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Mean and pessimistic projections of retirement adequacy

Yoonkyung Yuh[a], Sherman Hanna[b,*], Catherine Phillips Montalto[c]

[a]*Won-building 6th floor, Yumri-dong, Mapo-ku, Seoul Korea (ROK)*
[b]*Professor, Consumer and Textile Sciences Department, The Ohio State University, 1787 Neil Ave., Columbus, OH 43210-1295, USA*
[c]*Assistant Professor, Consumer and Textile Sciences Department, The Ohio State University, 1787 Neil Ave., Columbus, OH 43210-1295, USA*

Abstract

Retirement adequacy is estimated using a 1995 United States sample of households. Based on mean lognormal portfolio projections and current contribution rates, 52% of households are adequately prepared for retirement. Based on pessimistic projections, only 42% of households are adequately prepared. A regression of the ratio of projected wealth to needs at retirement shows that adequacy increases with stock share (mean projection) and the impact increases with time until retirement. With pessimistic projections, there is no significant relationship between stock share and the adequacy ratio. Planned retirement age and household spending behavior are each significantly related to the adequacy ratio. © 1998 Elsevier Science Inc. All rights reserved.

1. Introduction

The elderly population in the United States is growing at a much faster rate than the population as a whole. The number of persons 65 years old and over in 1996 (34 million) was 11 times larger than in 1900 (3 million). Over this same period, the number of persons under 65 years old only tripled. The elderly population is projected to more than double by the middle of the 21st century to 79 million, at which time elderly persons will represent 20% of the United States population (U.S. Bureau of the Census, 1998). While the number of older persons is rapidly growing, the financial situation for future retirees remains uncertain. Retirement income is commonly assumed to come from the triad of Social Security, private

* Corresponding author. Tel.: +1-614-292-4584; fax: +1-614-292-7536.
E-mail address: hanna.1@osu.edu (S. Hanna)

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pensions, and personal saving. Planned reductions in Social Security benefits for retirement before age 67 and the shift away from defined benefit pension plans (U.S. General Accounting Office, 1996) increase the importance of personal saving as a source of retirement income. Personal savings rates in the United States have decreased recently to very low levels, reaching −0.2% in September, 1998 (U.S. Department of Commerce, 1998), so individuals must carefully determine how much to save for retirement and how to invest savings in order to be prepared financially for retirement.

Retirement savings can be invested in a variety of ways, ranging from traditional savings accounts with relatively low rates of return, to publicly traded stocks and mutual funds offering relatively high rates of return. Previous research has documented variation across individuals in the choice of investment vehicles, or portfolio allocation (Bajtelsmit and Van Derhei, 1996). However, an individual's retirement funds are invested for a particular period of time during which market rates of return can vary. An individual investor may receive an unusually high or unusually low rate of return. While it is routine to use average rates of return to project retirement resources, this may over- or under-estimate the ultimate accumulation depending on the actual market rates of return. A better picture of the range of possibilities can be provided by making more than one projection of retirement resources.

The purpose of this study is to investigate the adequacy of retirement wealth using both mean and pessimistic projections of retirement wealth. Unique contributions of this research include use of household specific information on planned retirement age and portfolio allocation, projection of retirement wealth using asset specific growth rates, estimation of retirement needs based on household expenditure functions, and comparison of adequacy based on mean and pessimistic projections.

2. Review of the literature

2.1. Related empirical research

Analysis of retirement wealth adequacy requires information on the resources that will be available in retirement, as well as the amount needed to finance consumption during those years. Retirement adequacy can be defined as having resources exceed the amount needed to finance desired retirement consumption. A "retirement gap" exists when resources are less than the amount needed. Duncan et al. (1984) use this framework to determine savings goals for retirement. In order to implement such a framework, it is necessary to estimate the resources an individual will have accumulated at the date of retirement, as well as the amount needed to finance consumption during the retirement years. A variety of techniques have been used in previous research to estimate the amount needed to finance retirement consumption and to project the resources available for retirement.

2.1.1. Retirement needs

Estimation of retirement needs is often based on the life cycle hypothesis, and the assumption that individuals desire to smooth the level of consumption over their lifetime (Modigliani and Brumberg, 1954). Bernheim et al. (1997) challenge the validity of standard life cycle models to explain actual variations in saving and wealth. The most commonly used method to estimate the level of retirement need is to specify the percentage of preretirement income that represents the desired consumption level in retirement. This percentage is commonly referred to as the "replacement rate." Duncan et al. (1984) set the replacement rate equal to 100% in their standard model, but use rates in the range of 70% to 90% in their calculation of hypothetical cases. Other researchers adopt similar replacement rates in empirical research (Burns and Widdows, 1988, 1990; Mitchell and Moore, 1997). Palmer (1989, 1994) calculates replacement rates based on data from the Consumer Expenditure Survey. These replacement rates (based on gross income) range from 65% to 85%, vary with marital and employment status, and generally decline with income. Palmer's replacement rates are used by other researchers to estimate retirement needs (Li et al., 1996).

Approaches other than the replacement rate are used to estimate retirement needs. Moore and Mitchell (1997) jointly estimate replacement rates and savings rates given current earnings and projected assets. Yuh et al. (1998) use the household's level of preretirement consumption as a proxy for the household's desired level of retirement consumption.

2.1.2. Retirement wealth

In order to estimate the level of retirement wealth, it is necessary to determine which resources will be available for retirement, as well as to determine the value of the accumulated resources at the point of retirement. Empirical measures of retirement wealth commonly include the value of financial assets, but the treatment of nonfinancial assets, particularly the value of home equity, varies. Duncan et al. (1984) define retirement income to include social security, private pensions, house equity at retirement, and other assets not earmarked for other purposes (such as children's education). Burns and Widdows (1988), Li et al. (1996), Moore and Mitchell (1997), and Yuh et al. (1998) use similar definitions of retirement income that include the value of home equity. Burns and Widdows (1990) examine the sensitivity of retirement savings rates to the treatment of home equity. Bernheim (1996) excludes home equity from the calculation of assets available to finance consumption during retirement.

Home equity accounts for the largest share of total household wealth in the United States. It can be converted to a more liquid form by selling the house or using debt instruments such as second mortgages, home equity loans, and reverse mortgages. While most people do not sell their homes in retirement or use reverse mortgages to finance retirement consumption, home equity represents an important potential resource. Furthermore, a homeowner will be better off in retirement than an otherwise similar renter, so inclusion of home equity results in more valid comparisons between owners and renters. Using a comprehensive measure of asset availability is particularly important when evaluating the resources that could be used to finance expenditures during retirement, including costs of long-term care (Mitchell and Moore, 1997; Andrews, 1993).

Once the components of retirement wealth are defined, it is necessary to determine the value of the accumulated resources at the point of retirement. Li et al. (1996) use panel data containing information on households at the point of planned retirement. Retirement wealth is calculated as the household's net worth at the point of planned retirement plus the present value of income streams from Social Security and other pension plans. Much research focuses on determining the "future" retirement wealth adequacy of currently pre-retired households, particularly baby boomers.

For pre-retired households, wealth at the point of retirement in the future must be projected, and therefore information is needed on the future rates of return, or growth rates, for assets. Various approaches have been used to project the value of retirement wealth, including use of a common growth rate for all financial assets (Burns and Widdows, 1988), and use of asset specific growth rates (Moore and Mitchell, 1997; Yuh et al., 1998). For example, Burns and Widdows (1988) use growth rates of 0% and 3%. Moore and Mitchell (1997) project individual components of net financial wealth assuming the growth rates are geometric averages of historical real returns. While this approach is an improvement over the use of a common growth rate for all financial assets, it ignores risks associated with investments due to changes in interest rates over time. Yuh et al. (1998) also project individual components of financial and nonfinancial wealth, but use both average and pessimistic growth rates generated from historical rates of return and a lognormal forecasting model.

2.1.3. Savings rate

In general, the previous research suggests that pre-retired people are not adequately prepared financially for their retirement and thus need additional savings in order to have adequate retirement wealth. Moore and Mitchell (1997) examine the adequacy of asset holdings of persons on the verge of retirement using data from the Health and Retirement Study (HRS). They compare the projected value of assets at retirement with estimated retirement needs, and determine the level of saving needed to maintain the retirement consumption. Retirement is assumed to occur at ages 62 and 65. They conclude that the majority of older households will not be able to maintain current levels of consumption into retirement without increasing savings. In particular, the median HRS household would have to save an additional 16% of earnings to maintain the pre-retirement consumption level for age 62 retirement, or an additional seven percent of earnings for retirement at age 65.

In a related study, Mitchell and Moore (1997) use the HRS data to examine the adequacy of retirement wealth for a household with characteristics similar to HRS median characteristics (a married couple household, husband and wife both age 56 in 1992, with an annual household income of $46,000). Wealth accumulation is projected for retirement at age 65 assuming a portfolio of 60% bonds and 40% stocks. The wealth accumulation is compared to a retirement needs calculation using replacement rates of 70% and 80%. Substantial shortfalls in retirement wealth accumulations are found, and the authors conclude that the median American on the verge of retirement has accumulated too little wealth to support a comfortable retirement.

Bernheim (1996) calculates the ratio of actual savings to savings needed to maintain the preretirement level of living during the retirement years for respondents to a Merrill Lynch survey. A computer simulation model is used to determine the prescribed savings levels and these levels are compared with actual savings behavior. An Adequacy Index is developed based on actual savings as a percentage of prescribed savings for three cases: pessimistic, optimistic, and midpoint. The index indicates a significant shortfall in the retirement savings of the baby boom generation. The overall index at the midpoint (36%) indicates that the typical baby boom household needs to nearly triple its rate of saving to maintain the preretirement consumption level in the retirement years (Bernheim, 1996, p. 22).

Burns and Widdows (1988) apply the framework developed by Duncan et al. (1984) to data from the 1983 Survey of Consumer Finances to estimate savings rates needed to adequately fund baby boomers' retirement. Sizeable retirement gaps are generally found across all age and income groups. The authors conclude that the average family needs to increase the current level of saving in order to meet retirement needs.

2.1.4. Correlates of retirement wealth adequacy

Previous research has analyzed the correlates of retirement wealth adequacy. Li et al. (1996) use data from the National Longitudinal Survey of Older Men to compare needed resources and actual resources at the expected date of retirement for each household. The results suggest that men born between 1907 and 1921 are not well prepared financially for retirement. Only 46% of the sample has accumulated retirement wealth at the expected retirement age that is adequate to maintain the pre-retirement consumption level during retirement. Retirement age is found to be an important factor affecting retirement wealth adequacy. Being white, having a longer planning horizon, planning to retire at age 65 or later, and asset ownership all increase the probability of having adequate retirement wealth.

Yuh et al. (1998) use data from the 1995 Survey of Consumer Finances to analyze retirement adequacy of pre-retired households and estimate that slightly more than half of these households will be able to maintain the preretirement consumption level during the years following retirement. The probability of having adequate retirement wealth is found to increase with income, to be higher for households that have defined benefit or defined contribution pension plans, and for households that own their home mortgage free. The two most important factors related to retirement wealth adequacy are planned retirement age of the householder and household spending behavior. Planned retirement age is positively related to the probability of adequate retirement wealth. Spending at least as much as household income decreases the probability of adequate retirement wealth.

A common limitation that cuts across previous research on retirement adequacy is uniform assumptions that do not allow for variation across households. These assumptions often relate to planned retirement age, portfolio allocation, growth rates for assets, and retirement needs. By not allowing for variation across households, the corresponding estimates of retirement adequacy are prone to over or under represent actual adequacy. For example, planned retirement age affects both the amount of time prior to retirement during which assets accumulate as well as the amount of time that will be spent after retirement. Retirement at later ages, ceteris paribus, increases the time over which assets accumulate (thus increasing retirement resources), as well as decreases the amount of time spent after retirement (thus decreasing retirement needs). Both of these factors would influence the measure of retirement adequacy. Therefore, planned retirement age is an important variable in estimation of retirement adequacy, and information on the actual planned retirement age should be used instead of assuming retirement at given ages. Similarly, household specific information on portfolio allocation and retirement needs, as well as asset specific growth rates, will improve the accuracy of estimates of retirement wealth adequacy.

This study addresses several of these limitations. In contrast to previous studies, household specific information on planned retirement age, portfolio allocation, and asset specific growth rates are used to project retirement wealth. Rather than using set replacement rates, household expenditure functions are used to estimate retirement needs. The ratio of projected wealth to needs at retirement, a continuous measure of wealth adequacy, is analyzed in contrast to dichotomous indicators analyzed in previous work (Li et al., 1996; Yuh et al., 1998).The adequacy of retirement wealth is analyzed based on both mean and pessimistic projections of asset growth in order to consider the range of possibilities.

2.2. Conceptual framework

Under a life cycle model, assets are accumulated during an individual's work life mainly to finance consumption after retirement when earned income is reduced. A generally accepted goal of retirement planning is to provide enough income in retirement to prevent the level of living from dropping much below the preretirement level (Schulz, 1992). Thus, retirement wealth can be defined as *adequate* if total retirement income is equal to or greater than the total desired retirement consumption level (cf. Hatcher, 1997). The desired retirement level of living can be estimated from information on the preretirement level of living, assuming that individuals would like the same consumption level after retirement as before retirement.

Retirement wealth adequacy at the point of retirement (age R) can be defined as follows:

$$A_R + \sum_{t=1}^{T-R} B_t/(1 + r)^t \geq \sum_{t=1}^{T-R} C_t/(1 + r)^t \tag{1}$$

where

A_R = total asset accumulation upon retirement (age R),
B_t = pension income at age t,
C_t = consumption level at age t,
R = retirement age, and
T = age at death.

According to this equation, retirement wealth at the point of retirement is adequate if the sum of the accumulated assets plus the present value of pension income (including Social Security and annuities) is at least as large as the present value of retirement consumption.

3. Methodology

To operationalize the conceptual model retirement wealth must be clearly defined and methods for projecting the levels of retirement wealth and retirement needs must be selected. (For more details on the methodology refer to Yuh, 1998, and Yuh et al., 1998).

3.1. Empirical definition of retirement wealth

A comprehensive measure of retirement wealth is used in this study. Retirement wealth is defined to include financial assets, nonfinancial assets including housing wealth, and retirement income from defined contribution plans, defined benefit plans, and Social Security. In order to determine the level of retirement wealth at the planned retirement age, the value of current assets must be projected forward. This requires information on future rates of return for these assets.

3.2. Projection of future rates of return

Total wealth available for retirement from financial assets, nonfinancial assets, and defined contribution plans is projected using future real rates of return for each asset category. Future real rates of return are projected separately for stocks, bonds, money market instruments, business assets, and real estate assets using data on historical rates of return and a lognormal forecasting model (Ibbotson Associates, 1995). The lognormal forecasting model is used because, unlike the normal model, the lognormal model does not project negative values and therefore may produce more plausible predictions (Crow and Shimizu, 1988).

Using the lognormal model, it is straightforward to form probabilistic forecasts of both compound rates of return and ending period wealth values. Wealth at time n (assuming reinvestment of all income and no taxes) is:

$$\mathrm{Ln}(W_n) = \mathrm{Ln}(W_0) + \mathrm{Ln}(1 + r_1) + \mathrm{Ln}(1 + r_2) + \ldots + \mathrm{Ln}(1 + r_n) \quad (2)$$

where

W_n = the wealth value at time n
W_0 = the initial investment at time 0
$r_1, r_2.....r_n$ = the total returns on the portfolio for the rebalancing period ending at times 1, 2, and n.

The geometric mean return over the same period, rG, is:

$$rG = (W_n/W_0)^{1/n} - 1 \quad (3)$$

where

rG = the geometric mean return
n = the inclusive number of periods.

In the lognormal forecasting model, the expected value (m) and standard deviation (s) of the natural logarithm of the return relative of the portfolio can be calculated from the expected return (μ) and standard deviation (σ) of the portfolio as follows:

$$m = \ln(1 + \mu) - (s^2/2) \quad (4)$$

$$s = \{\ln[1 + (\sigma/1 + \mu)^2]\}^{1/2} \quad (5)$$

where

ln = the natural logarithm function.

Given the logarithmic parameters of a portfolio (m and s), a time horizon (n), and the z-score of a percentile (z), the percentile of the geometric mean return for an asset i is calculated as:

$$R_i = \exp\{m_i + z(s_i/n^{1/2})\} - 1 \tag{6}$$

where

Ri = percentile of the geometric mean return of asset i
m_i = expected value of natural logarithm of the return relative of asset i
s_i = standard deviation of natural logarithm of the return relative of asset i
z = the z-score of the percentile
n = investment horizon.

Using this equation, it is possible to calculate the various percentiles of the geometric mean return over various time horizons. In order to compare adequacy under mean and pessimistic conditions, rates of return at the 50th percentile and the 5th percentile are selected. The rate of return for the 50th percentile of each asset is used as the projected return for the mean portfolio performance, and the rate of return for the 5th percentile is used as the projected return for the pessimistic portfolio performance.

Data for historical rates of return from the *Stocks, Bonds, Bills and Inflation Yearbook* published by Ibbotson Associates (1995) are used to provide information on the mean and variance of the real rate of return for specific asset categories. The 1995 Yearbook provides historical return data from January 1, 1926 through December 31, 1994 for six categories of financial assets: small capitalization stocks, large stocks (S&P 500), corporate bonds, intermediate government bonds, long term government bonds, and Treasury bills. Real estate returns from 1947 to 1982 estimated by Ibbotson and Siegel (1984) are used to produce lognormal projections of future real rates of return for real estate assets. This real estate dataset is comparable to the historical return data in the Ibbotson Yearbook, and is the longest period of annual return data for real estate available. Information is available for residential real estate, farm real estate, business real estate, and composite real estate (average of the three categories).

3.3. Estimation of retirement needs

Following the assumption of the Life Cycle Savings Model (Modigliani and Brumberg, 1954) it is assumed that households desire to maintain the preretirement level of living during retirement. Retirement needs are defined as the total wealth needed to provide the level of preretirement consumption during all years of retirement.

$$W_n = C^*\{[1 - (1 + r_r)^{-d}]/r_r\} \tag{7}$$

where

W_n = retirement need (present value of total consumption needed in retirement),
C = annual consumption during retirement,
r_r = (expected) real interest rate from retirement to death, and

d = retirement period (the number of years from retirement age to death).

3.3.1. Annual consumption during retirement

A household expenditure function is used to predict annual consumption during retirement. The household expenditure function is estimated using data from the interview component of the 1993–1994 Consumer Expenditure Survey. The Consumer Expenditure Survey is conducted by the United States Bureau of the Census for the Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 1996) and is the most comprehensive source of detailed information on expenditures for goods and services by households in the United States. For this study households that are interviewed in four consecutive quarters (excluding the initial bounding interview) between the second quarter of 1993 and the fourth quarter of 1994 are retained. For each household, data on the four consecutive quarters of expenditure are summed to obtain actual annual household expenditures. All dollar values are adjusted to 1994 dollars.

A Box-Cox test is used to determine the best functional form for the expenditure equation, and the double-log model is selected:

$$\mathrm{Ln}\,(C_i) = f\,[\mathrm{Ln}\,(\mathrm{income}_i), Z_i]$$

where Z_i is a vector of household characteristics excluding the income variable.

A Chow test is used to compare separate regressions for households that do and do not spend less than income to a regression on the pooled sample of households. The Chow-test rejects the pooled model at the 1% level of significance, indicating that the two separate regressions provide a better fit than the regression on the pooled sample. These regression tables are available from the authors.

For each household in the sample, the appropriate household expenditure function (separate functions for households that spend less than income and households that do not) is used to predict annual consumption in the year preceding retirement. The predicted preretirement consumption level is used as a proxy for the desired level of retirement consumption.

3.3.2. Real interest rate

The appropriate real interest rate (r_r) for discounting total retirement needs should be based on a household's investment behavior. It is typically assumed that retired people invest very conservatively because of their low level of risk tolerance during retirement. In this study a real discount rate of 2.3% is used to calculate total retirement needs.

3.3.3. Retirement period

The retirement period is determined as the difference between an individual's expected age at death and age at planned retirement. Expected age at death is estimated by gender and marital status using Actuarial Annuity tables published by the Internal Revenue Service. Ordinary single life annuities are used for single people and ordinary joint life and survivor annuities are used for married couples (Internal Revenue Service, 1998, Tables I and II).

Table 1
Sample Characteristics and Wealth-Needs Ratio by Characteristics (Mean and Pessimistic Portfolio Projections)

Variables	%	Wealth-needs ratio (Mean)	Wealth-needs ratio (Pessimistic)
Total	100.0	131.7	103.8
Education			
less than high school grad.	9.8	93.7***	88.6***
high school graduate	29.8	120.9	100.3
some college	26.5	126.6	100.2
college or more	33.8	156.5	114.3
Race/Ethnicity			
White, non-Hispanic	81.0	136.7***	106.1***
Black, non-Hispanic	10.3	100.2	87.4
Hispanic	4.2	100.8	84.8
other, non-Hispanic	4.5	143.0	119.0
Excellent health			
yes	36.7	143.9***	110.2***
no	63.3	124.6	100.1
Marital status			
couple	69.8	137.2***	107.3***
unmarried male	9.7	134.6	98.4
unmarried female	20.5	111.8	94.5
Occupation			
professional, managerial, specialty	32.1	158.1***	117.2***
technical, sales, admin. support	25.2	132.6	103.1
service	8.3	104.7	93.9
precision production, craft, repair	12.8	122.8	97.8
operators, fabricators, laborers	20.1	107.2	93.4
farming, forestry, fishing	1.4	104.0	73.9
Self-employed			
yes	7.0	193.3***	110.2*
no	93.0	127.1	103.4
Household income			
$0 < income ≤ $32,000	24.7	108.5***	91.0***
32,000 < income ≤ 45,000	25.8	114.4	95.6
45,000 < income ≤ 71,000	24.7	131.5	106.6
income > 71,000	24.7	173.2	122.5
Ownership of DB plan			
yes	36.1	146.7***	124.7***
no	63.9	123.3	92.0
Housing tenure			
own without mortgage	16.4	147.3***	123.1***
own with mortgage	62.9	137.1	106.6
rent	20.7	102.9	80.0
Planned retirement age			
61 or earlier	34.6	114.1***	90.1***
62–65	55.4	132.3	105.7
66 or later	10.0	189.8	141.2
Have retirement as a saving goal			
yes	35.1	157.5***	120.2***
no	64.9	117.8	95.0
Use of financial planner			
yes	24.7	145.0***	111.0***
no	75.3	127.4	101.5

(continued on next page)

Table 1 *(continued)*

Variables	%	wealth-needs ratio (Mean)	wealth-needs ratio (Pessimistic)
Stock share			
0%	41.7	98.4***	90.7***
0% < stock < 13.5%	18.2	156.8	117.2
13.5 ≤ stock < 36.5	20.3	142.9	109.1
stock ≥ 36.5%	19.9	167.2	113.8
Spending ≥ income			
yes	51.1	91.8***	74.7***
no	48.9	173.4	134.3
Take high financial risk			
yes	20.7	153.6***	114.0***
no	79.3	126.0	101.2
Expect income growth			
yes	17.0	143.0***	102.4
no	83.0	129.4	104.1
Subjective life expectancy			
live ≤ 24 years	24.4	128.2***	111.1***
24 < live ≤ 32	24.3	129.7	100.3
32 < live ≤ 42	25.8	141.7	106.3
live > 42	25.5	126.8	97.9

Analysis of variance F-test for difference of means is statistically significant, * $p \leq 0.05$, *** $p \leq 0.001$
Source: 1995 Survey of Consumer Finances, combined data set, N = 6,310 (1,262 in each implicate)

3.4. Data and sample

The data analyzed in this study are from the public use tape of the 1995 Survey of Consumer Finances (SCF; Kennickell et al., 1997). The SCF is a triennial survey sponsored by the Federal Reserve with the cooperation of the Department of the Treasury. The 1995 SCF was conducted by the National Opinion Research Center (NORC) at the University of Chicago between July and December 1995. The purpose of the SCF is to provide comprehensive, detailed information on the financial characteristics of U.S. households. A total of 4,299 families are interviewed in the 1995 SCF. The 1995 SCF has five complete data sets called "implicates" as a result of multiple imputation to handle missing data. This study uses repeated-imputation inference (RII) techniques to combine the five different data sets to make valid inferences (Montalto and Sung, 1996; Rubin, 1987).

Households are included in the sample if the householder is age 35 to 70, works full-time, and indicates the age at which s/he plans to stop full-time work. The age cutoffs are necessary since income and portfolio projections are used to examine retirement wealth adequacy. Portfolio projections are simulated based on the household's current portfolio and financial situation (Yuh, 1998). Households are excluded from the study if information on the age at which the householder plans to stop working full-time is not available. Additionally, households are included only if they have positive non-investment income and total annual household income above the poverty threshold. A total of 1,387 households meet all of the criteria for inclusion.

Table 2
Regression of Wealth-Needs Ratio (%) on Household Characteristics, Mean Portfolio Projections

Variable	Estimate	Std Error	P-Value
Intercept	−208.1532	72.7955	0.0050**
Less than high school: reference			
High school graduate	8.0712	16.5438	0.6257
Some college	−11.5437	17.3004	0.5047
College or more	−16.9703	18.9179	0.3702
White, non-Hispanic: reference			
Black, non-Hispanic	−9.1628	14.6630	0.5321
Hispanic	−4.5669	22.9794	0.8427
Other, non-Hispanic	35.5614	17.8932	0.0486*
Excellent Health	6.5972	8.1427	0.4180
Married couple: reference			
Unmarried male	41.9206	13.3632	0.0018**
Unmarried female	13.7288	13.2616	0.3007
Household size	−0.8594	5.0021	0.8639
Proportion of members < 18	25.6501	26.6756	0.3382
Professional, managerial, specialty: reference			
Technical, sales, admin. support	−6.5285	11.0332	0.5547
Service	−11.2904	17.5343	0.5197
Precision production, craft, repair	−29.9816	15.6144	0.0562
Operators, fabricators, laborers	−30.9372	13.9746	0.0269*
Farming, forestry, fishing	−31.5121	35.4799	0.3745
Self employed	92.9234	11.2567	0.0000***
Log of household income	35.8350	6.2803	0.0000***
DB pension ownership	21.4864	8.1988	0.0088**
Rent	−52.6381	14.1551	0.0002***
Own with mortgage	−43.2536	10.2051	0.0000***
Own without mortgage: reference			
Retire at 61 or earlier: reference			
Retire at 62–65	27.8241	9.1217	0.0024**
Retire at 66 or up	85.3864	14.7443	0.0000***
Retirement saving goal	2.7374	8.3980	0.7446
Use of financial planner	0.8698	9.4058	0.9265
Stock share	−5.0523	49.0215	0.9181
Investment horizon	−0.4789	0.7873	0.5436
Investment horizon * Stock share	9.4966	2.5664	0.0004***
Spending ≥ Income	−82.4638	8.7886	0.0000***
High risk taking	17.0423	8.7914	0.0526
Expect income growth	11.1496	10.0444	0.2680
Expected life expectancy	−0.2688	0.3782	0.4778

F = 21.9227, p-value = 0.0000
R-square = 0.3757 to 0.4017
Combined data set, Number of observations in each implicate = 1,262
* : p-value ≤ 0.05, ** : p-value ≤ 0.01, *** : p-value ≤ 0.001

3.5. Household retirement wealth adequacy

Each household provides detailed information on assets that is used to estimate retirement wealth. Future rates of return projected with the lognormal forecasting model are used to project future real accumulations separately for business assets (using the returns on small capitalization stocks,) stocks and the stock components of mutual funds (using the returns on large stocks,) bonds (using the returns on corporate bonds), money market instruments (using the returns on Treasury bills), and real estate assets (using the returns on composite real estate). Total defined benefit pension wealth is estimated from the household's self-reported information on expected benefits from defined benefit pension plans. The geometric mean of the nominal rate of return for long-term corporate bonds (Ibbotson Associates, 1995, pp. 38–39), 5.4%, is used as the discount rate for calculating defined benefit pension wealth. The 1995 SCF does not provide direct identification of Social Security coverage. About 95% of jobs in the U.S. are covered by Social Security. The sample in this study consists of pre-retired households with at least one full-time worker, so all households are assumed to be covered by Social Security. The annual Social Security benefit is estimated using current Social Security replacement ratios based on current age, planned retirement age, current earnings, and marital status (Social Security Administration, 1995). The replacement ratio represents the portion of preretirement salary that Social Security income will replace. The estimated annual Social Security benefit is adjusted for early retirement or delayed retirement as indicated by the planned retirement age. The present value of Social Security at the point of planned retirement is estimated using the real discount rate used by the Social Security Administration (2.3%) in their long range projections (Moore and Mitchell, 1997).

One limitation of this study is that income taxes on retirement income are not taken into account. No previous study has explicitly taken income taxes on retirement income into account, probably because of the complexity of the task. The treatment of pension and annuity income is complex, including the uncertain effect of Roth IRAs over the next 20 or 30 years. Given the income distribution of elderly households, it is likely that a majority face an average federal income tax rate under 10%. The potential bias from ignoring income taxes on retirement income may be high for higher income households and zero for low income and most moderate income households.

4. Findings and discussion

4.1. Descriptive statistics

The dependent variable analyzed is the wealth-needs ratio expressed as a percentage:

[projected retirement wealth / total retirement needs]*100

To reduce the amount of variance in the dependent variable, households with a wealth-needs ratio greater than 1,000 based on the mean case projection are dropped, resulting in a sample of 1,262 households. Two different ratios are computed, based on the mean projection and the pessimistic projection. The median ratio is 102% for the mean projection and 87% for the pessimistic projection. For the mean projection, 25% of the households have a wealth-needs ratio of 68% or less, and for the pessimistic projection, 25% of the households have a ratio of 61% or less.

About 52% of the households in the sample have adequate wealth for retirement at the planned retirement age under the mean case projection. Only 42% of the households in the sample have adequate wealth for retirement at the planned retirement age under the pessimistic case projection. Sample characteristics are provided in the second column of Table 1. Only 36% of the households own defined benefit pension plans. About 40% of the households hold 13.5% or more of their non-housing assets in stock. Over half (55%) of the householders plan to retire between age 62 and 65, and 35% of the households have retirement as a major saving goal. About half of the households (51%) indicate their spending is at least as high as income last year, and the majority do not expect future real income growth (83%). About one fourth of the householders (25%) expect to live an additional 42 years or more, and another fourth (24%) expect to live an additional 24 years or less. About 21% of the households are willing to take high financial risk to earn high returns.

4.2. Analysis of variance

Results from analysis of the wealth-needs ratio by each variable are provided in the third column of Table 1 for the mean case projection, and in the last column of Table 1 for the pessimistic case projection. Analysis of variance F-tests are used to identify the categories of independent variables with significant differences in mean wealth-needs ratios, not controlling for other factors. For the mean case projection, all of the independent variables are significantly related to the wealth-needs ratio at the 0.1% level or better. For the pessimistic case projection, all independent variables, with the exception of the expectation of real income growth, are significantly related to the mean wealth-needs ratio at the 5% level or better.

The wealth-needs ratio is positively related to education, household income, planned retirement age, and the share of non-housing assets held in stocks, and varies with household spending behavior. The wealth-needs ratio (mean case projection) ranges from 94% for households with a householder who has not graduated from high school to 157% for households with a householder who is a college graduate. The ratio ranges from 109% for households with annual income of $32,000 or less, to 173% for households with annual income over $71,000. Households with a householder who plans to retire at age 66 or later have a much higher mean wealth-needs ratio (190%) than those with a householder who plans to retire before age 62 (114%) or between age 62 and 65 (132%). Households with a zero stock share have a mean wealth-needs ratio of 98%, compared to a ratio of 167% of households with a stock share or 36.5% or more. Mean wealth-needs ratios are higher for households that spend less than income (173%) compared to those that do not (92%).

4.3. Determinants of retirement wealth adequacy

Multivariate Ordinary Least Squares (OLS) regression analyses are performed to estimate the effect of each independent variable while simultaneously controlling for the effects of all other independent variables. The measure of retirement wealth adequacy used in the analyses is the wealth-needs ratio expressed as a percentage. Separate regressions are performed for adequacy ratios based on *mean portfolio performance* projections of total retirement wealth (Table 2) and *pessimistic portfolio performance* projections of total retirement wealth (Table

Table 3
Regression of Wealth-Needs Ratio (%) on Household Characteristics, Pessimistic Portfolio Projections

Variable	Estimate	Std Error	P-Value
Intercept	67.7287	44.0674	0.1304
Less than high school: reference			
High school graduate	6.8667	9.3918	0.4648
Some college	−3.4516	9.7785	0.7241
College or more	−5.2969	10.4124	0.6110
White, non-Hispanic: reference			
Black, non-Hispanic	−6.1461	8.3860	0.4637
Hispanic	0.3468	13.3589	0.9793
Other, non-Hispanic	34.6908	10.7793	0.0021**
Excellent Health	1.7044	4.6951	0.7168
Married couple: reference			
Unmarried male	19.3435	7.3878	0.0089**
Unmarried female	3.4093	7.4554	0.6475
Household size	−1.0024	2.6199	0.7021
Proportion of members < 18	16.1367	14.5988	0.2701
Professional, managerial, specialty: reference			
Technical, sales, admin. support	0.6829	6.3033	0.9139
Service	−8.7984	10.1076	0.3843
Precision production, craft, repair	−13.6439	8.9079	0.1275
Operators, fabricators, laborers	−15.4189	7.8768	0.0504
Farming, forestry, fishing	−36.0423	20.2499	0.0754
Self employed	20.3252	6.3783	0.0017**
Log of household income	6.6942	3.7562	0.0818
DB pension ownership	27.2414	4.6763	0.0000***
Rent	−40.6923	7.9816	0.0000***
Own with mortgage	−28.1107	5.8227	0.0000***
Own without mortgage: reference category			
Retire at 61 or earlier: reference			
Retire at 62–65	25.0765	5.1477	0.0000***
Retire at 66 or up	77.3792	8.5035	0.0000***
Retirement saving goal	2.5834	4.6160	0.5758
Use of financial planner	1.8390	4.9622	0.7112
Stock share	59.8913	46.4871	0.2088
Investment horizon	−0.9314	0.4250	0.0290*
Investment horizon * Stock share	1.5370	2.6086	0.5605
Spending $\geq$ Income	−56.7591	5.1399	0.0000***
High risk taking	12.4335	4.9803	0.0126*
Expect income growth	2.8483	5.7522	0.6211
Expected life expectancy	−0.0577	0.2134	0.7871

F = 17.6192, p-value = 0.0000
R-square = 0.3373 to 0.3527
Combined data set, Number of observations in each implicate = 1,262
* : p-value ≤ 0.05, ** : p-value ≤ 0.01, *** : p-value ≤ 0.001

3). Total retirement needs are estimated from a household expenditure function for both cases. Since this dependent variable captures the amount of total retirement wealth in the households relative to their needs, it measures the extent of adequacy of retirement wealth in each household.

4.4. Discussion of regression results

For the mean portfolio performance regression, race/ethnicity, marital status, occupation, self-employment, income, ownership of a defined benefit pension, housing tenure, planned retirement age, the interaction of stock share and investment horizon, and spending behavior are significantly related to the mean wealth-needs ratio at the 5% level or better (Table 2). Results for the pessimistic portfolio performance regression are similar with the exception that the investment horizon and high risk tolerance are significant, while occupation, income, and the interaction of stock share and investment horizon are not significant (Table 3). Although significant in the bivariate analysis, education, health status, having retirement as a saving goal, stock share, expectation of real income growth, and subjective life expectancy do not have statistically significant effects on the wealth-needs ratio when the other independent variables are controlled.

The predicted wealth-needs ratio increases with the log of household income for the mean portfolio projection but not for the pessimistic projection. The increase in the predicted wealth-needs ratio is large for an increase from very low income to middle income (e.g., $10,000 to $40,000) but small for increases above $40,000. For the mean portfolio projection, the wealth-needs ratio is related to an interaction term for investment horizon and stock share, but not to stock share or investment horizon variables individually. The net effect of all three variables is that the predicted wealth-needs ratio increases with horizon for values of stock share over 5%. The predicted wealth-needs ratio increases with stock share for horizons of at least 1 year. For the pessimistic portfolio projection, the wealth-needs ratio is not significantly related to stock share by itself or to the interaction term for investment horizon and stock share, but it is related to the investment horizon variable. The net effect of all three variables is that the predicted wealth-needs ratio decreases with horizon for values of stock share under 60%.

Planned retirement age also has a large effect on the wealth-needs ratio. For the mean portfolio projection, those who plan to retire at age 66 or later have a predicted wealth-needs ratio 85 percentage points higher, and those who plan to retire between age 62 and 65 have a predicted wealth-needs ratio 28 percentage points higher than otherwise similar households who plan to retire before age 62. For the pessimistic portfolio projection those who plan to retire at age 66 or later have a predicted wealth-needs ratio 77 percentage points higher, and those who plan to retire between age 62 and 65 have predicted wealth-needs ratio 25 percentage points higher than otherwise similar households who plan to retire before age 62.

Spending as much as or more than income has a large effect on the wealth-needs ratio. For the mean portfolio projection, those who report spending at least as much as income have a predicted wealth-needs ratio 82 percentage points lower than otherwise similar households who spend less than income. For the pessimistic portfolio projection, those who report spending at least as much as income have a predicted wealth-needs ratio 57 percentage points lower than otherwise similar households who spend less than income.

To provide some idea of the magnitude of the effects of planned retirement age and overspending behavior, predicted wealth-needs ratios at retirement are calculated based on the regression results in Tables 2 and 3. A hypothetical household is defined to have mean values for continuous variables (median value for household income) and the most common

Table 4
Predicted Retirement Wealth-Needs Ratio for a Hypothetical Scenario, for Mean and Pessimistic Portfolio Projections, by Spending and Retirement Age

	Predicted retirement wealth-needs ratio			
	Mean projection		Pessimistic projection	
Retire at	spend ≥ income	spend < income	spend ≥ income	spend < income
< 62	52.2	134.6	50.9	107.7
62–65	80.0	162.5	76.0	132.8
≥ 66	137.6	220.0	128.3	185.0

Predicted wealth-needs ratios at retirement were calculated based on the mean portfolio projection (Table 2) and pessimistic portfolio projection (Table 3). A hypothetical household is defined to have mean values for continuous variables (median value for normal income) and the most common categories for dummy variables in the model, except for health and having retirement as a savings goal. Thus, the example household is assumed to have the following characteristics: White non-Hispanic married couple, with one child, a college educated householder in excellent health employed in a professional occupation, annual household income of $45,000, no defined benefit pension plan, retirement portfolio with a 14% stock share, owns a house with a mortgage, 16 years away from retirement, not expecting future income growth, does not use a financial planner, does not expect income growth, not a risk taker, has retirement as a saving goal, and expects to live 34 years.

values for dummy variables in the model. The predicted probabilities of having adequate wealth at retirement for this scenario are presented in Table 4. The importance of spending less than income can be clearly seen—even those planning to retire before age 62 have a projected wealth-needs ratio at retirement of 135% if they spend less than their income, compared to 52% for comparable households that spend at least as much as income (mean portfolio projection). Retiring at a later age has a large impact on the wealth-needs ratio. For households currently spending at least as much as income, those planning to retire before age 62 have a projected wealth-needs ratio at retirement of 52%, compared to a ratio of 80% for those retiring between ages 62 and 65, and a ratio of 138% for those planning to retire after age 65.

5. Conclusions

This study projects that almost half of U.S. households headed by a worker age 35 to 70 will not be able to maintain the current level of spending in retirement, even if investments achieve an average rate of return in the future. The proportion unable to maintain the level of spending increases to 58% with pessimistic investment projections. These estimates are based on current projections of Social Security pensions and ignore the effect of income taxes, so the situation could be worse than reported.

Planned retirement age and household spending behavior are important factors affecting the adequacy of retirement wealth. Later retirement increases the number of years to accumulate retirement resources and decreases the number of years in retirement. In addition, retirement age is directly related to pension availability and the level of pension benefits. Spending less than income implies saving, and thus increases the opportunity to save for retirement. Overspending decreases the wealth accumulations for retirement and increases estimated retirement consumption needs.

Based on mean projections, the interaction between the stock share and the investment horizon (number of years until retirement) is an important factor affecting retirement wealth adequacy. A higher stock share with the same investment horizon or a longer investment horizon with the same stock share significantly increase the adequacy of retirement wealth. The lack of a significant negative effect of stock share on the wealth-needs ratio implies that increasing the stock share will not impose a risk for households in general, even if projected future real returns for investments are at the levels of the lowest 5% for time periods in the past. (Households with little diversification may be at risk, but low diversification could not be measured accurately in the dataset.) Aggressive investment or saving strategies should be encouraged especially for individuals who have longer investment horizons. Moreover, asset allocation decisions within retirement saving programs are important for individual investors given the increase in 401(k) and related retirement saving programs and the decrease in defined benefit plans since the 1980s. Evidence of higher rates of return for stocks in the long run should be used to encourage stock investment within retirement savings programs. Clearly though, a simple first step to an adequate retirement is getting spending under control. The fact that education was not significant in the regressions suggests that there is not an inherent barrier to teaching workers about saving for retirement. Many of the variables with substantial significant effects in the regressions are factors that households can control, as illustrated in Table 4 for spending and retirement age.

References

Andrews, E. S. (1993). Gaps in retirement income adequacy. In R. Schmitt & Pension Research Council (Eds.), *Future of Pensions in the United States*. (pp.1–52). Philadelphia: University of Pennsylvania Press.

Bajtelsmit, V. J., & Van Derhei, J. A. (1996). Risk aversion and retirement income adequacy. In O. S. Mitchell (Ed.), *Positioning pensions for the twenty-first century*. Philadelphia: University of Pennsylvania Press.

Bernheim, B. D. (1996). *The Merrill Lynch Baby Boom Retirement Index: update '96*. Stanford University: Merrill Lynch.

Bernheim, B. D., Skinner, J. & Weinberg (1997, September). What accounts for variation in retirement wealth among U.S. households? mimeo, Stanford University.

Burns, S. A., & Widdows, R. (1988). An estimation of savings needs to adequately fund baby boomers' retirement. In V. Hampton (Ed.), *Proceedings of the 34th Annual Conference of the American Council on Consumer Interests* (pp. 15–8). Columbia, MO: American Council on Consumer Interests.

Burns, S. A. & Widdows, R. (1990). Sensitivity of a retirement analysis framework to changes in retirement analysis parameters. *Financial Counseling and Planning 1*, 71–91.

Crow, E. L., & Shimizu, K. (1988). *Lognormal Distribution*. New York: Marcel Dekker.

Duncan, G. J., Mitchell, O. S., & Morgan, J. N. (1984). A framework for setting retirement savings goals. *Journal of Consumer Affairs 18*(1), 22–46.

Hatcher, C. B. (1997). A model of desired wealth at retirement. *Financial Counseling and Planning 8*(1), 57–64.

Ibbotson Associates. (1995). *Stocks, Bonds, Bills, and Inflation Yearbook*. Chicago, IL: Ibbotson Associates.

Ibbotson, R. G., & Siegel, L. B. (1984). Real estate returns: a comparison with other investments. *AREUEA Journal 12*(3), 219–242.

Internal Revenue Service. (1998). *How to use actuarial tables* [Online]. Available: http://www.irs.ustreas.gov/prod/forms−pubs/graphics.

Kennickell, A. B., Starr-McCluer, M., & Sundén, A. E. (1997). Family finances in the U.S.: recent evidence from the Survey of Consumer Finances. *Federal Reserve Bulletin 83* (1), 1–24.

Li, J., Montalto, C. P., & Geistfeld, L. V. (1996). Determinants of financial adequacy for retirement. *Financial Counseling and Planning 7*, 39–48.

Mitchell, O. S., & Moore, J. F. (1997). *Retirement wealth accumulation and decumulation: New developments and outstanding opportunities*. Wharton Financial Institutions Center Working Paper 97-12, The Wharton School of the University of Pennsylvania, Philadelphia.

Modigliani, F., & Brumberg, R. (1954). Utility analysis and the consumption function: an interpretation of cross-section data. In K. Kurihara (Ed.), *Post Keynesian Economics* (pp. 388–446). New Brunswick, NJ: Rutgers University Press.

Montalto, C. P., & Sung, J. (1996). Multiple imputation in the 1992 Survey of Consumer Finances. *Financial Counseling and Planning 7*, 133–146.

Moore, J. F., & Mitchell, O. S. (1997). *Projected retirement wealth and savings adequacy in the Health and Retirement Study*. Pension Research Council Working Paper 98-1. The Wharton School of the University of Pennsylvania, Philadelphia.

Palmer, B. A. (1989). Tax reform and retirement income replacement ratios. *The Journal of Risk and Insurance 56*, 702–725.

Palmer, B. A. (1994). Retirement income replacement ratios: an update. *Benefits Quarterly 10*(2), 59–75.

Rubin, D. B. (1987). *Multiple Imputation for Nonresponse in Surveys*. New York: Wiley.

Schulz, J. H. (1992). *The Economics of Aging*. Westport, CT: Auburn House.

Social Security Administration. (1995). *Annual Statistical Supplement, 1995 to the Social Security Bulletin*. Washington, DC: US Department of Health and Human Services, Social Security Administration.

U.S. Bureau of Labor Statistics. (1996). *Consumer Expenditure Survey: 1994 Interview Survey CD ROM/Public Use Tape Documentation*. Washington, DC: U.S. Bureau of Labor Statistics.

U.S. Bureau of the Census. (1998). Population profile of the United States 1997. *Current Population Reports*, P23-194. Washington, DC: U.S. Government Printing Office.

U.S. Department of Commerce. (1998, November 3). Personal income and outlays: September 1998, BEA 98-34. Washington, DC: Author.

U.S. General Accounting Office. (1996, October 3). Private pensions: most employers offer pensions that use defined contribution plans, GGD-97-1. Washington, DC: Author.

Yuh, Y. (1998). Adequacy of preparation for retirement: mean and pessimistic case projections. Unpublished doctoral dissertation. The Ohio State University, Columbus, OH.

Yuh, Y., Montalto, C. P., & Hanna, S. (1998). Are Americans prepared for retirement? *Financial Counseling and Planning 9*(1), 1–12.