Do Households Make Saving and Investment Decisions Together?

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How much should a household save? The typical financial planning approach uses some assumed rate of return and some savings goals such as retirement, and calculates the amount needed to be saved each year to reach the goals. However, if a higher rate of return is assumed, the needed percent of income to save will be lower. For example, if a 2% real rate of return is assumed for a 25 year old who will have a constant real salary until retirement, then have a pension equal to 30% of salary, and wants a total retirement income equal to 90% of aftertax salary, then, ignoring tax issues, the worker's savings rate should equal 13% of his or her salary. However, if the worker chose a stock portfolio that could be expected to have a 6% real rate of return, the worker would only need to save 5% of his or her salary. Samuelson (1969) formulated and solved a many-period lifetime model of consumption and investment decisions based on the idea that investors should consider saving-consumption and investment decisions at the same time. In Samuelson's model, investors were assumed to have a certain amount of initial asset which they invested to finance their lifetime consumption; investors had intertemporally additive concave utility functions and faced a financial market with one safe asset and one risky asset. Based on those assumptions, Samuelson derived the optimal rules for saving-consumption and portfolio allocation for a variety of probability distributions. Generally, the optimal saving-consumption level and the portfolio allocation will depend on each other. However, for the constant relative risk aversion utility function, the consumption-saving decision depended on the investment decision, but the investment decision was independent on the consumption-saving decision. However, if the investor's risk preference depends on the level of wealth, such as with the constant absolute risk aversion utility function, then the optimal saving decision will interact with the investment decision.

Merton (1969) used a model similar to Samuelson's discrete-time model to examine the combined problem of the optimal portfolio allocation and the optimal saving-consumption level for an individual in a continuous-time model. With similar assumptions, Merton also derived the optimal rules for household consumption and portfolio allocation. The results were in general comparable with Samuelson's findings. Hakansson (1970) showed that the optimal consumption for any period was a linear increasing function of wealth, and the optimal portfolio allocation in different assets depends only on the consumer's one-period utility function and one-period returns of different assets. Merton (1971) furthered his study on the optimal rules for saving-consumption and portfolio allocation by incorporating more general utility functions, price behavior assumptions, and income from non-capital gain sources. Merton showed that the optimal rules of consumption and portfolio allocation depended on each other (Merton, 1971). Purvis (1978), Smith (1978), and Owen (1981) also successfully presented models that jointly determine saving-consumption and portfolio allocation decisions. To summarize these studies, the portfolio allocation decision in general affects the optimal saving-consumption decision. The saving-consumption decision affects the optimal portfolio allocation, if the consumer's relative risk aversion depends on the level of wealth.

Much effort has been devoted to model these two decisions in one framework. However, few empirical analyses have been done on how those two decisions interact. The lack of empirical testing of these models might be due to the fact that most of the models that consider the saving-consumption and the portfolio allocation decision at the same time are too complicated to be employed in empirical analysis. To test such complicated models, a huge amount of information needed. This study investigates the empirical relationship between saving-consumption and portfolio allocation decisions. The 1995 Survey of Consumer Finances (SCF) cross-sectional survey dataset is used to investigate the relationship between household saving-consumption and portfolio allocation and evidence of response in saving and investment behavior to changes in expectations of the financial markets.

Data and Methodology

The data used in this study are from the public use tape of the 1995 Survey of Consumer Finances (SCF) cross-section data. The 1995 SCF gathered detailed household level information on the composition of assets and liabilities of 4,299 households. It is difficult to assess the investment preferences of households with low levels of financial assets, since they usually do not have anything left for investment other than liquid assets to cover normal transactions during one month. Therefore, households with financial assets equal to or less than one month's income were excluded from the sample used in this study. Retired households were also excluded from the sample, because household saving and portfolio behavior are quite different between retired households and households containing at least one employed person. After imposing the above two criteria, a total of 1,856 households were used in the empirical analysis. The households in the sample represent about 68% of all American households. Because the SCF sample is not an equal-probability sample, data used in this study were weighted to obtain more precise information about the average U.S. household. The Federal Reserve Board used multiple imputation to replace missing values in the 1995 SCF, and the public dataset contains five replicates. The descriptive results reported in this research were obtained by combining results from the five implicates based on Bayesian theory (Rubin, 1987). The Probit and Tobit results reported in the next section were performed on the first implicate.

The empirical model specification and estimation depend on the relationship between the household saving and portfolio allocation decisions, that is, whether the two decisions are independent or interdependent. With the constant relative risk aversion assumption, the portfolio decision could be estimated without considering the saving variable and the saving equation could be estimated by viewing the portfolio decision as one of the endogenous factors. However, empirical studies have yielded limited support for the constant relative risk aversion assumption (Cohn, Lewellen, Lease, & Scharbaum, 1975; Siegel & Hoban, 1982). There is no guarantee that the constant relative risk aversion assumption is valid. The empirical model presented in this study assumes that households make the saving decision and the portfolio allocation decision simultaneously. The estimating equation for the saving and portfolio allocation decisions are:

$$S^*_i = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ki} + \sum_{m=K+1}^{K+M} \beta_m X_{mi} + \beta_R R^*_i + e_{s,i}$$

$$R^*_i = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ki} + \sum_{n=K+M+1}^{K+M+N} \beta_n X_{ni} + \beta_S S^*_i + e_{r,i}$$

Variable S^*_I and R^*_I represent the optimal saving decision and portfolio allocation decision of the ith household, respectively. X_{ki} is the value of the kth explanatory variable that affects both the household saving and the portfolio allocation decision. X_{mi} is the value of the mth explanatory variable that only affects the household saving decision, not the portfolio allocation decision. X_{ni} is the value of the nth explanatory variable that only affects the portfolio allocation decision, but not the saving decision. The β terms are response coefficients and $e_{s,i}$ and $e_{r,i}$ are stochastic terms. Since the two decisions are assumed to be determined jointly, S^*_I is an explanatory variable in the portfolio allocation equation and R^*_I is an explanatory variable in the saving equation. The two equations should be estimated simultaneously.

Dependent Variables

Savings. The 1995 SCF asked a set of questions regarding household's saving in the previous year. Respondents were asked the following question:

"Over the past year, would you say that (your/your family's) spending exceeded (your/your family's) income, that it was about the same as your income, or that you spend less than your income? (Spending should not include any investment you have made.)"

In this study, saving was coded as a binary variable based on the question stated above. The variable was defined as 1 if the respondent reported that income was greater than spending (excluding spending on investments and durables), zero otherwise. Therefore, instead of estimating the real dollar amount of saving or dissaving, the saving equation estimates the probability of saving money over the past year.

Portfolio Allocation. In this study, household non-housing assets were divided into two categories -- risky and non-risky assets, based on the assets' exposure to risk. Risky assets include directly held stocks, risky assets in IRAs and pension accounts, directly held mutual funds (excluding money market mutual funds), directly held bonds, managed assets (including trusts, annuities and managed investment accounts), saving bonds, other financial assets, investments in real estate, business assets, and other non-financial assets. Non-risky assets include checking accounts, saving accounts, money market accounts, cash value of whole life insurance, and non-risky assets in IRAs and pension accounts. The proportion of the non-housing assets being invested in risky assets was defined as the measure of portfolio allocation. This proportion can range from zero to one.

Independent Variables

Variables Associated With Both the Saving Decision and Portfolio Allocation Decision: Household social-demographic variables include respondent's age and age squared, Years till retirement, household size, Highest educational attainment among spouses, Number of earners, Race and Ethnicity, Health condition of both spouses, Occupation, and Full-time. Age and Age squared were measured as the reported years of age of the respondent at the time of interview. The number of years till retirement was coded as the actual number of years until the respondent expected to retire from the labor force. For those who reported they did not expect to stop working, the retirement age was assumed to be 70. Household size was coded as the actual number of persons in the household. Education was measured by the highest educational attainment of the respondent or his/her spouse, and coded as three dummy variables: College, High School, and Non-high school. Number of earners was coded as the actual number of persons working for pay. Marital status was coded as 1 if the respondent was married and 0 otherwise. Respondents' race and ethnicity was coded into four dummy variables: White, Black, Hispanic, and other races. Health condition was coded as 1 if either spouse reported a poor health condition and 0 otherwise. Occupation was coded into eight dummy variables to indicate the occupation of the respondent. The eight dummy variables are Self-employed, Manager, Technician, Service, Craftsman, Laborer, operatives workers, and Farmer. Full-time was coded as 1 if the respondent worked more than 35 hours a week and 0 otherwise.

Household financial status variables include Total household net worth, Insolvency, Pension income after retirement, and home ownership. Total household net worth is the value of financial assets plus non-financial assets less the total debts. Insolvency was coded as 1 if the household was insolvent (negative net worth) and 0 otherwise. The Pension income after retirement variable was coded as 1 if the respondent expected to have the pension to maintain living standards; 0 otherwise. Home ownership was coded as 1 if the respondent was a home owner; 0 otherwise.

Expectation and attitudinal variables include Expectation about the general economy, Expectation about future family income, Expectation about interest rate, and Attitude towards credit. Expectation about the general economy was coded as 1 if the respondent expected the U.S. economy to perform better; 0 otherwise. Expectation about future family income was coded as 1 if the respondent expected total family income to go up more; 0 otherwise. Expectation about interest rate was coded as 1 if the respondent expected the interest rate to be higher, 0 otherwise. Attitude towards credit was coded into three dummy variables to indicate whether the respondent felt buying things on credit was a good idea, a bad idea, or good in some ways and bad in others.

Wealth transfer variables include Expected inheritance, Received inheritance, and Attitude towards bequest. Expected inheritance was coded as 1 if the response is yes and 0 otherwise. Received inheritance was coded as 1 if the response is yes and 0 otherwise. Attitude towards bequest was coded as 1 if the respondent thought was important and 0 otherwise.

Saving motives variables were based on respondent responses about their reasons for saving. These questions recorded more than 20 reasons ranging from education to funeral expenses. These 20 reasons were separated into 5 groups: retirement, education, emergency, durables, and others. Five dummy variables were created and the two most important saving goals listed by the respondent were coded.

Variables Only Associated With the Saving Decision. Household current income was coded as a continuous variable. Transitory variation in current income was categorized by three dummy variables indicating if the total household income in the past year was unusually high or low compared to what the household would expect in a "normal" year, or it was the same.

Variables Only Associated with Portfolio Allocation. The investment horizon variable was created based on two questions regarding the most and least important time periods in terms of household financial planning. Investment horizon was defined as the weighted average of the two time periods. The most important planning period was assigned a weight of 5 and the least important Period was assigned a weight of one. The risk tolerance variables were created based on the household's response to a question regarding the respondent's attitude toward risk. Three dummy variables were created to indicate the four levels of financial risk the respondent is willing to take to earn investment return.

Analysis

The error terms in the two equations may be correlated, so single equation estimation ignoring the joint endogeneity of the decisions may produce biased estimates of the parameters. Since the saving and portfolio allocation decisions are assumed to be determined jointly, the two equations must be estimated at the same time to correctly address the simultaneity problem. The simultaneous equation system can be estimated as suggested by Maddala (1983, pp. 246). This model differs from the usual simultaneous equation system in that the dependent variable in the first equation is binary and the dependent variable in the second equation is censored (see Chen, 1997). This model can be estimated by maximizing the likelihood function of a structural two stage Probit-Tobit model. The two stages of the estimation procedure provided by Maddala (1983) are presented as follows. In stage one, the reduced form of the saving and portfolio allocation equations are estimated by the Probit and Tobit methods, respectively. In stage two, S_i and R_i on the right hand sides of the two equations are replaced with the predicted values S_i^{**} and R_i^{**}, from stage one. The two new equations are estimated by Probit and Tobit, respectively to obtain unbiased and consistent estimates of the joint model.

Results

Demographic Characteristics

There were 1,147 households in the entire sample reporting saving and 709 reporting dissaving in 1994. The weighted proportion of households reported savings was 54%.

Probit and Tobit Results

The results of the second stage of the two-stage Probit and Tobit for the determinants of household savings and portfolio allocations can be seen in the full version of this paper on the web (Chen, Hanna, & Montalto, 1998). Since the estimated coefficients of Probit and Tobit analysis can not be interpreted directly, marginal effects for each independent variable were calculated and reported. According to the Probit and Tobit results, there is no significant endogenous relationship between the household saving decision and the portfolio allocation decision. This suggests the assumption that households are making saving and portfolio allocation decisions simultaneously might not be valid.

Determinants of Household Saving

The Probit regression results in this study suggest that respondent age, marital status, household size, race and ethnicity, current net worth level, expected pension adequacy, future inheritance, saving motives, occupation and current household income are significant factors that affect the probability of saving. The relationship between age and the probability of saving is found to be non-linear. The probability of saving decreases as the age increases before age 44. After age 44, the probability of saving starts to increase. Married couple households are more likely to save, others things being equal. One plausible explanation is that married couples are more forward looking than others. They might be more motivated by future consumption needs which will drive them to save more. Household size is negatively related to household savings. Households with more family members would need to spend more to keep the same living standard. Home owners are more likely to save, while people who expect to have adequate pension income after retirement are less likely to save. This makes intuitive sense. Households with adequate pension income after retirement do not need to save as much as others to finance their consumption after retirement. Households with clearly defined saving goals are more likely to save. The results also indicate that saving tends to move in the same direction as current household income. Respondent's occupation, expectation on future economy, and attitude toward credit were not found to be significantly related to household savings. The predicted proportion of risky asset holding is not significantly related to the household saving decision when it is treated as an endogenous variable.

Determinants of Household Portfolio Allocation

The Tobit regression results indicate that age, self-employed status, and willingness to take above average financial risk are significantly related to proportion of risky asset holding. The relationship between age and the proportion of risky asset holdings is found to be non-linear. The proportion of risky asset holdings increases as the age increases, however, the marginal effect decreases. Self-employed people tend to invest more in risky assets. One plausible explanation for the positive effect is that self-employed people are more likely to invest their savings into their own business than others. Households' willingness to take financial risk is positively related with the holdings of risky assets. Household portfolio allocation tends to move in the same direction as their risk preferences, other things being equal. The predicted probability of saving is not significantly related to the proportion of risky asset holding when it is treated as an endogenous variable.

Discussion and Conclusion

By controlling for the differences in household socio-demographic characteristics, financial status, and other factors, the relationship of household saving and portfolio allocation is investigated. No evidence of endogenity between household saving and portfolio allocation was discovered. Neither the estimated coefficients, nor the likelihood ratio tests indicate that households make saving-consumption and the portfolio allocation decisions simultaneously. This implies that households do not seem to make saving-consumption and portfolio allocation decisions at the same time. However, it is possible that the endogenous relationship was not discovered by the empirical analysis due to data limitations, model mis-specifications, and variable measurement errors. Because both dependent variables are not perfectly measured, especially the saving variable, household saving and investment decisions might not be captured accurately. Similar suspicion could be raised with respect to many independent variables too. It is also possible that some important factors that could have considerable impact on household financial decision making are not included in the empirical analysis, although efforts were made to try to incorporate the most relevant variables.

The results of this study contribute to the literature in two ways. First, this study explored the relationship of household saving and portfolio allocation decisions. Empirical results do not support the endogenity of household saving and portfolio decisions. Secondly, this study also found that many household characteristics and financial factors affect household saving and portfolio allocation. These findings should be of great importance in terms of understanding household financial decision-making. The results of this study have very important implications for financial planning, consumer education, and public policy.

Optimally, households should consider their saving decision and portfolio allocation decision simultaneously. However, the empirical results of this study do not find any endogenous relationship between these two decisions. This could be due to the fact that the cost of finding the optimal solution for both saving and investment could be very high for individual households. Because of the complexity and the increasing marginal computational cost to find the optimal solution, households might not necessarily pursue the optimal solution. In other words, the computational cost prevents people from getting the best solution (Shefrin & Thaler,1988; Browning & Lusardi, 1996). Consequently, households are not using their resources optimally, although it is theoretically possible to do so. A consumer education program might be the best strategy to help household choose optimal saving and portfolio allocation decisions. The program can be designed based on this study and previous literature. A well-developed computer expert system could be one way to implement such a strategy.

This study is subject to several limitations. The 1995 SCF is the most comprehensive survey on American households financial information. However, several important components of household saving and portfolio allocation are not included in the survey questions. For example, the exact saving amount is not available because no consumption information is included in the survey. The sample used in this study represents about two thirds of total American households. The results presented in this study should be interpreted with caution, since they might not hold for the entire population of American households or other sub-groups. Future studies on all American households would provide more insights. A simultaneous equation model is required in order to investigate the possible endogenous relationship between household saving and portfolio allocation. However, none of the statistical packages could perform a simultaneous equation model with one binary and one censored dependent variable. A structural two-stage Probit and Tobit procedure was used as a compromise. Therefore, advanced statistical tools would help to deal with this limitation. This limitation could also be solved by having a continuous measure of household saving in a dataset with good portfolio information.

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Endnotes

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