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ASSET ACCUMULATION, INFORMATION, AND THE LIFE CYCLE

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ABSTRACT

Empirical tests of the life cycle model have focused on its implications for the level of a household's total net worth and paid little attention to changes in portfolio composition over the life cycle. In this paper, we examine a new survey of the asset holdings of 6,010 U.S households and show that there is a pronounced life-cycle pattern to both the number and value of assets held by U.S. households. Direct survey evidence suggests that incomplete information is a significant determinant of household portfolio composition. We test the hypothesis that information about investment opportunities arrives stochastically over time, estimating a Poisson model for the arrival of new information.

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ASSET ACCUMULATION, INFORMATION, AND THE LIFE CYCLE*

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1. Introduction

Empirical tests of the life cycle model have focused almost exclusively on its implications for the level of a household's total net worth. Relatively little attention has been paid to changes in portfolio composition over the life cycle. Although this emphasis is understandable, it obscures some important features of household savings behavior. As we show below, there is a pronounced life-cycle pattern to both the number and value of assets held by U.S. households. In this paper we examine the factors that are responsible for the small degree of diversification that is observed in household portfolios.

To examine the extent of diversification we present evidence from a new survey of the asset holdings of 6,010 U.S. households. The survey distinguishes thirty-six different assets and liabilities, and contains a large number of wealthy households. We are, therefore, able to explore the changing composition of household portfolios over the life cycle in some detail. The evidence suggests a degree of incompleteness in portfolios that is difficult to reconcile with conventional portfolio theory. Transaction costs almost certainly play some role but in themselves are inadequate to explain the lack of diversification of such a high proportion of the rich. To explain the degree of incompleteness in portfolios, we focus on one aspect of bounded rationality, namely incomplete knowledge of the investment opportunities that are available. In section 4 we develop and test a simple model in which the flow of information about new investment opportunities is stochastic and arrives with a constant probability (conditional on household characteristics) each period.

This model is related to the concept of "noise traders" employed by Black (1986), Shiller (1984), Glosten and Milgrom (1985), and De Long et al. (1987). In those models noise traders are assumed to engage in purchases or sales of assets for exogenous reasons unrelated to the factors that determine the "optimal" portfolio decisions of informed traders. Incomplete information about investment opportunities will lead to certain features of behavior characteristic of noise traders, in particular, entry into, but not exit from, the market. The arrival of information about investment opportunities will induce purchases of assets that would not occur in a conventional model of portfolio choice with complete information. The evidence presented in this paper provides some empirical justification for this aspect of the behavior of noise traders.

The process for the arrival of information about new investment opportunities described above implies that age will be an important determinant of portfolio composition. Such life cycle effects will vary among assets according to the importance of information for the acquisition of different assets. Previous empirical studies of the life-cycle model have focused on two questions more concerned with the total size of a household's wealth than with its composition. These are, first, can the model explain the observed level of savings in the economy, and, second, can it explain the observed age-profile of wealth-holdings? Neither question has been fully resolved.[1] Apart from the now voluminous literature on the effects of pensions and social security on private saving, remarkably little attention has been paid to the changing composition of household portfolios over the life-cycle. Moreover, social security and pension wealth are probably the assets over which a household has least discretion.

Those studies that have tested for changes in the composition of household portfolios over the life cycle found little evidence of any significant age effect. Using data from the Oxford Savings Survey conducted in 1953, Lydall (1955) found that in the UK only equity in housing and the value of liabilities declined after retirement. The former result is contradicted by the more recent studies for the US and Canada of Bernheim (1984) and King and Dicks-Mireaux (1982) respectively. Moreover, the Oxford study distinguished only four categories of assets and liabilities and consequently provides little information about portfolio composition. Uhler and Cragg (1971) used data from the 1960-62 Michigan Surveys of Consumer Finances to estimate a logit model for the number of assets owned by a household and found age to be an insignificant explanatory variable for each of the four alternatives considered (owning one, two, three or four or more assets). Likewise, Blume and Friend (1975) found no effect of age on the extent of diversification of portfolios for households in the 1962 Federal Reserve Board Survey.[2] In contrast, Dicks-Mireaux and King (1984), using data for 10,118 Canadian families in 1977 found that the probability of owning each of the eleven assets distinguished in the survey was higher for households where the age of the head was greater than forty than for younger households, with the exception of business equity and registered home ownership savings plans.

There are two main reasons that may explain why these studies (with one exception) failed to capture any life cycle influences on portfolio composition. First, they imposed a simple linear relationship between portfolio composition and age, or they employed a single age dummy. This specification may fail to detect a true nonlinear relationship. Secondly, the number of assets distinguished in the studies was small. The survey analyzed here enables us to overcome this problem.

In section 2, we describe the survey data and present some summary statistics. The evidence on the life cycle behavior of portfolios is examined in section 3. In section 4, we develop and estimate a model of the impact of the arrival of new information on asset accumulation.

2. The Survey Data on Household Portfolios

Our data are drawn from the 1978 Survey of Consumer Financial Decisions conducted by SRI International.[3] This was a survey of 6,010 U.S. households based on a stratified random sample which "oversampled" high income units. It provides, therefore, an especially valuable source of information on the portfolio behavior of wealthy households. No fewer than 2,460 households (40 percent of the sample) reported a figure for 1978 net worth in excess of $100,000. The mean net worth of the sample was $223,188 (over $400,000 at 1987 prices). The largest value of reported net worth was $73 million, and the sample contains 204 millionaires. Assets were valued at market values in May and June 1978. Information was recorded on the holdings of 23 different types of asset and 13 types of liability, and these 36 categories are shown in Table 1.

The assets include checking accounts, various types of savings accounts, money market funds, bonds of various types, stocks, mutual funds, IRA-Keogh accounts, convertible securities, owner-occupied housing, real estate and other tangibles, life insurance, tax shelters and other assets. The liabilities include home mortgages, personal loans, and other loans specifically related to particular assets. Certain assets were excluded from the survey, namely entitlement to future social security payments and some types of private pensions (primarily defined benefit plans), the value of future inheritances, and ordinary consumer durables.[4]

Table 1a summarizes the asset holdings of households in the sample. Columns one and two show the shows the mean value of each asset holding in dollars and as a proportion of the mean net worth of households in the sample, respectively. The most important assets owned by households in the sample (as a proportion of net worth) were homes (33 percent), stocks (23 percent) and investment real estate (22 percent). Other assets held in large amounts include pension plans, municipal bonds, and closely-held stock. It is worth noting that all of these are assets that received favorable tax treatment. In Table 1b we present the corresponding population estimates of household asset holdings using the weights provided by SRI. Over half the net worth of the population is held in owner-occupied housing, just under one-fifth in investment real estate, and only one-tenth in stocks and stock mutual funds. Over ten percent is held in savings and credit union share accounts and another eight and a half percent in savings certificates and savings bonds.

In the final column of Tables 1a and 1b is shown the percentage of households owning each asset. Certain assets were owned by almost everyone--over ninety percent of the sample (and 88 percent of the population) had checking accounts. Similar proportions held savings accounts. Almost 60 percent of the sample, but only about 40 percent of the population had pensions or retirement plan accounts. Annuities were purchased by just one percent of the sample and one-half of one percent of the population.

Almost one-half of the sample owned corporate equity either directly or indirectly through a mutual fund. About 10 percent of the sample held corporate bonds. The proportion of households owning tax-exempt municipal bonds was also about ten percent of the sample, although the average holdings were significantly higher than for taxable bonds. Eighty-four percent of the sample owned their own home and almost 10 percent owned a second home. Over 40 percent invested in miscellaneous tax-preferred assets including tax shelters, closely-held stock, convertible securities, investment real estate and tangibles such as art and gold (owned by a surprisingly high 1,230 households). Well over half the sample had both a home mortgage and some other liability. Personal loans and credit card accounts were the most common form of other liabilities.

In contrast, only one-quarter of the population held equity either directly or through a mutual fund, only three percent held corporate bonds, and three percent municipal bonds. Sixty-five percent of the population owned their own home and less than one-quarter invested in special tax-preferred assets such as investment real estate, tangibles and closely-held stock. More than a third of the population had home mortgages and 37 percent had credit card liabilities.

As a test of the quality of the survey data we compared the estimated population total for asset holdings (using population weights to gross-up the survey figures) with the aggregate holdings of assets in the year-end balance sheets published by the Federal Reserve. This comparison is shown in Table 2. The two sources use different classifications of assets, and it was possible to make a direct comparison for only nine asset categories.

There is also a difference in the dates to which the two sources refer. The SRI survey was conducted in the spring of 1978 and the Federal Reserve data shown in Table 2 refer to the end of 1977.

The population totals for assets and liabilities implied by the survey data are very close to Federal Reserve balance sheet totals. Total net worth estimated from the full sample is 100.2 percent of the balance sheet figures. This degree of accuracy is, however, fortuitous and the comparison is more varied if we look at the estimates for individual assets. Nevertheless, for checking accounts, savings accounts, equities, municipal bonds, home mortgages and other liabilities, the two sets of estimates are close. The largest discrepancies are for taxable bonds (where the survey data are about 50 percent of the balance sheet total) and the residual category "other assets" (where the survey data are about two-thirds of the balance sheet figure). The first may well be due to under-reporting (although the Federal Reserve data include holdings of foreign bonds, which were not recorded in the SRI Survey) and the second to a difference in the definition of "other assets" which in both sources is a residual item. It is also interesting to note that the survey estimates of home values are higher than the balance sheet estimates. The rapid increase in house prices in the two year period immediately prior to the survey is more likely to show up in survey responses than in the balance sheet totals where the price indices for structures and land used to compute value estimates may not reflect the rise in the price of second-hand dwellings.

Given the very different sources of the estimates, and the fact that many of the Federal Reserve balance sheet totals for the household sector are obtained as a residual, the matching between the two sets of wealth estimates is surprisingly close. This increases our confidence in the value of the survey data to examine portfolio composition.

3. Evidence on Portfolio Composition and the Life Cycle

The figures in Table 1a document the variety of assets owned by wealthy households in the US. They also demonstrate a surprising lack of diversification by such households. Over 50 percent of the sample did not own corporate equity either directly or through a mutual fund.[5] Fewer than 10 percent of the sample exploited the tax-exempt nature of municipal bonds. The size of average liabilities in different categories suggests that the majority of households did not take advantage of the opportunity of tax-deductible borrowing to purchase assets taxed at concessionary rates.

The extent of diversification is illustrated in Table 3 which shows the sample and estimated population frequency distribution of the number of assets and liabilities in household portfolios. No household in the sample held more than 23 out of the possible 36 types of asset and liability. The median number of assets and liabilities owned by the sample was only eight (six using population weights). Given the very high average wealth of the households in our sample (almost a quarter of a million dollars), it is surprising that households held such a small number of assets.

There is also a clear life cycle pattern to the number of assets owned. Figure 1 shows the average number of assets and liabilities held in each five-year age group of the sample. There is a pronounced "hump-shaped" profile that peaks at the age of sixty. The number of assets owned increases rapidly in the early stages of life, reaches a plateau in the age ranges forty through sixty and then declines rapidly in old age.

For some assets, such as IRA and Keogh plans and home mortgages, there is a natural life cycle in their acquisition and disposal. The pronounced nature of the hump-shaped pattern suggests, however, that this can only be part of the story.

We shall try to distinguish between two competing explanations for this apparent lack of diversification and its variation over the life cycle. These are (i) transaction costs and (ii) incomplete information about investment opportunities.

In the presence of transaction costs, individuals face a trade-off between the benefits of a particular investment, including the diversification it offers, and the costs of the additional transaction. The acquisition of an asset will, therefore, be justified only if the size of the desired investment exceeds some critical minimum. Thus, individuals will typically hold only a subset of the assets available in the market. More importantly, the number of assets held will be an increasing function of net worth. A hump-shaped profile for net worth could, therefore, induce a similar pattern for the number of assets held.

It is commonly supposed that the "hump" age profile for wealth implied by the life cycle model has received little support from surveys of household wealth. Lydall (1955) and Mirer (1979), for example, concluded that there was no significant tendency for wealth to decline with age. Among the problems with these early studies was their failure to control for differences in permanent income. More recent studies, however, have shown that there is some, albeit limited, decumulation of wealth after retirement. Bernheim (1984) and Hurd (1986) for the United States, and King and Dicks-Mireaux (1982) for Canada, all found rates of decumulation on the order of 2-3 percent per year. Using panel data from the Retirement

History Survey, for example, Hurd (1986) estimated that the annual rate of decumulation of wealth excluding housing was 3.2% per year for households where the head had retired, and 1.5% per year for wealth including the value of housing. Although panel data have some advantages over cross-section data they also have disadvantages. The volatility of asset prices means that the estimated rate of decumulation is compounded with changes in asset values resulting from unanticipated revaluations. The quality of the survey data may also be lower.

The evidence from our survey is summarized in Figures 2a and 2b. To analyze the wealth-age relationship it is important to control for differences in permanent income. As a proxy for permanent income we constructed an estimate of normal age-adjusted annual earnings, which we call "permanent earnings". This differs from current earnings in two ways. First, current earnings contain a transitory component. Secondly, there is an age-earnings profile over the life cycle. We adjust for both. With only cross-section data we are unable to distinguish between the pure age-earnings profile and the cohort effect. Hence we impose an estimate of the cohort effect in our computation of permanent earnings. Details of this and the procedure we used to estimate permanent earnings are described in the Appendix. Figure 2a shows the median ratio of net worth to permanent earnings in each five-year age group. There is clear evidence of decumulation at the end of life. Figure 2b shows the same ratio when permanent earnings are defined without any imposed cohort effect. Again the hump-shaped profile for net worth is evident. The observation that wealth is run down after retirement is not, therefore, sensitive to the particular cohort adjustment used in this study. It is plausible, therefore, that the interaction between transaction costs and the age profile for wealth could induce a life-cycle pattern in the number of assets owned. The rate at which wealth is decumulated between the ages of 70 and 80 implied by the profile shown in figure 2a is 3.4% per year. Given the quality of the survey data, this finding, together with the similar results of Bernheim (1985) and Hurd (1986), suggest that the conventional wisdom that wealth does not decline after retirement requires modification. The low observed rates of decumulation contradict the predictions of a simple life-cycle model with a nonstochastic date of death. They are, however, consistent with the life-cycle model if the length of life is uncertain and annuities markets are imperfect (Davies (1980), King (1985)).

The second factor that influences the degree of diversification is the stock of "investment opportunities"; that is, the information that an investor possesses about purchasing and holding assets. Conventional models of portfolio choice assume that individuals allocate net worth among a fixed number of available assets with a known distribution of returns. The assumption that investors start from a fixed list of known investment opportunities is strong. It is probable that the information possessed by many individuals about sophisticated investment opportunities is significantly incomplete. For such "information-intensive" assets the probability of ownership will increase with age as information is acquired over time.

In contrast, if transaction costs are the major cause of incomplete portfolios then both the probability of ownership of any given asset, and the total number of assets owned, will be determined primarily by the level of wealth. In section 4 we set out a simple model of the arrival of new information about investment opportunities to demonstrate formally that the two explanations of the extent of diversification--transaction costs and incomplete information--can be tested in terms of wealth and age effects respectively.

To identify the effect of information on portfolio composition we examine a subset of the financial assets identified in Table 1 for which information would seem to be most relevant. Seven "information-intensive" financial assets are identified, corresponding to categories 6 through 15 in Table 1. These are:

1. Corporate equity

   (categories 11 and 12).
2. Municipal bonds.
3. Corporate bonds.
4. Savings certificates and savings bonds

   (categories 6 and 7).
5. Treasury bonds.
6. Money market funds and instruments

   (categories 8 and 9).
7. Single-premium annuities.

One simple way to test for lack of diversification and the possible importance of information is to examine the portfolio composition of households with substantial liquid assets. Table 4 examines the 729 households in our sample (12.1 percent) with "substantial liquid assets" defined as more than $30,000 (about $55,000 at 1987 prices) in checking accounts, savings accounts, and credit union share accounts. One in four of these households (one in two if population weights are used) held no equity. Three quarters held no corporate bonds and a similar proportion held no municipal bonds (89 and 92 percent, respectively, with population weights).[6] It would appear that such households would have benefited from diversifying their portfolios and it is difficult to believe that transaction costs are a sufficient explanation for their failure so to do.

4. A Simple Model of Information and Asset Accumulation

The survey presents some direct evidence on the importance of information in determining the acquisition of assets. For each of four different assets--stocks, stock mutual funds, bonds, bond funds--households not owning the asset were asked "Why doesn't anyone in your household hold any [stocks, etc.]?". Table 5 shows the proportion of households who responded "[I/We] don't know enough about it". The first column shows the number of households who chose that response as a percentage of the total number of households who did not own that asset. The second column shows the number of households who chose that response as a percentage of the total sample of 6,010 households. More than a third of those who did not own stock or stock mutual funds said that it was because they did not know enough about it. This figure accounts for almost one-fifth of the sample in the case of stocks and almost thirty percent for stock mutual funds. The numbers for bonds and bond funds are similar and even larger in magnitude. Columns three and four present the estimated population responses using the weights provided by SRI. Not surprisingly, correcting for the oversampling of high-income households reveals that lack of information is an even more important deterrent to asset accumulation than the sample responses suggest.

Consider a simple model of the impact of information on asset purchases in which the arrival of new information about investment opportunities is exogenous. Households start life with some initial stock of "investment opportunities" that describes the information available to the household about the assets in which they might invest. In each subsequent period information about new investment opportunities arrives stochastically. The number of new investment opportunities that arrives each period is assumed to follow a Poisson distribution. Given the augmented stock of investment opportunities the investor may (when transaction costs are taken into account) decide to add another asset to his portfolio.

The stochastic process for the arrival of new information has two testable implications. The first is that, conditional upon wealth, the probability that an "information-intensive" asset will be owned increases with age. The second is that the model generates a frequency distribution for the number of information-intensive assets held by a cross-section of households drawn from the population. For the information arrival process described above, the distribution of the number of assets owned by the population is a mixture of Poisson distributions.

To test the first implication, we estimate a probit model for the ownership of each of the seven information-intensive assets. The maximum likelihood estimates are shown in Table 6. The model was estimated on the sample of 5408 observations for which data on the age of head of household and total net worth were recorded. The explanatory variables include the log of age, the log of wealth and the square of the log of wealth, the marginal tax rate, and six dummy variables representing household characteristics. The risk aversion dummy variable is based on responses to a question regarding the head of household's current attitude toward risk.[7] The theoretical specification implies that after controlling for the effect of wealth and other characteristics age should have a positive influence on the probability of ownership. In six out of the seven cases the age coefficient is positive (the exception being Treasury bonds) and in five cases the coefficient is significantly different from zero at the 5% level.

The second test of the model relates to the cross-section frequency distribution of asset ownership. Suppose that the arrival of new investment opportunities can be described by a Poisson distribution with parameter $\rho_{i\tau}$ for investor i at age τ. The data that we observe are for the stock of assets owned rather than the purchases in earlier periods. If the stochastic arrival process is independent across periods, then the stock of investment opportunities at age t, θ_{it}, is also given by a Poisson distribution with parameter

$$\theta_{it} = \sum_{\tau=1}^{t} \rho_{i\tau} \qquad (1)$$

In principle, the value of $\rho_{i\tau}$ may be a function of age if the relevant household characteristics vary with age. Such a model could be estimated with panel data. Because we are limited to the use of cross-section data, however, we shall assume that the expected value of the number of investment opportunities arriving each period varies across households according to the specification

$$\rho_{i\tau} = g(\tau)\ e^{X_i'\beta} \qquad (2)$$

where X_i is a vector of household attributes determining access to information, β the associated parameter vector, and $g(\tau)$ is positive, allowing age to influence the rate at which information arrives. We choose the exponential form to ensure that $\rho_{i\tau} > 0$, a necessary condition for a

Poisson process. Thus, (1) becomes

$$\theta_{it} = \sum_{\tau=1}^{t} g(\tau)e^{X_i/\beta} = (\sum_{\tau=1}^{t} g(\tau))\ e^{X_i/\beta} = f(t)\ e^{X_i/\beta} \tag{3}$$

where f(.) is a monotone increasing function of age.

The use of cross-section data means that we cannot distingush between age and cohort effects. Some cohort effects are captured by observable variables such as education, but the particular effect that is of most relevance here is the change in the set of financial instruments available to investors that has occurred over time. The classification of the seven information-intensive assets was made partly to minimise this problem. Any remaining cohort effect will be in the opposite direction to the information-based age effect identified above, and so the estimated age effect may be biassed downwards.

The number of assets owned at age t will be determined jointly by the number of investment opportunities and the level of transaction costs. At low levels of wealth, individuals may, because of transaction costs, hold only a subset of the assets about which they have received information. We assume that the proportion of opportunities in which investors choose to invest is denoted by μ. The number of assets owned by investor i at age t is then described by a Poisson distribution with parameter

$$\lambda_{it} = \mu\theta_{it} \tag{4}$$

The ratio μ will depend upon wealth and any other attributes that affect the influence of transaction costs on the number of assets owned.

For simplicity, and to ensure that $\mu > 0$, we assume $\mu = e^{Z_i\Gamma}$ where Z_i is a vector of household characteristics relevant to transaction costs and Γ the associated parameter vector. We have assumed that the rate at which new information arrives is exogenous and hence represents a pure transaction cost effect. It is possible that the intensity of search for investment opportunities is a function of wealth. If this is the case then will reflect also the effect of wealth on the set of investment opportunities, This will not, however, affect the estimate of the information-based age effect.

The probability that a household will own n assets is given by

$$\Pr(n_{it}=n) = \frac{e^{-\lambda_{it}}\lambda_{it}^{\ n}}{n!} \tag{5}$$

For a sample of H households the log likelihood is

$$L = -\sum_{i=1}^{H}(\lambda_{it} - n_{it}\ln(\lambda_{it})+\ln(n_{it}!))$$

$$= -\sum_{i=1}^{H}(f(t)e^{X_{it}'\beta + Z_{it}'\Gamma} - n_{it}(\ln f(t) + X_{it}'\beta + Z_{it}'\Gamma) + \ln(n_{it}!)) \tag{6}$$

In this model, λ_{it} is a deterministic function of the household characteristics X_{it} and Z_{it}. The stochastic nature of the specification comes from the assumption of a Poisson process for the arrival of new information. Because the parameter of the Poisson process is a function of household characteristics, the predicted frequency distribution is a mixture of Poisson distributions.

Table 7 presents estimates of this model. The first column shows the means and standard deviations of the data. The second column shows OLS estimates for the simple regression model in which the dependent variable is the natural logarithm of the number of information-intensive assets owned.[8] The third column presents the maximum likelihood estimates of the Poisson model when the age term f(t) is approximated by ct^{α}. The model predicts that $\alpha>0$.

In both the OLS and the Poisson specifications the age term is highly significant even after controlling for wealth and other household characteristics. The value of α, reported in column 3 of Table 6, is significantly greater than zero, as predicted by the model (even though it may, as noted above, be biassed downwards because of changes in the availability of assets over time). It is also less than unity suggesting that the rate of arrival of new information decreases with age.

The goodness of fit of the Poisson specification is illustrated in Figure 3 which shows the actual and predicted frequencies of the number of assets owned by households in the sample. The fit is rather good given the simplicity of the model.

5. Conclusions

The evidence presented in this paper shows that there is an interesting life-cycle pattern to both the number and type of assets owned by US households. We have suggested that this pattern reflects not only the importance of transaction costs but also incomplete information about investment opportunities. The probit estimates for the ownership of "information-intensive" assets show that in all cases but one, the probability of ownership increases with age, even after controlling for changes in wealth, marginal tax rate, and household characteristics. A simple Poisson process for the arrival of new information seems to fit the data surprisingly well. Information about investment opportunities is necessary for the construction of the optimal portfolio and arrives over time. Hence age is an important determinant of portfolio composition. The concept of a stock of investment opportunities, which is augmented by the stochastic arrival of new information, is consistent with the existence of a nontrivial group of "noise traders" in the market.

APPENDIX

To examine the life-cycle profile of the ratio of net worth to "permanent earnings" for households in the sample, we require estimates of the permanent earnings for each household in the sample. We define permanent earnings as normal age-adjusted annual earnings. Permanent earnings, Y_i, are assumed to be described by the following model:

$$\ln Y_i = W_i\delta + s_i - c(A_i) \tag{A1}$$

where W_i is a vector of observable variables, such as occupation, education, religion, and race, for individual i, and δ the associated parameter vector. The second term, s_i, represents unobservable characteristics such as motivation, aptitude, and luck, and, by construction, has zero mean for the population and variance σ_s^2. The third term, c(A), is a cohort effect that represents factors such as capital accumulation and technical progress which imply that for a given set of characteristics W, younger generations have higher earnings than their elders.

Current earnings different from permanent earnings because (1) there is a transitory component to earnings and (2) earnings vary systematically over the life cycle (the age-earnings profile). Current earnings for year t, E_{it}, are given by

$$\ln E_{it} = \ln Y_i + h(A_{it} - A^*) + u_{it} \tag{A2}$$

where h(.) represents the age-earnings profile (taken to be constant across the population) with A* some standard age with respect to which permanent earnings are defined. The transitory component, u_{it}, is assumed to be uncorrelated with s_i, and to have zero mean and variance σ_u^2.

From (A1) and (A2), we derive the earnings equation

$$\ln E_{it} = W_i\delta + g(A_{it}) + s_i + u_{it} \tag{A3}$$

where $g(A_{it}) = h(A_{it} - A^*) - c(A_{it})$. Given our previous assumptions, the error term $s_i + u_{it}$ has mean zero and variance $\sigma_s^2 + \sigma_u^2$.

Least squares estimation of (A3) will yield consistent estimates of δ and g(.), although if the u_{it} are correlated across households, the estimates will be inefficient. It is clear that the cohort effect and the age-earnings profile cannot be separately identified from estimation of g(.). We therefore follow King and Dicks-Mireaux (1982), who used data from outside the sample to impose a cohort effect. Our estimate of the cohort effect is described below. We may construct an estimate of permanent earnings for each individual in the sample, using the estimates of δ and g(.), provided that we can impute a value for s_i, the unobservable individual-specific effect. From the residuals of (A3), we have an estimate of $(s_i + u_{it})$. The minimum variance estimator of s_i given $(s_i + u_{it})$ is

$$\hat{s}_i = \alpha(s_i + u_{it}) \tag{A4}$$

where

$$\alpha = \frac{\sigma_s^2}{\sigma_s^2 + \sigma_u^2} \tag{A5}$$

Hence the estimate of permanent income is

$$\ln Y_i^e = W_i\hat{\delta} - \hat{c}(A_{it}) + \hat{s}_i \tag{A6}$$

where, from (A4), $\hat{s}_i$ is the product of α and the residual from the earnings equation. Thus, given values for σ_s^2 and σ_u^2, the King and Dicks-Mireaux procedure yields estimates of permanent earnings for each individual in the sample.

With longitudinal data, it would be possible to obtain estimates of σ_s^2 and σ_u^2 by estimating a fixed-effects model. Since our data come from a single cross section, however, we must assume a value for α. The magnitude of σ_s^2 depends upon the variables included in W; the more relevant variables that are included, the smaller will be the residual variance. From a survey of longitudinal studies of earnings, King and Dicks-Mireaux concluded that a reasonable value for α, given the variables available to them, was 0.5. Since our data is comparable in scope to theirs, we adopt the same value.

We estimated separate earnings equations (A3) for male and female earners. In an attempt to limit the sample to those in full-time work, we excluded individuals whose reported annual earnings were less than $4,000. We corrected for the resulting sample selection bias using the two stage procedure suggested by Heckman (1976, 1979). This procedure yields consistent estimates of the parameters (provided g(.) is linear in parameters). The results of both the first-stage probits and the second-stage OLS estimates of the earnings equations are available on request.

To construct the estimate of permanent earnings, we take a standard age of 45. In estimating the cohort effect, we follow King and Dicks-Mireaux in assuming that one-half the growth rate of real earnings resulted from improvements in eduction, changes in occupational structure, and other factors represented by the explanatory variables in the earnings equation, and the other half resulted from capital accumulation and technical progress. The latter is the cohort effect. Data on growth rates in earnings and consumer prices in the U.S. indicate that between 1929 and 1978 the annual growth rate of real earnings was 1.8%.[9] We therefore take the annual cohort effect on earnings to be 0.9%.

The final estimate for permanent earnings is given by (A6), with $\alpha = 0.5$; that is, natural logarithm of permanent earnings equals the age-adjusted predicted value of the log of earnings based on the observable variables, plus one-half the estimated residual from the earnings equation. For those individuals omitted from the estimation because of low earnings, permanent earnings was predicted using the estimates of (A6) and taking $\hat{s}_i = 0$. Household permanent earnings is simply the sum of the estimates for husbands and wives.

NOTES

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1. On the first question see Kotlikoff and Summers (1981) and Modigliani (1984). On the second question see Atkinson (1971), Atkinson and Harrison (1978), Bernheim (1984), Blinder, Gordon and Wise (1983), Brittain (1978), Davies (1980), Diamond and Hausman (1984), King and Dicks-Mireaux (1982, 1984), Lydall (1955), Mirer (1979), Shorrocks (1975), and White (1978).

2. Feldstein (1976) also used the 1962 FRB Survey and estimated portfolio composition equations that included dummy variables for each age group, but since the study focused on the effects of tax rates the age coefficients were not reported in the paper.

3. The survey was made available for academic research through the auspices of the National Bureau of Economic Research.

4. More expensive durables such as boats, planes, and works of art are included.

5. The nature of indirect ownership through contractual savings is unclear; to the extent that the returns on such schemes do not reflect the risks of the fund (as with defined benefit pension plans), there is no genuine indirect equity stake.

6. Even among those households with more than $50,000 (about $90,000 at 1987 prices) in liquid assets, more than two-thirds held no municipal bonds, three quarters held no corporate bonds, and one in five held no equity (86, 90, and 43 percent, respectively, when population weights are used).

7. The "Risk aversion" dummy takes the value one if the head of household chose either "I wish to reduce financial risks to the <u>barest minimum</u>" or "I am willing to take a <u>small amount</u> of financial risk hoping to realize a fair return on my investment" and takes the value zero if the response chosen was either "I am willing to take <u>moderate</u> financial risks hoping to achieve about average financial gains for investments" or "I prefer to take <u>substantial</u> financial risks hoping to realize substantial financial gains from investments".

8. It is possible that the number of information-intensive assets owned is zero. In this case we define the dependent variable to be zero and add a dummy variable that takes the value unity when the number of such assets is

zero to the set of regressors. For further discussion of the analysis of count data see Hausman et al. (1984).

9. Economic Report of the President, 1980, U.S. Government Printing Office, Washington, D.C.

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TABLE 1a

Summary of Household Asset Holdings

Sample

	Mean Asset Holding (in dollars)	Percent of Total Wealth	Percent of Households Owning Asset
1. Checking accounts	2,419	1.1	92.5
2. Savings accounts	10,336	4.6	85.8
3. Credit union share accounts	835	0.4	27.3
4. Cash value of life insurance	3,163	1.4	54.4
5. Pension or retirement plan account	10,485	4.7	57.3
6. Savings certificates	6,589	3.0	31.8
7. U.S. Savings Bonds	913	0.4	33.5
8. Money market funds	65	0.0	0.7
9. Money market instruments	1,018	0.5	1.7
10. Single-premium annuities (excluding IRA's)	811	0.4	1.1
11. Stocks	49,833	22.3	45.9
12. Stock mutual funds	2,269	1.0	12.7
13. Corporate bonds	3,059	1.4	8.9
14. Treasury bonds	2,158	1.0	3.0
15. Municipal bonds	6,860	3.1	9.9
16. Primary residence	70,293	31.5	84.0
17. Secondary residence	4,049	1.8	8.4

Source: Own calculations based on 1978 SRI "Survey of Consumer Financial Decisions".

Table 1a, continued

	Mean Asset Holding (in dollars)	Percent of Total Wealth	Percent of Households Owning Asset
18. Investment real estate	49,982	22.4	24.2
19. Tax shelters and equipment leases	1,910	0.9	4.2
20. Closely-held stock	19,020	8.5	7.4
21. Convertible securities, REITS, boats, and planes	9,452	4.2	15.2
22. Tangibles (marketable art, gold, etc.)	4,022	1.8	20.5
23. Other assets	1,701	0.8	3.1
LIABILITIES			
24. First mortgage on primary residence	8,281	3.7	54.1
25. Second mortgage on primary residence	257	0.1	5.7
26. Mortgage on second home	869	0.4	2.8
27. Home improvement loan	9,122	4.1	5.7
28. Personal loans	1,813	0.8	34.3
29. Cash value loans	956	0.4	15.4
30. Revolving bank card account	564	0.3	38.9
Liabilities against:			
31. Tax shelters	456	0.2	0.6
32. Closely-held stock	1,549	0.7	0.8
33. Convertible securities, REITS, boats and planes	306	0.1	1.2
34. Investment real estate	13,700	6.1	10.1
35. Tangibles	20	0.0	0.2
36. Other assets	160	0.1	2.3
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NET WORTH	223,188	100.0	100.0

TABLE 1b

Summary of Household Asset Holdings

Population Estimates

	Mean Asset Holding (in dollars)	Percent of Total Wealth	Percent of Households Owning Asset
1. Checking accounts	1,335	2.3	87.7
2. Savings accounts	5,629	9.8	80.5
3. Credit union share accounts	584	1.0	26.5
4. Cash value of life insurance	1,395	2.4	46.7
5. Pension or retirement plan account	2,903	5.1	41.4
6. Savings certificates	4,210	7.3	26.6
7. U.S. Savings Bonds	746	1.3	28.0
8. Money market funds	11	0.0	0.7
9. Money market instruments	374	0.7	0.6
10. Single-premium annuities (excluding IRA's)	121	0.2	0.3
11. Stocks	5,096	8.9	23.3
12. Stock mutual funds	658	1.1	6.2
13. Corporate bonds	529	0.9	3.3
14. Treasury bonds	599	1.1	0.9
15. Municipal bonds	665	1.1	2.9
16. Primary residence	30,261	52.7	65.2
17. Secondary residence	1,122	2.0	5.2

Source: Own calculations based on SRI Survey.

Table 1b, continued

	Mean Asset Holding (in dollars)	Percent of Total Wealth	Percent of Households Owning Asset
18. Investment real estate	10,200	17.8	14.2
19. Tax shelters and equipment leases	149	0.3	1.1
20. Closely-held stock	1,208	2.1	1.8
21. Convertible securities, REITS, boats, and planes	2,155	3.7	6.4
22. Tangibles (marketable art, gold, etc.)	782	1.4	12.2
23. Other assets	439	0.8	1.9
LIABILITIES			
24. First mortgage on primary residence	3,537	6.2	35.2
25. Second mortgage on primary residence	92	0.2	4.5
26. Mortgage on second home	126	0.2	0.9
27. Home improvement loan	5,997	10.4	4.4
28. Personal loans	683	1.2	23.4
29. Cash value loans	212	0.4	7.6
30. Revolving bank card account	446	0.8	37.3
Liabilities against:			
31. Tax shelters	25	0.0	0.1
32. Closely-held stock	58	0.1	0.2
33. Convertible securities, REITS, boats and planes	48	0.1	0.5
34. Investment real estate	2,488	4.3	4.7
35. Tangibles	12	0.0	0.0
36. Other assets	41	0.1	1.5
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NET WORTH	57,406	100.0	100.0

TABLE 2

Balance Sheet Comparisons

Asset Categories	Federal Reserve Balance Sheet Totals: Aggregate Holdings ($ billions)	SRI Survey: Aggregate Holdings ($ billions)	SRI Survey: Percent FRB Total
Checkable Deposits and Currency	124.66	104.41	83.7
Liquid Savings	1088.36	903.06	83.0
Corporate Equities	732.89	544.17	74.2
Taxable Bonds	183.01	88.20	48.2
Municipal Bonds	70.15	51.99	74.1
Residential Structures	1649.56	2453.16	148.7
Other Assets	801.65	545.88	68.1
TOTAL ASSETS	4650.27	4690.87	100.8
Home Mortgages	635.10	772.27	120.0
Other Liabilities	408.48	313.63	76.8
TOTAL LIABILITIES	1043.57	1075.90	103.1
NET WORTH	3606.70	3614.98	100.2

Source: Own calculations based on 1978 SRI "Survey of Consumer Financial Decisions" (using population weights) and "Balance Sheets for the US Economy, 1945-82", Flow of Funds Division, Federal Reserve System.

TABLE 3

Frequency Distribution of Number of Assets Held

Total number of assets and liabilities held	Number of households: Sample Frequency	Sample Percent	Population Estimates Frequency	Population Estimates Percent
0	20	0.3	115	1.9
1	49	0.8	181	3.0
2	140	2.3	369	6.1
3	281	4.7	666	11.1
4	376	6.3	676	11.2
5	496	8.3	744	12.4
6	648	10.8	756	12.6
7	739	12.3	719	12.0
8	706	11.7	580	9.7
9	691	11.5	458	7.6
10	541	9.0	277	4.6
11	411	6.8	203	3.4
12	324	5.4	124	2.1
13	231	3.8	67	1.1
14	157	2.6	39	0.6
15	93	1.5	20	0.3
16	58	1.0	12	0.2
17	19	0.3	2	0.0
18	13	0.2	2	0.0
19	7	0.1	1	0.0
20	2	0.0	0	0.0
21	5	0.1	1	0.0
22	2	0.0	0	0.0
23	1	0.0	0	0.0

Source: Own calculations based on SRI survey. Population estimates were calculated using the weights provided in the survey.

TABLE 4

Lack of diversification among households
with substantial liquid assets

	Households holding the asset		
	Sample		Population Estimates
	Number	Percent	Percent
Corporate equity	551	75.6	53.0
Municipal bonds	191	26.2	10.8
Corporate bonds	160	22.0	8.0
Savings certificates and savings bonds	427	58.6	73.1
Treasury bonds	143	19.6	14.6
Money market funds and instruments	50	6.9	2.1
Single-premium annuities	19	2.6	1.8

Source: Own calculations based on SRI survey
Note: "Liquid assets" is here taken to include checking accounts, savings accounts, and credit union share accounts and "substantial" to mean in excess of $30,000 (about $55,000 at 1987 prices). There are 729 households in this subsample.

TABLE 5

Ignorance and Asset Holding

Attitude Survey Results[1]

	Sample		Population[4] Estimates	
	Percent of Question Respondents[2]	Percent of Total Sample[3]	Percent of Question Respondents	Percent of Total Population
STOCKS	36.7	18.9	40.7	29.4
STOCK MUTUAL FUNDS	36.1	28.3	45.6	38.9
BONDS	31.5	20.1	34.0	25.0
BOND FUNDS	42.2	36.7	46.5	41.9

Source: Own computations based on SRI survey.

Notes: 1. This table is based on the responses to four questions in the attitude section of the survey. The questions were: "Why doesn't anyone in your household hold any stocks (stock mutual funds, bonds, bond funds)?". The figures presented above reflect the number of households who chose response (1): "Don't know enough about it".

2. Column one is derived by dividing the number of households who chose response (1) by the number of households who responded to the question.

3. Column two is derived using the same numerator and the total number of households in the survey (6,010) in the denominator.

4. Columns three and four present estimated population responses using weights supplied by SRI.

TABLE 6

Probit Estimates

Variable	Mean	Equity	Corporate Bonds	Municipal Bonds
Log of age	3.864	.526	.854	.730
	(.313)	(.071)	(.122)	(.121)
Log of wealth	6.525	-.113	.031	-.144
	(1.567)	(.070)	(.163)	(.129)
[log(W)]2/100	.450	3.831	1.772	3.601
	(.191)	(.602)	(1.080)	(.877)
Marginal tax rate	.283	.522	.188	.442
	(.204)	(.112)	(.154)	(.163)
Risk aversion	.645	-.104	-.148	-.044
	(.478)	(.050)	(.065)	(.065)
Managerial occupation	.291	.270	-.021	.136
	(.454)	(.049)	(.073)	(.070)
Professional occupation	.194	.143	.088	.102
	(.395)	(.060)	(.082)	(.083)
Married	.821	.100	-.006	-.203
	(.383)	(.065)	(.092)	(.090)
Post-graduate education	.259	.707	.667	.498
	(.438)	(.061)	(.089)	(.087)
College education	.402	.527	.382	.261
	(.490)	(.048)	(.080)	(.079)
Intercept		-3.681	-6.214	-5.301
		(.342)	(.812)	(.723)
Number of cases		2662	483	528
Log likelihood		-2876.19	-1342.43	-1347.44
Likelihood at the optimal constant		-3747.89	-1627.50	-1729.76

Note: The data set used in estimating the probits contained 5408 observations; 602 observations were excluded because of missing data. Heteroscedasticity-consistent standard errors in parentheses.

TABLE 6, continued

Probit Estimates

Variable	Savings Bonds	Treasury Bonds	Money Market Funds	Annuities
Log of age	.814 (.071)	-.297 (.080)	.203 (.173)	.427 (.224)
Log of wealth	.525 (.111)	.037 (.057)	.399 (.295)	2.009 (.632)
[log(W)]2/100	-2.457 (.790)	.656 (.443)	-.252 (1.780)	-10.877 (3.940)
Marginal tax rate	-.272 (.105)	.250 (.129)	.330 (.241)	.080 (.288)
Risk aversion	.117 (.049)	.100 (.057)	-.154 (.093)	-.037 (.122)
Managerial occupation	-.047 (.049)	-.058 (.058)	-.013 (.106)	-.157 (.136)
Professional occupation	-.022 (.060)	.035 (.067)	.027 (.125)	-.185 (.156)
Married	-.205 (.063)	-.143 (.075)	.014 (.138)	.004 (.169)
Post-graduate education	.058 (.059)	.137 (.070)	.314 (.149)	.339 (.192)
College education	.066 (.047)	.134 (.057)	.245 (.132)	.361 (.173)
Intercept	-5.806 (.481)	-.590 (.340)	-5.798 (1.290)	-12.943 (2.550)
Number of cases	1820	765	133	57
Log likelihood	-3170.45	-2145.94	-515.72	-274.44
Likelihood at the optimal constant	-3454.16	-2204.33	-624.15	-316.20

TABLE 7

Estimates of the Information Model[1]

Variable	Mean[3]	OLS[2]	Maximum Likelihood Poisson Model
Number of assets held	1.192 (1.175)		
Log of age	3.864 (.313)	.144 (.018)	.555 (.054)
Log of wealth	6.525 (1.567)	-.118 (.012)	.544 (.049)
[log(W)]2/100	.450 (.191)	1.557 (.116)	-1.866 (.351)
Marginal tax rate	.283 (.204)	.084 (.034)	.184 (.074)
Risk aversion	.645 (.478)	.0002 (.015)	-.003 (.035)
Managerial occupation	.291 (.454)	-.012 (.014)	.058 (.036)
Professional occupation	.194 (.395)	.009 (.018)	.063 (.041)
Married	.821 (.383)	-.028 (.018)	-.091 (.044)
Post-graduate education	.259 (.438)	.087 (.018)	.414 (.044)
College education	.402 (.490)	.048 (.012)	.311 (.039)
Intercept		-.125 (.077)	-5.094 (.248)
Dummy (n=0)		-.307 (.009)	
Standard error of residuals		.376	
Log likelihood			-6867.09

1. The sample is 5408 households (602 households were dropped because of missing data).
2. For the OLS estimates, the dependent variable is the log of the number of assets held. Heteroscedasticity-consistent standard errors in parentheses.
3. Standard deviations of the data in parentheses.