The Portfolio Efficiency of Older Worker Households

Households increasingly will rely on their investment portfolios, both inside and outside of retirement accounts, for much of their spending in retirement. This paper uses data from the 2001 Survey of Consumer Finances to analyze the efficiency of actual investment portfolios of households with an older worker and to compare each household's portfolio to a simulated efficient portfolio derived for each household for five types of portfolio investments. The paper also presents mean and median portfolio allocation by age. We found that most households have inefficient portfolios and that the risk of their portfolios could be reduced without reducing the expected return.

Christine Whuei-wen Lai[1]
Sherman D. Hanna[2]

Introduction

As a society, the United States is aging. In 2000, 12.4% of Americans were 65 or older (Hetzel & Smith, 2000), but it is projected that by 2050, 20.7% of the population will be elderly (U.S. Census Bureau, 2004). When a society is aging, the adequacy of money for retirement deserves more attention. Retirement adequacy exists when resources available to a household during retirement are sufficient to support their desired level of consumption. Yuh, Hanna, and Montalto (1998), using the 1995 Survey of Consumer Finances (SCF) dataset with households age 35 to 70 with an employed person, found that 52% of households are adequately prepared for retirement based on a mean projection of retirement assets, while only 42% of households are adequately prepared based on a pessimistic projection. Using the same methodology with the 1998 SCF, Yao, Hanna and Montalto (2003) found 56% were on track for an adequate retirement in 1998, based on mean projection of retirement assets. Hanna, Garman and Yao (2003) found that projected retirement adequacy for older worker households improved slightly between 1998 and 2001.

This study is motivated by the idea that Americans need to be better prepared for retirement, and that it might be possible to improve the efficiency of investment portfolios for retirement. The study compares actual portfolios to efficient portfolios for households with a worker aged 56 and over and recommends changes that would result in more wealth for retirement. We determine actual portfolios, including information on defined contribution plans, using data from the 2001 SCF, and compare the actual portfolio for each household to a simulated efficient portfolio we create for that household. Based on the comparison, we recommend changes that could increase expected returns without increasing risk. For this study, we define household wealth as income available from Social Security, defined benefit plans, and defined contribution plans, as well as the value of financial and non-financial assets, excluding home equity.

Literature Review

The idea of diversification is age-old. The phrase "don't put all your eggs in one basket" existed long before modern finance theory. It was not until 1952, however, that Harry Markowitz (1952) published a formal model of portfolio selection embodying diversification principles, thereby paving the way for his 1990 Nobel Prize for economics (Markowitz, 1990). The principal idea behind his mean-variance efficient portfolio is that, for any risk level, rational investors are interested only in the portfolio with the highest expected return. Alternatively, the efficient portfolio allocation is the set of portfolios that minimize the variance for any target expected return. These two methods of computing the efficient set of risky portfolios are equivalent.

In practice, the investment industry has long sought to develop a common framework for evaluating the performance of a portfolio with diverse risk and reward characteristics. The Sharpe ratio (Sharpe, 1966; 1994) provides a summary of these two important aspects of an investment and has been widely used in financial industry. The Sharpe ratio is defined as the ratio of the expected excess return, over the risk free rate of return, of the portfolio over the standard deviation of the return. A Sharpe Ratio of 1.0 indicates an investment return that is proportional to

the risk taken in achieving that return. The higher the Sharpe ratio, the better the investment portfolio. Finding the efficient portfolio in the Markowitz mean-variance framework with a risk-free asset is equivalent to maximizing the Sharpe Ratio of the portfolio.

Gibbons, Ross and Shanken (1989) proposed a test of the significance of the difference between the actual portfolio held by an investor and a corresponding efficient portfolio, based on the difference between the Sharpe ratios of the two portfolios. Given a set of risky assets, any two portfolios, Pi and Pj, can be constructed to exhibit Sharpe ratios of Si and Sj. If Pi is an efficient portfolio while Pj's efficiency is unknown, then it must be true that Si>=Sj. To test the significance of their difference, the null hypothesis can be stated as

Ho: Si=Sj.

This hypothesis can be tested using the following test statistic:

$$W = \left[\frac{\sqrt{1+S_i^{\,2}}}{\sqrt{1+S_j^{\,2}}} \right]^2 - 1$$

W follows a Wishart distribution. Gibbons et al. (1989) showed, under the assumption that asset returns are multivariate normal and under the null hypothesis that the actual portfolio is an efficient portfolio, that W can be transformed into a central F distribution as following, where T is the number of observations in a time series, and n is the number of investment opportunities (assets). Gibbons et al. (1989) showed that under the null hypothesis, the transformed W-statistic is centrally distributed as F with degree of freedom N, and T-N-1, as shown in the following:

$$F = \frac{T(T-n-1)}{n(T-2)} W$$

Since the power of this test is critically affected by the degrees of freedom of the F test, Gibbons et al. suggested that the ratio of T/N should be at least 3.0 as a rule of thumb. For more details of the assumptions, see Lai (2003). It is also possible to use this technique to compare actual portfolios to efficient portfolios, as the discussion in Methodology, below, indicates.

Methodology

In this study, the mean-variance efficient portfolio for each household with a worker age 56 or older is obtained from simulation. Sharpe ratios are then calculated for the household's actual portfolio and for the mean-variance efficient portfolio for that household, and the improvement in the performance by reallocating to a mean–variance efficient portfolio is estimated and tested. Although the Sharpe ratio has received some criticism, especially in the aspect that the ratio may be subject to estimation error when both the expected return and risk are unobservable and must be estimated from return data (Lo, 2002), *ex ante* Sharpe Ratios can provide useful insights if properly used. The *ex ante* Sharpe Ratio can be computed from simulated returns when the expected return and the associated risk are taken into account

The Gibbons technique, described above, is applied to test whether the Sharpe ratios of the mean-variance efficient portfolios from prescriptive models are significantly greater than the Sharpe ratios of portfolios from empirical studies. Note that W is a non-negative number because Si>=Sj. In addition, under the null hypothesis W is equal to zero, which implies that the two portfolios have similar mean-variance efficiency. A large W will lead to

the rejection of the null hypothesis and the conclusion that the mean-variance efficiency of the two portfolios is significantly different.

This study is carried out in three steps. In the first step, the asset allocations of current portfolios of households in the 2001 SCF are estimated. In the second step, the distributions of the expected return and risk of current portfolios for U.S. households with older workers are estimated, based on the 2001 SCF and a return series from a "bootstrap" resampling simulation procedure. Households with an employed person age 56 years old and over are included in the older worker category. In the third step, mean-variance efficient portfolios are computed for each household.

The portfolio allocations are based on a household's investment in money market-related assets, stock-related assets, bond-related assets, real estate-related assets, and business ownership-related assets. Each category has a different risk and return pattern and differently affects the household's wealth. Investment assets are defined as the sum of these five asset categories minus one month's before tax income to allow for the next month's living expenses. The primary residence is not included as a real estate- related asset because it is not a liquid asset and cannot be reallocated without incurring substantial costs, and this study is interested in whether a household would be better off reallocating investment assets. Further, one of the main purposes of a residence is not for investment purposes but for consumption and psychological reasons (Ioannides & Rosenthal, 1994). Appendix I presents the procedures used to obtain actual household portfolios based on the 2001 SCF. Aizcorbe, Kennickell, and Moore (2003) provide additional detailed descriptions of the 2001 SCF and changes in portfolios from previous surveys.

Siegel (1999) and others have argued that stocks are relatively safer in the long run compared to the short run (Siegel, 1999). This argument implies that the variance of stock returns increases more slowly than proportionally with the investment horizon. (e.g., Poterba & Summers, 1988; Campbell, 1988). Several recent studies support this argument and focus on the predictability of stock returns to explain the reduction of long-term risk relative to short-term risk (e.g., Lewellen, 1999).

In this study, instead of assuming the distribution forms for various types of investments, simulation procedures are used to obtain returns that are plausible, with means and standard deviations, for the number of years until each household's planned time of retirement. This method permits development of investment alternatives that reflect the reduction of risk for holdings with longer terms. For each respondent in the SCF, the number of years before retirement ranges from one year to thirty-eight years. We used a "bootstrap" resampling simulation procedure to generate simulated investment returns for each category of investment for the different periods of time. The method takes into account the reduced risk in long-term holdings and produces a pseudo annual return to enable the creation of an efficient portfolio for each household based on the number of years until that household's planned retirement The actual procedure for the bootstrap resampling, based on Butler & Domian (1991), and Hickman, Hunter, Byrd, Beck, & Terpening (2001), is described in Appendix II.

The efficient portfolios are developed by determining the weights for each financial asset available to investors with an objective of minimizing the variance subject to the target expected return (i.e. the expected returns on current household portfolios). Efficiency tests are performed for each older worker household based on the portfolio efficiency statistics and tests proposed by Gibbons, et al. (1989).

Findings and Discussion

Table 1 presents for each of the five categories of allocation, the mean and median percent allocation to that category by the different age groups. Money market-related assets represent the largest category of assets of older worker households, with a mean of 45% and a median of 28% of total allocations, but for households under the age of 56, the mean of total allocations in money market-related assets is 27% and the median is only 8%. The second largest asset category for households with older workers is stock-related assets with a mean of 21%, while for younger households, the mean percentage of total assets held in stocks is 41%. Business ownership represents the third largest category for older worker households, with a mean of 17% of total assets.

Figure 1 presents the distribution of annualized expected returns for older worker households compared to the distribution of annualized expected return of the total sample, based on the actual household portfolios estimated from the 2001 SCF. The horizontal axis represents the annualized expected return while the vertical axis represents the percentage of the sample in the older worker category or the percentage of all households with each return. For

example, 2% of the older worker households (over 55) have an expected annualized expected return equal to 0 (due to having no investment assets). The mean annualized expected return for all older worker households is 6.4%, while the mean expected annualized return for all households in the 2001 SCF is 7.0%. As shown in Figure 1, the distributions of annualized expected returns for both the older worker category and the total population are widely spread and asymmetric. There are two possible explanations for the shape of this distribution: the extreme investment asset values of U.S. households and the possibility that some household investors are too conservative in their investments.

Table 2 summarizes the actual portfolio and the mean-variance efficient portfolios from simulation programs for older worker households. The last column provides a summary measure of inefficiency on the average, with the actual Sharpe ratios and the Sharpe ratios for efficient portfolios for households in each age range. For instance, for older worker households with the head age 56 to 60, the mean actual Sharpe ratio is 0.87 and the efficient portfolio for households in that age range would have a Sharpe ratio of 1.48, a substantial difference. A reduction in portfolio risk could be obtained without sacrificing expected returns by reallocating investments from the current investments in money-market-related and stock assets to real-estate related assets, such as Real Estate Investment Trusts (REITs) and business ownerships.

Formal test results are summarized in Table 3, showing that on average, 75% of older worker households aged age 56 to 60, and 82% of older worker households age 61 to 65 hold statistically significant inefficient mean-variance portfolios, where inefficient portfolios are defined as those for which the Sharpe ratio from the simulation result is significantly larger than the Sharpe ratio from the empirical result. The results for households older than 75 are not meaningful because of the small numbers. Compared to common stocks and bonds, real estate provides good returns at low volatility levels, and real estate allows diversification since it has a low correlation with common stocks and bonds.

The results in Table 2 in terms of increasing business ownership have to be interpreted in terms of the proxy used for business assets (Appendix I). Most households who do not currently have their own business cannot easily acquire one. However, what the results really imply is that a diversified ownership of small company stocks, combined with real estate investments and cash equivalent investments, are more consistent with efficient portfolios than portfolios with a substantial amount of large stocks. The results for real estate investments should also be considered in terms of the proxy used for real estate – the assumption was that there was diversification consistent with the indexes used. Buying one apartment building or an interest in one shopping center would not produce the diversification assumed for these analyses.

Conclusions

Given concerns about retirement adequacy, improving the efficiency of portfolios for households approaching retirement is very important. This paper provides an exploratory analysis of the issue. Based on the analyses presented, most households approaching retirement could achieve substantial reductions in portfolio risk without sacrificing expected return, or increase expected returns without increasing portfolio risk.

Appendix I
Investment assets

The 2001 SCF data set is a rich dataset for the study of financial assets of U.S. households. In addition, this data set can be used to study the relationship between households' characteristics and their financial assets. Furthermore, human wealth can be estimated from the data set. However, in the 2001 SCF, there is no clear measurement of what percentage of a household's financial assets is held in the form of stock-related assets, bond-related assets, or even real-estate related assets. This is because some types of financial assets classified in the 2001 SCF are also mixed portfolios of stock-related, bond-related and real-estate related assets. As a result, one needs to make assumptions about the composition of these kinds of financial assets in order to get a better understanding of the expected return and risk of U.S. household portfolios. Furthermore, there is no information about whether stock-related assets are invested in small capitalization stocks, medium capitalization stocks, or large capitalization stocks in the 2001 SCF data set. The following describes the method of calculating each of the five categories of assets employed for this study.

Money market-related assets

Money market-related assets are calculated by adding up the amounts held by household members in the following accounts: checking, saving, certificates of deposit, money market mutual fund, money market deposit accounts, and cash or call money accounts with the brokers.

Stock-related assets

In the SCF data set, the following assets are included in the survey: stock-related assets in publicly traded stocks, combined mutual funds, thrift, IRA, annuities, trust and managed investment accounts. When respondents in the survey answer that most of their IRA is invested in stock, for example, the amount they report in the IRA is added to stock related assets. Similar calculations are applied to respondents' accounts of mutual funds, thrift, annuities, trust and managed investment accounts. There are no specific descriptions of the composition of combined mutual funds and other mutual funds. It is assumed that these mutual funds are balanced funds in this paper. Generally speaking, the composition of balanced funds in the U.S. is about 50% in bond and money market-related assets and 50% in stocks. (The composition of balanced fund are obtained from the Snapshot of U.S. balanced funds from Morningstar, URL: http://www.morningstar.com) Therefore, 50% of households' combined mutual funds and other mutual funds are assigned as stock funds and 50% of these assets are assigned as bond funds in this paper. As a result, stock-related assets include stock mutual funds, combination and other mutual funds, publicly traded stocks, thrift invested in stock, IRAs invested in stock, annuities with equity interest invested in stocks and stock related mutual funds, and trusts and managed investment accounts with equity interest invested in stocks and stock related mutual funds.

Bond-related assets.

Similar reclassifications performed for money market-related assets are applied to bond-related assets. In the SCF, bond-related assets are found among bond mutual funds, saving bonds, combined mutual funds, thrift, IRAs, annuities, trust and managed investment accounts. When respondents in the survey answer that most of their IRA is invested in bonds, for example, the amount they report in the IRA is assigned to bond related assets in this paper. Similar calculations are applied to respondents' accounts of mutual funds, thrift, annuities, trust and managed investment accounts. Therefore, bond-related assets include tax-free bond mutual funds, government bond mutual funds, other bond mutual funds, combination and other mutual funds, bonds, not including bond funds or savings bonds, saving bonds, IRAs invested in bonds, annuities with equity interest invested in bonds and bond related mutual funds, and trusts and managed investment accounts with equity interest invested in bond and bond related mutual funds.

Real estate-related assets.

Real estate-related assets include mortgage bonds, IRAs invested in real estate, annuities with equity interest invested in real estate and real estate related mutual funds, trusts and managed investment accounts with equity interest invested in real estate and real estate related mutual funds, other residential real estate Section E properties, and nonresidential debt, including Section E nonresidential, miscellaneous property, and Section I nonresidential real estate.

An unpublished real estate series obtained from Ibbotson Associates (updated from Ibbotson & Siegel, 1984) is used for the return series of real estate-related assets. This series is a value-weighted index based on real estate returns for residential real estate, farmland returns, and commercial real estate. This index is the longest time series available, dating from 1948.

However, there are some limitations in using an index to proxy the return on real estate –related assets for household investors. The analyses are based on the following assumptions: each household's real estate holdings match the corresponding category in terms of expected return and variance. This assumption may be difficult to accept because those who hold investment real estate often have little geographic diversification – discovery of a Love Canal type of environmental disaster in the area could cause losses much higher than those represented by the aggregate real estate index used in this paper. Therefore, a national index for real estate has far too small a standard deviation. This problem of little geographic and property diversification will affect not only the standard deviation of household current portfolios but also the simulation results of mean-variance efficient portfolios discussed later. Some adjustments have been made to mitigate this problem in this paper.

To address this problem, the Sharpe approximation approach is used to adjust the risk of holding real estate in only one region or the risk of holding only one type of real estate instead of a well-diversified portfolio. The Sharpe approximation is:

$$\sigma_I^2 + 1/M \, \sigma \, \varepsilon^2 \qquad (1)$$

where
σ_I^2 : Variance of a national index for real estate,
$\sigma \, \varepsilon^2$: Average variance of holding real estate by regions and by types of real estate,
M: is 1 in this case.

To calculate $\sigma \, \varepsilon^2$, the NCREIF return series provides the most return information on real estate by types and by regions. These real estate return series are conducted by the National Council of Real Estate Investment Fiduciaries, an association of institutional real estate professionals who share a common interest in their industry. These return series are from 1978 to 2000 and are investigated for four regions and four types of real estate across the U.S. The four regions of these data series include East, South, West and Midwest and the four types include Apartment, Industrial, Retail and Office. It needs to be noted that: the *indexes* of the four regions (East, South, West and Midwest) and four types (Apartment, Industrial, Retail and Office) from the National Council of Real Estate Investment Fiduciaries (NCREIF) are used to calculate $\sigma \, \varepsilon^2$ in this paper. Indexes are still used because of the lack of time series return data for individual real estate holdings. Therefore, the adjustment to the undiversified risk of real estate holding for most households is still limited due to the limitation in data sets.

In this paper, the primary residence is not included in the calculation of real estate- related assets because the main purpose of this research is to study the current asset allocation of U.S. households and to investigate whether or not household investors can be better of reallocating their investment assets. The primary residence is not a liquid asset and is not easily altered without incurring substantial costs. In addition, the main purpose of having a primary residence is for consumption and psychological reasons, not the investment return. Therefore, the primary residence is treated as an exogenous variable in the budget constraint in the mean-variance efficient model.

Business ownership-related assets.

Business ownership-related assets include business interests, IRA invested in business interests, annuities with equity interest invested in businesses and trusts and managed investment accounts w/equity interest invested in business ownership. The average return series for individual stocks in the portfolio Decile 10 (smallest size) in the Center for Research Securities Prices (CRSP) data set is used to calculate the expected return and risk of households' portfolio holdings in business ownership. Following are the procedures used in this paper to get time series return data which are used to proxy the return of household business ownership.

The CRSP assigns a portfolio number (from 1-10, largest to smallest) to each of the securities in the NYSE-AMEX-NASDAQ based on securities' year-end market capitalization every year from 1/1/1948 to 12/31/2000. One company will move in and out of a particular assigned portfolio due to the change of year-end market capitalization. The portfolio number for each security is obtained every year from 1948 to 2000.

The annual inflation –adjusted return for each company in portfolio 10 is obtained from 1948-2000.

Data from step 2 is sorted by year. The mean of the inflation-adjusted annual return for companies staying in portfolio 10 for a particular year is obtained. This mean is used to proxy the return on business ownership for that particular year. For example, there are 96 companies staying in portfolio 10 in 1948; the mean of these companies' inflation-adjusted annual return was -4.99%. This is the return to proxy the return on business ownership in 1948. This procedure is repeated every year from 1948 to 2000.

A company that stays in portfolio 10 for only one year since 1948 will not be included in the sample to calculate the return.

In step 4, companies that stay in portfolio 10 for only one year since 1926 are not included in the sample to calculate the average variance. However, there is one possible problem when this kind of return series is used to proxy the return on households' business ownership. That is a survivorship problem. For example, if one company

in portfolio 10 goes bankrupt during a particular year, it will be moved out of portfolio 10 and will not be included in the individual stock sample for that year in this paper. However, once this company gets out of bankruptcy, it will be counted in the sample again in the year when this company gets out of bankruptcy. Similarly, if one company in portfolio 10 grows so fast that it has year-end market capitalization above the threshold of portfolio 9 (the second smallest size portfolio number) in a particular year, this company will not be counted in the sample for that year in this paper. Therefore, there is a survivorship bias with this procedure.

Appendix II
Bootstrap sampling technique

The following steps were followed in the creation of pseudo annual investment returns for each of the five types of investment for different lengths of time of investment.

1. Randomly select one of the years from 1948 to 2000. Record the observed inflation-adjusted return for this year for each of the five types of investment categories .

2. Repeat this random selection n times with replacement to construct a representative n-year holding-period return for the particular type of investment.

3. Repeat this procedure 500 times to generate n-year holding-period return distribution from the observed history of inflation-adjusted returns.

References

Aizcorbe, A. M., Kennickell, A. B.,& Moore, K. B. (2003). Recent changes in U.S. family finances: evidence from the 1998 and 2001 Survey of Consumer Finances, Federal Reserve Bulletin, 89, 1-32.

Butler, K. & Domian, D. (1991). Risk, diversification, and the investment horizon, The Journal of Portfolio Management, 41-47.

Campbell, J. Y. & Shiller, R. J. (1988). Stock prices, earnings, and expected dividends, Journal of Finance 43, 661–676.

Gibbons, M., Ross, S., & Shanken, J. (1989). A test of the efficiency of a given portfolio, Econometrica 57(5), 1121-1152.

Hanna, S., Garman, E. T., & Yao, R. (2003, June 19). Projected retirement adequacy of workers age 50 to 61: The role of 401(k) plans in the context of total wealth. Report to the Profit Sharing/ 401(k) Council of America. [Available: http://www.psca.org/DATA/retireAdeq/study2.pdf]

Hickman, K., Hunter, H., Byrd, J., Beck, J. & Terpening, W. (2001). Life cycle investing, holding periods, and risk. Journal of Portfolio Management 27(2), 101-111.

Hetzel, L. & Smith, A. (2001). The 65 years and over population: 2000. Census Briefs. Retrieved from http://www.census.gov/prod/2001pubs/c2kbr01-10.pdf, April 5, 2004.

Ioannides, Y.M. & Rosenthal, S. (1994). Estimating the consumption and investment demands for housing and their effect on housing tenure status, The Review of Economics and Statistics, 127-141.

Lai, W. (2003). Are United States household portfolios efficient? Ph.D. dissertation, The Ohio State University, listed in Dissertation Abstracts International, AAT 3088868.

Lewellen, J. (1999). The time-series relations among expected return, risk, and book-to-market, Journal of Financial Economics 54, 5–43.

Lo, A. (2002). The statistics of Sharpe ratios, Financial Analysts Journal, 36-52.

Markowitz, H. (1952). Portfolio selection, Journal of Finance 7, 77-91.

Markowitz, H. (1990). Foundations of portfolio theory. Nobel Prize in Economics lecture. www.nobel.se/economics/laureates/1990/markowitz-lecture.html

Poterba, J. & Summers, L. H. (1988). Mean reversion in stock returns: Evidence and implications, Journal of Financial Economics, 22, 27–60.

Sharpe, W. (1966). Mutual fund performance. Journal of Business, 119-138.

Sharpe, W. (1994). The Sharpe ratio, Journal of Portfolio Management, 21, 49–58.

Siegel, J. (1999). Stocks for the long run, 2nd ed. (Irwin).

U.S. Census Bureau. (2004). U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin, Table 2a. Retrieved April 18, 2004: http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf

Yuh, Y., Hanna, S., & Montalto, C. P. (1998). Mean and pessimistic projections of retirement adequacy, Financial Services Review, 175-193.

Table 1
Actual Household Asset Allocations as a Percentage of Total Allocations - 2001 SCF

A. Mean percentage of total assets invested in each type of asset by age

	Money Market	Stock	Bond	Real Estate	Business Ownership
30-35 years old	28.08%	45.34%	7.99%	5.43%	5.12%
36-40 years old	23.70%	40.42%	12.57%	6.57%	8.88%
41-45 years old	28.07%	39.17%	11.50%	6.26%	8.61%
46-50 years old	29.21%	37.77%	9.52%	8.61%	8.40%
51-55 years old	27.39%	40.96%	9.20%	9.57%	8.38%
56-60 years old	30.87%	37.11%	8.59%	7.47%	11.83%
61-65 years old	29.10%	36.22%	14.91%	9.72%	6.27%
66-70 years old	44.66%	14.57%	9.77%	11.57%	15.38%
71-75 years old	30.86%	35.35%	0.38%	12.30%	21.10%
76-80 years old	82.97%	1.43%	0.41%	14.91%	0.29%
> 80 years old	50.92%	0.04%	0.00%	0.01%	49.03%
< 56 years old	27.29%	40.73%	10.16%	7.29%	7.88%
56 years old and over	44.90%	20.79%	5.68%	9.33%	17.32%

B. Median percentage of total allocations invested in each type of asset by age

	Money Market	Stock	Bond	Real Estate	Business Ownership
30-35 years old	6.81%	40.10%	0.00%	0.00%	0.00%
36-40 years old	5.39%	29.13%	0.00%	0.00%	0.00%
41-45 years old	11.47%	28.36%	0.00%	0.00%	0.00%
46-50 years old	10.29%	24.53%	0.00%	0.00%	0.00%
51-55 years old	7.72%	35.95%	0.14%	0.00%	0.00%
56-60 years old	11.19%	23.26%	0.00%	0.00%	0.00%
61-65 years old	5.94%	23.44%	0.00%	0.00%	0.00%
66-70 years old	29.31%	0.00%	0.00%	0.00%	0.00%
71-75 years old	21.22%	0.00%	0.00%	0.00%	0.00%
76-80 years old	89.43%	0.00%	0.00%	10.57%	0.00%
> 80 years old	11.75%	0.00%	0.00%	0.00%	88.25%
< 56 years old	8.34%	31.61%	0.03%	0.00%	0.00%
56 years old and over	28.14%	7.78%	0.00%	1.76%	14.71%

Table 2

Comparison between Actual Portfolios Estimated from 2001 SCF and Mean-Variance Efficient Portfolios for Older Worker Households (Age 56 and over)

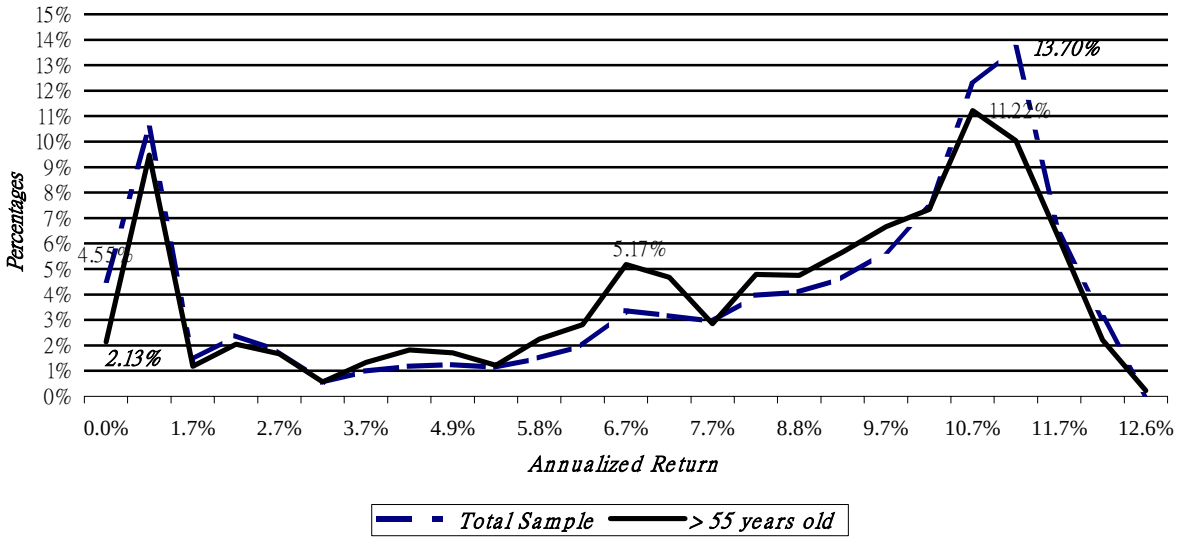
		Money Market	**Stock**	**Bond**	**Real Estate**	**Business Ownership**	**Risk-Adjusted Return (Sharpe Ratios)**
		Mean	Mean	Mean	Mean	Mean	Mean
56 to 60 years	Actual	32.74%	39.36%	9.11%	7.92%	10.88%	0.87
	Recommended	24.66%	1.95%	0.33%	43.19%	29.88%	1.48
61 to 65 years	Actual	30.24%	37.64%	15.50%	10.10%	6.52%	0.76
	Recommended	27.28%	0.69%	0.37%	45.62%	26.05%	1.38
66 to 70 years	Actual	46.55%	15.18%	10.18%	12.06%	16.03%	0.70
	Recommended	36.82%	0.58%	0.36%	41.37%	20.87%	1.15
71 to 75 years	Actual	30.86%	35.35%	0.38%	12.30%	21.10%	1.17
	Recommended	15.88%	0.04%	0.00%	50.39%	33.69%	1.53
76 to 80 years	Actual	82.97%	1.43%	0.41%	14.91%	0.29%	0.69
	Recommended	66.58%	0.12%	0.00%	32.89%	0.41%	0.81
81 years and over	Actual	50.92%	0.04%	0.00%	0.01%	49.03%	0.41
	Recommended	32.85%	0.00%	0.00%	24.90%	42.25%	0.47

Table 3

Efficiency Tests of Household Investors' Portfolios for Older Worker Households

Age Groups	**Inefficient Portfolios $F>F^*_{(0.01,4,145)}$**		**Efficient Portfolios $F =< F^*_{(0.01,4,145)}$**	
	# of households	%	# of households	%
56 to 60 years old	215	75%	70	25%
61 to 65 years old	124	82%	27	18%
66 to 70 years old	50	71%	20	29%
71 to 75 years old	8	81%	2	19%
76 to 80 years old	1	32%	3	68%
81 years old and over	2	67%	1	33%

Figure 1
Annualized Expected Returns of Older Worker Households (Aged 56 Years Old and Over) versus Total Sample in 2001 SCF



Descriptive Results: Annualized Expected Returns of All Households and of Older Worker Households

	Mean	Median	Std.Dv.	100%	75%tile	25%tile	10%tile	Minimum
Total Sample	7.00%	8.43%	1.77%	12.58%	10.77%	2.44%	1.08%	0.00%
>55 Years Old	6.42%	7.01%	1.46%	12.58%	10.11%	2.17%	1.09%	0.00%

Endnotes

[1] Christine Whuei-wen Lai, Assistant Professor, Finance Department of Yuan Ze University, Chungli, Taiwan. E-mail: lai@saturn.yzu.edu.tw

[2] Sherman D. Hanna, Professor, Ohio State University, Consumer Sciences Department, 1787 Neil Avenue, Columbus, OH 43210-1290. Phone: 614-292-4584. FAX: 603-457-6577. E-mail: hanna.1@osu.edu