest that, on the margin, life insurance holdings offset perhaps 10 percent of the variation in financial vulnerabilities, while the median regressions imply that insurance coverage is entirely unrelated to the degree of financial vulnerability. Furthermore, when we restrict attention to those for whom living standards would actually decline (absent insurance) upon a spouse's death, the corresponding OLS coefficients are 1.01 (σ = 0.039) for primary earners, and 0.913 (σ = 0.031) for secondary earners, while the corresponding median regression coefficients are 1.04 (σ = 0.009) for primary earners, and 1.10 (σ = 0.020)

[16]For secondary earners, insurance reduced mean IMPACT by 22.1 percentage points (from -72.6 percent to -50.5 percent) among those with severe exposures, by 13.9 percentage points (from -29.5 percent to -15.6 percent) among those with IMPACT (ignoring insurance) between -20 percent and -40 percent, by 13.8 percentage points (from -9.7 percent to 4.1 percent) among those with IMPACT (ignoring insurance) between 0 percent and -20 percent, and by 9.8 percentage points (from 0.0 percent to 9.8 percent) among those with no exposure.

for secondary earners. Consequently, for those at-risk of some reduction in living standard, insurance coverage bears very little relation to the degree of financial vulnerability, and there is even some evidence that the correlation may be slightly negative (as indicated by a coefficient in excess of unity).

We draw two other important conclusions from table 4. First, life insurance had, at best, a moderate impact on financial exposures among the at-risk population. For example, among severely at-risk secondary earners, insurance reduced the average consequences of a spouse's death (mean IMPACT) by only thirty percent, from -72.6 percent to -50.5 percent. This is a far cry from the three-fourths overall reduction in mean IMPACT noted in table 2. For this same group, households would have needed to hold an average of $234,189 to assure each surviving secondary earner of an undiminished living standard. In fact, they held on average roughly one-quarter of this amount ($59,961). This implies a discrepancy far larger than the $8,022 overall difference noted in table 2.

Second, for a fixed level of financial exposure, households were more inclined to protect wives and secondary earners than to protect husbands and primary earners. For example, among severely at-risk individuals, only 27.5 percent of wives had no insurance protection, compared with 46.3 percent of husbands. For severely at-risk wives, insurance reduced mean IMPACT by 22.1 percentage points (from -72.6 percent to -50.5 percent), compared with only 10.2 percentage points (from -72.8 percent to -62.6 percent) for husbands.

The frequencies of severe and significant uninsured financial exposures, implied by the distributions of actual IMPACT in table 3, are lower than Auerbach and Kotlikoff's estimates. Possible explanations for the disparity include increases in female labor force participation since the 1960s, changes in patterns of insurance coverage, and methodological differences.

Table 5 provides disaggregated results for various population subgroups. To conserve space, we confine our attention to primary and secondary earners (results for husbands and wives are similar). In addition to reporting the percentage of each subgroup with severe and significant exposures based on IMPACT with

actual insurance (Freq. Actual) and on IMPACT ignoring insurance (Freq. Ins=0), we also report the fractional reduction in each exposure rate resulting from insurance coverage (Frac. Addr.).[17]

Significant and severe uninsured financial vulnerabilities were more common among low income households, couples with disparate earnings, relatively young households, couples with dependent children, and especially non-whites. As one would expect, the likelihood of having a substantial uninsured vulnerability declines monotonically with the affected individual's age. For secondary earners, the frequency of vulnerability is non-monotonic in total household earnings; those belonging to middle income households are least likely to experience significant or severe declines in living standard upon the primary earner's death.

Households with combinations of risk factors may be particularly likely to have substantial uninsured financial vulnerabilities. To investigate this possibility, we estimated quantile regressions (omitted) describing actual IMPACT as a function of various individual and household characteristics. Among wives and secondary earners, financial vulnerabilities tend to rise with total household earnings and spouse's earnings share, and tend to fall with own age, spouse's age, educational attainment, own pension status, spouse's pension status, and homeownership. In many cases, these effects are strongest among the fraction of the population that is least well insured (that is, at the 25th percentile), and weakest among the fraction of the population that is best insured (at the 75th percentile). This suggests that well-insured individuals may better appreciate the relationships between household characteristics and insurance needs. The coefficients for other variables, including total household earnings, the ratio of assets to earnings, number of dependents, and self-assessed survival probabilities (own and spouse) were generally insignificant. For husbands and primary earners, the estimated coefficients were typically smaller and often statistically insignificant at conventional levels of confidence.

The absence of significant relations between actual IMPACT and self-assessed measures of survival probabilities merits emphasis. It implies that low levels of insurance are not attributable to optimism

[17]Formally, frac. addr. (fraction addressed) = [(Freq. Ins=0) - (Freq. Actual)]/(Freq. Ins=0).

concerning longevity. Fixing insurance premiums, an increase in perceived longevity is equivalent to an increase in the implied load factor. Consequently, this finding also casts doubt on the hypothesis that high load factors account for substantial uninsured vulnerabilities.

Using these regression estimates, we computed fitted quantiles for households with the following profiles of high-risk characteristics: spouse accounts for 100 percent of earnings (50 percent in the case of primary earners), ages 52 (husband) and 48 (wife), one dependent, no college degree, no pensions, non-white, renter. According to our estimates, the median high-risk secondary earner (wife) would experience a drop in sustainable living standard upon his or her spouse's death of 40.0 (31.2) percent. Even at the 75th percentile, there would be a 6.9 (2.9) percent decline. At the 25th percentile, resources would not be sufficient even to cover fixed expenditures (the fitted value is less than -100). In contrast, for primary earners and husbands, the effects of high-risk characteristics are smaller, and concentrated in the lower tail of the distribution. The fitted median and 75th percentile values of IMPACT for high-risk primary earners and husbands are within a percentage point of zero, while the 25th percentile values are -15.4 percent for primary earners, and -36.8 percent for husbands.

According to table 5, conditional upon the existence of a significant or severe vulnerability, households in the upper and lower tails of the income distribution, older households, and non-whites were less likely to moderate the financial consequences of a spouse's death through life insurance. Households were less likely to address severe vulnerabilities for primary earners. Note that a low proclivity to address exposures can coincide either with high (as in the case of lower income households and especially non-whites) or low (as in the case of older individuals and primary earners) levels of underlying vulnerability.

5. Robustness

In table 6, we examine the extent to which our estimated frequencies of significant and severe uninsured vulnerabilities are sensitive to changes in key assumptions and parameters. To conserve space, we focus on primary and secondary earners. For purposes of comparison, we reproduce our base-case results in the first line of the table.

Changes in the real interest rate, baseline wage growth rate, and maximum lifespan are relatively inconsequential.[18] In each case, this reflects the opposing effects of offsetting forces. With higher interest rates, a given level of life insurance coverage generates higher real income. However, since survivors are typically more dependent on long-duration life annuities than intact couples, the present discounted value of their resources tends to decline by a larger proportion when the rate of return rises. For older workers, the rate of wage growth is relatively unimportant because it affects comparatively few years of earnings. Moreover, while a given rate of growth produces a larger absolute increase in earnings for primary earners, secondary earners tend to be younger, and therefore benefit from higher growth over a longer time frame. A reduction in maximum lifespan reduces the resources that a survivor needs to achieve a given living standard, but increases the living standard that the intact couple can achieve from available resources.

The consumption growth rate refers to steepness of the sustainable living standard trajectory. For our base-case, we compute the highest living standard that is sustainable throughout life in all contingencies; this corresponds to a consumption growth rate of zero. For sufficiently patient (impatient) households, it may be more natural to construct benchmarks based on a rising (falling) living standard trajectory. The proportional effects of a change in the consumption growth rate on the resource needs of survivors and intact couples are approximately equal. Our results are therefore robust with respect to changes in this parameter.

In contrast, our findings are sensitive to assumptions concerning household economies of scale, pension survivor benefits, and housing. The frequencies of exposure to significant and severe financial consequences are noticeably lower in the absence of household scale economies (an extreme and somewhat

[18]For our base case, we assume that the inflation rate and real interest rate are both 3 percent.

implausible assumption), and higher when we reduce the rate of pension survivor benefits from 100 percent to 50 percent.

As mentioned previously, our base case assumptions concerning housing are consistent with empirical evidence indicating that older households avoid changing residences prior to death, and that they resist using housing equity to finance ordinary living expenses. Analysis of the HRS panel corroborates the reluctance to move among widows. By the second wave of the HRS (April 1994 through December 1994), 83.8 percent of newly widowed women had not changed residence. Wave 3 (May 1996 through February 1997) contains information on residences for 62.3 percent of these initial widows; 82.7 percent had not moved. Wave 4 (February 1998 through March 1999) contains information on 56.3 percent of the initial widows; 92.6 percent had not moved.[19]

Since some widows do move, we examine sensitivity to two alternative assumptions. For the first, we adopt the extreme position that housing consumption is completely and continuously flexible, and that housing equity is a perfect substitute for other forms of wealth. For the second alternative, we adopt an intermediate position: a survivor downsizes the couple's primary residence by 30 percent, but thereafter avoids using housing equity to finance ordinary living expenses.[20] Though the first alternative dramatically reduces the estimated frequencies of individuals at risk of severe or significant financial consequences, the effect of the second alternative is small.

For our base case, we assume that survivors do not alter their labor force participation. Since non-working wives approaching retirement age have limited employment options subsequent to their husbands' deaths, this assumption is particularly appropriate for the HRS sample. Between the first two waves of the

[19]Apparently, there is some sample selection: those who do not move are more likely to remain in the sample.

[20]In this exercise, we assume that the financing for the new house is the same as the continuation financing for the old house. Consequently, upon a spouse's death, the decline in home equity equals the reduction in the value of the home, and there is an offsetting increase in non-housing assets; mortgage payments are unchanged, but other housing expenses fall by 30 percent.

HRS survey, only 2.9 percent of newly-widowed non-working women went back to work, compared with 4.0 percent of non-working non-widows; 6.7 percent of newly-widowed working women withdrew from the labor force, compared with 9.3 percent of working non-widows. Thus, the net change in labor force participation differed only slightly for these two groups. Only 5.6 percent of new widows said that they increased their work hours subsequent to their husbands' deaths; 4.2 percent said that they decreased their hours, and 90.2 percent reported no change. On average, contemporaneously reported employment fell by 2.8 hours per week for widows, compared with 0.4 hours per week for non-widows. Results for subsequent waves of the HRS are qualitatively similar.

To evaluate the sensitivity of our results with respect to possible changes in labor force participation, we consider an extreme alternative assumption: all survivors, whether out of the labor force or employed part-time, return to full-time employment. We impute full-time earnings based on regressions of earnings on demographic characteristics, estimated separately for fully employed men and women. A survivor's contingent earnings are set equal to the maximum of imputed earnings and actual earnings. Due to familiar sample selection problems, this procedure tends to overstate potential earnings for non-workers; it therefore understates survivors' financial vulnerabilities. As indicated in table 6, the estimated frequencies of financial vulnerability are only moderately sensitive to this alternative assumption. This not particularly surprising. Financial vulnerabilities are common even among dual-earner couples (recall table 5). Moreover, only 32 percent of the wives in our sample were not employed, and only 13 percent worked part-time.

In principle, shifts in non-labor income might also cushion the financial impact of a spouse's death. Our analysis makes no allowance for this possibility. Presumably, the most important source of potential support is assistance from relatives. Between the first two waves of the HRS, only 6.2 percent of new widows reported receiving any assistance of this type. Between the second and third waves, the figure was 7.5 percent; and between the third and fourth waves, it was only 2.5 percent. In addition, support may have been modest and/or temporary in many of these cases. Consequently, there is little evidence that external support payments

are significant in practice.

If important economic variables are measured with error, our calculations may overstate the thickness of the upper and lower tails of the distribution of IMPACT, thereby exaggerating the frequencies of significant and severe financial vulnerabilities. Measures of household assets tend to be particularly noisy. However, as illustrated in the final two rows of table 6, our findings are not particularly sensitive to moderate changes in the values of wealth (a 20 percent increase or decrease). Accurate measurement of life insurance coverage is, of course, particularly critical for our analysis. Fortunately, the HRS data match up reasonably well with other sources of information concerning this variable.[21]

As mentioned in section 2, we have ignored the possibility that remarriage might cushion the impact of a spouse's death. Since it is difficult to model the consequences of remarriage, we did not conduct pertinent sensitivity analysis. However, given the age distribution of individuals in the HRS sample, the assumption of no remarriage seems generally appropriate. Analysis of the HRS panel corroborates this suspicion. By the second wave of the HRS, only 3.6 percent of newly widowed women had remarried. Wave 3 contains information on marital status for 62.2 percent of these initial widows; 11.5 percent had remarried. Wave 4 contains information on 56.7 percent of the initial widows; 10.6 percent had remarried. Of those widowed between waves 2 and 3, less than one percent had remarried by wave 3, and only 4.3 percent had married by wave 4.[22]

Although the estimated fractions of individuals with significant and severe uninsured financial

[21]The Life Insurance Marketing and Research Organization (LIMRA) has published statistics on ownership of life insurance for 1984; see American Council of Life Insurance (1992). LIMRA classifies households by the age of the household head. The percentages of households for which at least one member owned individual or group life insurance were as follows: 71 percent for age 65 and over, 91 percent for ages 55 through 64, and 89 percent for ages 45-54. Average total coverage (inflated to 1992 dollars) among households with insurance was $17,959 for age 65 and over, $64,681 for ages 55 through 64, and $110,998 for ages 45 through 54. The HRS sample cuts across these three age groups. At least one household member owned insurance for 84 percent of HRS households, and average total coverage among households with insurance was $117,010.

[22]Wave 4 contains marital status information on 87.0 percent of women who were widowed between waves 2 and 3.

vulnerabilities are sensitive to certain critical assumptions, it is important to emphasize that the poor correlation between coverage and vulnerability is robust. From table 6, we see that the reduction in the estimated incidence of vulnerability is largest when we assume either that there are no economies of shared living, that housing expenditures are completely flexible, or that all survivors work full time. However, for all of these alternative scenarios, simple probit and OLS regression (identical to those discussed in section 4) continue to indicate that those with greater vulnerabilities (measured by IMPACT, ignoring insurance) are less likely to have coverage, and have less coverage on average, than those with greater vulnerabilities.

6. Conclusions

Using data on older workers from the 1992 Health and Retirement Survey along with an elaborate life-cycle planning model, we have quantified the extent to which the death of each individual would have affected the financial status of his or her survivors, and we have measured the degree to which life insurance holdings moderated these consequences. On average, life insurance was sufficient to avert significant declines in survivors' living standards. However, this average obscures a startling mismatch between insurance holdings and underlying financial vulnerabilities. The impact of life insurance on the financial security of at-risk individuals was surprisingly small. We have also identified household characteristics that are correlated with uninsured financial vulnerabilities, as well as with the proclivity to address any given degree of vulnerability by purchasing life insurance.

Table 1 Sample life insurance benchmarks

	Insurance benchmark for husband	Insurance benchmark for wife
Base case	133,500	0
+ Age (58,54)	68,500	0
- Age (50,46)	192,000	0
+ Husband's earnings ($60K)	195,000	0
- Husband's earnings ($30K) ($20,000)	70,500	28,000
+ Wife's earnings ($30K)	111,500	69,000
- Wife's earnings ($0)	174,000	0
+ Child (age 16)	139,000	0
- Child	132,000	0
+ Earnings growth (2%)	143,500	0
- Earnings growth (0%)	125,000	0
+ Real interest rate (5%)	118,500	0
- Real interest rate (1%)	152,000	0

Assumptions for base case: age of husband: 54, age of wife: 50, husband's employee earnings: $45,000, wife's employee earnings: $25,000, husband's retirement age: 64, wife's retirement age: 63, number of children: 1, age of child: 18, non-housing net wealth: $50,000, primary home value: $100,000, mortgage balance: $20,000, earnings growth: 1%, real interest rate: 3%.

Table 2 Descriptive statistics

Table 2a: Household level variables

	Mean	Median
Non-housing net wealth	186,128	48,500
Primary home ownership	0.93	1
Primary home value	105,165	85,000
Household non-asset income	68,532	50,853
Number of children	0.23	0

Table 2b: Individual level variables

	Husband		Wife		Primary earner		Secondary earner	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Age	58	57	54	54	57	56	54	55
Non white	0.153	0	0.153	0	0.153	0	0.153	0
Gender	0	0	1	1	0.184	0	0.816	1
College degree	0.283	0	0.205	0	0.292	0	0.196	0
Pension coverage	0.471	0	0.363	0	0.526	1	0.308	0
Non-asset income	50,741	36,077	17,790	12,763	54,753	37,851	13,779	10,665
Actual life ins.	66,165	25,000	20,940	4,991	64,081	24,176	23,024	5,000
Benchmark life ins.	62,098	0	17,126	0	72,103	1,688	7,121	0
Δ liv. std., ignore ins.	-6.62%	0.00%	-17.6%	0.00%	-3.93%	0.00%	-20.3%	-0.70%
Δ liv. std., actual if spouse dies	-1.81%	0.24%	-4.49%	0.85%	0.70%	0.39%	-7.00%	0.26%

Note: Actual and benchmark life insurance refer to insurance on the life of the individual listed at the top of the column.
Changes in living standard (Δ liv. std.) for the spouse listed at the top of each column depend on insurance on the life of the other spouse.

Table 3 Distribution of Changes in Living Standard for Surviving Spouses

Panel A: Husbands and Wives

	Surviving spouses are:			
	Wives		Husbands	
IMPACT	Ignoring Insurance	Actual	Ignoring insurance	Actual
<-40%	16.85%	11.03%	6.44%	5.06%
-40% to -20%	12.12%	9.37%	4.21%	2.98%
-20% to 0%	18.13%	15.95%	7.76%	6.96%
0%	52.91%	10.03%	81.59%	32.28%
0% to +20%	-	43.59%	-	49.93%
+20% to +40%	-	6.25%	-	1.85%
>+40%	-	3.79%	-	0.95%
Observations	2113	2113	2113	2113

Panel B: Primary and Secondary Earners

	Surviving spouses are:			
	Secondary earners		Primary earners	
IMPACT	Ignoring insurance	Actual	Ignoring insurance	Actual
<-40%	20.26%	13.54%	3.03%	2.56%
-40% to -20%	13.16%	10.32%	3.17%	2.04%
-20% to 0%	17.13%	15.76%	8.76%	7.15%
0%	49.46%	9.56%	85.04%	32.75%
0% to +20%	-	41.55%	-	51.96%
+20% to +40%	-	5.92%	-	2.18%
>+40%	-	3.36%	-	1.37%
Observations	2113	2113	2113	2113

Table 4 Effect of Life Insurance on Changes in Living Standards for Surviving Spouses, by Level of Vulnerability

Surviving souses are:	Range for IMPACT, ignoring insurance	Mean IMPACT		Insurance Holdings		
		Ignoring insurance	Actual insurance	Percent uninsured	Mean benchmark	Mean actual
Wives	<-40%	-72.6%	-50.5%	27.5%	234,189	59,961
	-40% to -20%	-29.5%	-15.6%	22.7%	119,120	59,494
	0% to -20%	-9.7%	4.1%	21.4%	45,293	63,319
	0%	0.0%	9.8%	19.0%	0	70,643
Husbands	<-40%	-72.8%	-62.6%	46.3%	171,016	22,568
	-40% to -20%	-28.1%	-16.0%	33.7%	89,554	29,700
	0% to -20%	-9.7%	-0.1%	26.8%	30,241	26,103
	0%	0.0%	3.6%	39.6%	0	19,868
Secondary	<-40%	-72.7%	-52.7%	30.1%	238,327	52,835
earners	-40% to -20%	-29.3%	-14.9%	22.7%	122,388	59,065
	0% to -20%	-9.8%	4.7%	20.4%	45,101	62,279
	0%	0.0%	9.7%	19.3%	0	70,645
Primary	<-40%	-72.5%	-61.6%	50.0%	72,271	28,156
earners	-40% to -20%	-28.5%	-19.2%	37.3%	66,287	21,698
	0% to -20%	-9.4%	-0.8%	28.1%	32,324	32,363
	0%	0.0%	3.8%	38.5%	0	21,929

Table 5 Frequency of Severe and Significant Financial Consequences for Surviving Spouses: Selected Population Subgroups

	Consequences for Secondary Earners						Consequences for Primary Earners					
	Severe (>40%)			Significant (>20%)			Severe (>40%)			Significant (>20%)		
	Freq. Actual	Freq. Ins=0	Frac. Addr.	Freq. Actual	Freq Ins=0	Frac. Addr.	Freq. Actual	Freq Ins=0	Frac. Addr.	Freq. Actual	Freq Ins=0	Frac. Addr.
Full sample	13.5%	20.3%	0.335	23.9%	33.4%	0.284	2.56%	3.03%	0.155	4.60%	6.20%	0.258
HH earnings < $45K	20.5%	27.0%	0.241	31.0%	40.0%	0.225	5.37%	5.83%	0.080	7.93%	9.57%	0.171
HH earnings $45-$100K	7.62%	15.1%	0.495	17.3%	28.4%	0.391	0.68%	1.25%	0.456	2.51%	4.15%	0.395
HH earnings > $100K	14.2%	18.4%	0.228	27.1%	31.7%	0.145	0.46%	0.46%	0.000	1.38%	2.75%	0.498
Dual earners	12.1%	18.5%	0.346	22.8%	32.4%	0.296	3.11%	3.64%	0.146	5.64%	7.52%	0.250
Single earners	19.6%	27.6%	0.290	28.4%	37.7%	0.247	0.24%	0.49%	0.510	0.24%	0.73%	0.671
Earnings diff. 1-1 to 2-1	8.52%	12.5%	0.318	17.5%	25.0%	0.300	5.49%	6.32%	0.131	10.6%	13.9%	0.237
Earnings diff. over 4-1	18.6%	27.7%	0.329	29.6%	40.4%	0.267	0.32%	0.54%	0.407	0.32%	0.65%	0.508
Age of survivor: 40-49	15.8%	27.3%	0.421	29.8%	43.8%	0.320	6.60%	7.55%	0.126	11.3%	11.3%	0.000
Age of survivor: 50-59	14.2%	20.9%	0.321	25.2%	35.1%	0.282	2.53%	2.97%	0.148	4.49%	6.23%	0.279
Age of survivor: 60-69	8.90%	12.6%	0.294	14.1%	19.9%	0.291	1.35%	1.86%	0.274	3.21%	4.90%	0.345
No children	12.3%	18.8%	0.346	22.7%	31.6%	0.282	2.27%	2.78%	0.183	4.20%	5.79%	0.275
One or more child	19.8%	27.5%	0.280	29.8%	42.7%	0.302	4.01%	4.30%	0.070	6.59%	8.31%	0.207
Whites	11.2%	17.9%	0.374	21.0%	31.0%	0.323	1.90%	2.23%	0.148	3.69%	5.08%	0.274
Non-whites	26.4%	33.2%	0.205	39.8%	46.9%	0.151	6.23%	7.48%	0.167	9.66%	12.5%	0.227

Table 6 Frequency of Severe and Significant Financial Consequences for Surviving Spouses: Robustness (Full Sample, Actual Insurance)

	Consequences for Secondary Earners		Consequences for Primary Earners	
	Severe (>40%)	Significant (>20%)	Severe (>40%)	Significant (>20%)
Base case	13.5%	23.9%	2.56%	4.60%
Real interest rate = 1%	13.2%	23.7%	2.20%	4.55%
Real interest rate = 5%	13.7%	23.6%	2.34%	4.39%
Baseline wage growth rate = 0%	13.2%	23.0%	2.51%	4.41%
Baseline wage growth rate = 2%	14.2%	25.0%	2.42%	4.93%
Maximum lifespan = 85	13.5%	23.7%	2.56%	4.60%
Consumption growth rate = 1%	13.3%	23.5%	2.39%	4.45%
Consumption growth rate = -1%	14.0%	24.2%	2.56%	4.84%
No ecs. of shared living (α=1)	10.7%	16.0%	1.71%	3.09%
Survivor receives 50% pens. bens.	17.5%	32.0%	2.61%	5.12%
Housing completely fungible	6.01%	12.2%	0.36%	1.20%
Survivor downsizes house by 30%	12.9%	22.9%	2.18%	4.30%
Survivors fully employed	9.89%	19.3%	2.41%	4.45%
Wealth reduced by 20%	14.8%	25.4%	2.84%	4.93%
Wealth increased by 20%	13.1%	22.9%	2.45%	4.61%

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Appendix

Data Imputation

Life Insurance. The HRS collects information about term and whole life insurance policies, but not the term component of whole life policies. We impute the term component using a regression explaining the ratio of cash value to face value as a function of the age of each spouse, the face value of the policy, family income, family size, and financial assets. We estimate this regression using data from the 1995 Survey of Consumer Finances (SCF).[23]

Non-Asset Income. Our calculations require data on each spouse's past and future covered earnings as well as future total (covered and uncovered) earnings. We obtain past covered earnings from the HRS restricted data file. We impute future covered and total earnings as follows. First, we adjust actual earnings in the current year (1991) to remove the effects of temporary fluctuations. Specifically, we assume that actual earnings for 1991 equaled the maximum of 1991 reported earnings and 1991 covered earnings. We then define adjusted covered earnings in year $t \leq 1991$ as covered earnings in year t adjusted for inflation to 1991 dollars, multiplied by $(1 + \text{assumed earnings growth rate})^{(1991-t)}$. Next, we define normal adjusted covered earnings as a five year average (1987-1991) of adjusted covered earnings. We then set normal earnings equal to 1991 earnings times the ratio of normal adjusted covered earnings to 1991 covered earnings. To compute future earnings, we let normal earnings grow at the assumed real earnings growth rate. We obtain future covered earnings directly from imputed future earnings based on applicable statutes.

The HRS provides information on other kinds of non-asset income. We treat some of these income sources, such as Veteran's Benefits, SSI, disability income, welfare, child support, and regular help from friends or relatives, as non-taxable. Except for Social Security disability income and child support, we assume these income streams continue, with full adjustments for inflation, until the respondent's death. Social Security disability income is assumed to end at age 62, when the recipient becomes eligible for Social Security retirement benefits. We divide child support received by the number of children to obtain child support per child and assume it is received until the child in question reaches 18.[24] We treat other kinds of special receipts, such as income from trust funds and royalties, as taxable. We assume they will be received for ten years beyond the survey date, and that the payments will be constant in nominal terms. Relatively few respondents receive these kinds of income flows, and the amounts are generally small relative to average earnings. We assume that HRS respondents retire at their stated intended ages of retirement or age 70, whichever is smaller. For those who fail to say when they will retire, we use age 65.

Pension Plans, Retirement Accounts, and Social Security. The HRS provides information on nominal benefits currently received from defined benefit pension plans as well as expected nominal benefits for future pension recipients. It also indicates whether these benefits are indexed for inflation. We assume that a surviving

[23] In this analysis, we restrict attention to policies that name the spouse or children living in the household as beneficiaries. Roughly 5 percent of individuals hold a life insurance policy that names some other party or entity (such as a trust) as beneficiary.

[24] The HRS reports only the sum of child support and spousal support. However, we confine our attention to couples, 98 percent of which are married. Since spousal support generally ends upon remarriage (and also declines somewhat on average when individuals become unmarried partners), we can safely assume that the entire reported amount is child support.

spouse would receive 100 percent of the monthly benefit or lump-sum distribution. We further assume that employer-sponsored defined contribution plans and all private retirement accounts (IRAs and Keoghs) provide for tax-deductible contributions and tax-deferred accumulation. Contributions in all future years up to age 59 are set equal, in real terms, to contributions in the survey year. The HRS contains information on 401(k) accounts for individual spouses, but IRA and Keogh account balances are reported only at the household level. We impute each spouse's IRA and Keogh account balances and contribution amounts based on their share of 1991 household labor earnings.[25]

We code an individual as having a pension or retirement account of a particular type if and only if the individual affirmatively indicates that he or she had such a pension or retirement account. If the individual provides insufficient information to ascertain whether he or she had a pension or retirement account (for example, if the response was "don't know"), we assume that no such account exists.

If an individual is already receiving Social Security benefits, we assume that benefits have already started. Otherwise, we impute the initial age of benefit receipt as follows. If the individual is still working, we assume that benefits will start at his or her projected retirement age (but not earlier than age 62). If the individual is retired, we assume that benefits will start at age 62 for those currently under 62, and at the current age for those over 62. In all cases, the initial age of benefit receipt is between 62 and 70. For respondents currently receiving social security disability benefits, we assume that they switch to retirement benefits at age 62.

Our calculations also require information on the age at which individuals begin to receive private pension benefits. If the individual is already receiving benefits, we assume that benefits have already started. If the individual is not receiving benefits, but indicates the age at which he or she expects benefits to begin, we use that age. Otherwise, we impute the initial age of pension benefit receipt in exactly the same manner as for Social Security retirement benefits, based on work status, current age, and projected retirement age. In all cases, we truncate the benefit inception date at 70.

Individuals with previous marriages lasting more than ten years and ending in divorce or separation (roughly 20 percent of the total HRS sample), and individuals with previous marriages lasting more than nine months and ending in the spouse's death (roughly 8 percent of the total HRS sample) are eligible to receive Social Security benefits based on the earnings history of their prior spouse. This presents us with a problem, since we do not have access to covered earnings histories for prior spouses. We assume that all such individuals receive benefits based on either their own earnings history or that of their current spouse.

Housing. Our calculations require information on a variety of specific housing expenditures, including mortgages, home insurance premiums, property taxes, and other recurring expenses. The HRS contains detailed information on recurring expenses such as association fees and site rental charges for households living in mobile homes. While it does not contain information on home insurance premiums, it does include the face amount of insurance. We imputed annual home insurance premiums by assuming a rate of $0.0025 for each dollar of insurance coverage. Information on property taxes is usually available. When it is not, we impute it using the home value and applying the average ratio of property taxes to home value obtained from the rest of the sample.

[25]The ownership of these balances influences the timing of withdraws. This, in turns, affects tax liabilities. The timing of withdrawals also may determine whether the couple is liquidity constrained as it approaches retirement.

In some instances, mortgage payments reported in the sample include property taxes and home insurance premiums; in such cases, respondents were not asked separately about their taxes and premiums. We impute property taxes from home value by applying the average ratio of property tax to house value for our entire sample. Similarly, we impute insurance premiums by applying the average ratio of (imputed) insurance premium to house value for our entire sample. We assume that the mortgage payment accounts for any residual.

Unfortunately, the HRS does not report the number of years left on each mortgage. We assume that each household took out a 30 year mortgage in the year it purchased its home (which is reported in the HRS), and that it has never refinanced; this allows us to compute the number of years remaining on the mortgage. In cases where the respondent did not report a mortgage payment, we impute one based on the reported balance, the imputed number of years left in the loan, and a representative mortgage interest rate for 1991.

In some instances, rental payments reported in the sample include heat and electricity expenses; in such cases, respondents were not asked separately about these utility payments. We apportion the reported number into separate components by assuming that the ratio of rent to utilities is the same for these respondents as the average ratio computed from the rest of the sample. The HRS does not include any information concerning property taxes paid on second homes. We calculate these from second home values based on the assumption that the ratio of property taxes to value is the same as the average for primary homes (0.0018 monthly). Finally, we set monthly rental payments equal to zero for the few respondents who report that they live in a house or apartment that they neither rent nor own.

Other Variables. For confidentiality reasons, the HRS does not report the respondent's date of birth or state of residency. We assume that each respondent was born on the fifteenth of his or her birth month.[26] For the purposes of computing state taxes, we use Massachusetts law. We set the maximum age of life to 95 for all individuals. We assume that funeral expenses and associated legal fees for deceased spouses will be equal (in real terms) to the sample median for those who died in 1991 ($5,000, based on 90 observations). Aside from funerals, we do not impute any other special expenditures. We set intended bequests equal to zero. As a measure of a household's net worth, we use total non-housing assets minus total non-housing liabilities. Total non-housing assets include checking and saving accounts, money market funds, CDs, government saving bonds, T-bills, stocks, mutual funds, investment trusts, business equity, bonds, bond funds, real estate other than primary and vacation homes, the cash value of life insurance policies, and some miscellaneous items. Total non-housing liabilities include personal loans, student loans, credit card balances, car loans, installment loans, and other non housing debt. Housing debt (mortgages and equity lines of credit) are considered separately (see above). We assume that, apart from mortgages and other outstanding housing debt, households cannot borrow against future income. For our base case, we use a 3 percent rate of inflation and a 3 percent real pre-tax rate of return.

[26]Ten respondents did not report month of birth; we assume they were born in June.

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