Portfolio Choice in the Presence of Personal Illiquid Projects

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ABSTRACT

Personal projects, such as a private business or the purchase of a home, influence individuals' portfolio choice. We conduct a theoretical analysis of this influence when financial assets are required to provide liquidity to personal projects. Due to this liquidity consideration, individuals behave in a more risk-averse fashion when there is a large penalty for discontinuing or under-investing in the final stages of the projects. In addition, using data from the 1995 Survey of Consumer Finances, we find that households that are saving to invest in their own businesses or in their own homes indeed have significantly safer financial portfolios.

A large portion of private assets are invested in personal illiquid projects. These are projects that must be partly self-financed and are costly to sell. According to the 1995 Survey of Consumer Finances (SCF), residential housing and capital invested in unincorporated businesses account for 41.2 percent and 19.1 percent, respectively, of household wealth.[1] In this paper, we study the impact of these personal illiquid projects on individuals' portfolios of financial assets. Personal projects influence portfolio choice in two ways. First, financial assets can be used to provide diversification against bad outcomes of personal projects. This interaction is well-recognized in the literature as it emanates from standard portfolio theory. Second, financial assets can be used to provide liquidity to personal projects when the timing of investment in these projects is important. This latter interaction is the focus of our paper. We show that it helps explain why individuals, particularly young investors and entrepreneurs, have larger than expected holdings of safe financial assets.

In the financial planning literature, young investors are advised to hold a larger share of risky assets in their financial portfolios in order to capture the superior expected return of these assets. As investors grow older, they are advised to gradually reduce their holdings of risky assets. Jagannathan and Kocherlakota (1996) show that this advice is economically sound as long as the investor's human wealth is relatively uncorrelated with stock returns. The reason is wealth diversification: As investors age, their human wealth declines, and so they become more exposed to the risk of their financial portfolios.[2] The resulting higher correlation between consumption and financial wealth makes investors behave in a more risk-averse fashion.[3] Hence, according to this argument, we expect to see the share of safe assets in financial portfolios increase with age.

In Table I, we show the mean percentage of cash in financial portfolios across the age of the head of the household. The data we employ are from the 1995 SCF. The term "cash" refers to relatively safe and liquid assets, and includes checking and savings accounts, call accounts at brokerages, and money market accounts either in deposits or in mutual funds. The financial portfolio includes, in addition to cash, stock and bond mutual funds, directly held stocks and bonds, IRAs and thrift-type accounts, cash value of whole life insurance, other managed assets (trusts, annuities, and managed investment accounts), and other financial assets (loans, future proceeds, royalties, futures, non-public stock-deferred compensation, and money in hand).

[Table I]

Two observations are apparent from Table I. First, cash constitutes a large percentage of the financial portfolio across the board. Second, young households have more conservative portfolios than middle-aged households. This pattern is robust even after controlling for wealth and income (we give evidence for this effect in Section II.B.). To help explain these observations, we introduce a model in which the presence of multi-period personal illiquid projects, such as a private business and the purchase of a home, leads to larger holdings of cash in financial portfolios. As younger households are more likely to invest in these types of projects (again, we give evidence to this effect in Section II.B.), our model helps explain not only why the demand for cash is so large despite the much higher expected return on stocks, but also why younger households have larger cash holdings than middle-aged households.[4]

In a recent paper, Heaton and Lucas (2000) show that entrepreneurs have significantly safer portfolios of financial assets than other investors with similar age and wealth. As argued by these authors, entrepreneurs hold a safe portfolio of financial assets to diversify the risk of their businesses. However, this is not the only possible reason. We argue in this paper that entrepreneurs may choose a safe financial portfolio to ensure a smooth continuation of their business projects.

Individuals are more risk averse in their portfolio choice when financial assets are used to fund projects that have a substantial penalty for discontinuing or under-investing in the final stages. This penalty may be the result of lumpiness in the investment process, which means that once production has started, it has to be continued at a given size. This penalty may also be the result of strong complementarity between investments made at two different stages of the project. In other words, once an individual has committed an initial investment in a project, he faces a penalty due to the lack of liquidity if the project is either abandoned or is continued on an inappropriate scale.

Consider an entrepreneur who has invested heavily in renovating the first floor of a building to open a restaurant. This entrepreneur would be unwise to put all his funds in stocks instead of buying food and paying employees during the first few weeks of business. A downturn in the stock market would compromise not only the funds invested in stocks, but also - if he has exhausted his debt capacity - the continuation of his business. Furthermore, due to transaction costs, the entrepreneur would lose some of the capital already invested in the renovations, or at least the return on this capital for the period it takes to sell the business. Hence, the illiquidity of the business project makes advisable a relatively safe financial portfolio.

Another example is residential housing, which generates both monetary and nonpecuniary returns. The purchase of a home can be viewed as part of a wider project of settling in a particular area. An individual who has committed to a job in an area and plans to remain there faces a minimum investment (i.e., the down payment) for the purchase of a home. Once the individual is close to achieving this minimum and is looking for a suitable residence, again, he would be unwise to put all of his funds in stocks. A downturn in the stock market may delay or frustrate his investment in a highly productive asset: the home. In this case, the initial investment in the project may be relatively small. However, the lumpiness induced by the minimum investment makes advisable a relatively safe portfolio, with two caveats. First, if housing prices in a particular area are correlated with the stock market, buying stocks may actually be the safer alternative. On average, though, the correlation between housing prices and stock returns is low.[5] Second, if the chances of accumulating the minimum investment with a safe portfolio are not good, the individual may find it optimal to bet his future in the stock market, or in a casino. Once the individual owns the home, expenses such as mortgage payments, property taxes, and maintenance are complementary to the initial investment in the house. Hence, the individual again may be unwise to put at risk financial assets that are planned for these expenses.

Although we do not formally test the theoretical model for lack of appropriate data, we do look at the 1995 SCF for supporting evidence. We find that even after controlling for standard household characteristics (e.g., age, wealth, income, etc.), households that are saving either to purchase their own homes or to invest in their own businesses have significantly safer portfolios. In contrast, households that are saving for retirement have significantly riskier portfolios.

Our modeling of the interaction between liquidity needs and portfolio choice relates to the analysis of corporate risk management in Froot, Scharfstein, and Stein (1993), and the liquidity-based asset-pricing model in Holmström and Tirole (1998). As in these papers, liquidity is required for physical investment, and risk aversion emanates from the desire to meet physical investment needs. The main difference in our paper is that we analyze the effects of multi-period projects in which different stages of investment are interdependent. Hence, there is a clear incentive to hold a safe financial portfolio to ensure the completion of a project once it is started. This focus allows us to find numerical examples with strong interaction between physical investment and portfolio choice. Also, we analyze the model from the point of view of a consumer-entrepreneur, which enables us to explore some of the model's empirical implications using data from the SCF.

A much larger body of literature, which is too broad to survey here, has studied the effect of labor income risk and borrowing constraints on portfolio composition (see, for example, Heaton and Lucas (1997), Cocco, Gomes, and Maenhout (1998), and Koo (1998)). In this body of literature, it is assumed that in the event of a temporary rise in spending needs or a temporary drop in labor income, investors may face borrowing constraints. Thus, when these episodes do occur, investors are more vulnerable to the risk of their financial portfolios. As a result, they should avoid risky assets.[6] Despite the intuitive appeal of this argument, its effects are only economically significant for low-income investors who collectively hold a small portion of a country's assets. In contrast, the borrowing constraints that we study in this paper are relevant even for well-off entrepreneurs, as we endogenize the size of the personal projects that they choose.

In recent contributions, Viceira (2001) incorporates the fact that labor income is risky and non-tradable in the determination of the optimal portfolio over the life cycle. Likewise, Storesletten, Telmer and Yaron (1999) incorporate idiosyncratic labor income risk in a general equilibrium model with overlapping generations in an attempt to explain the equity premium puzzle. In these models, the inability to diversify labor income risk enhances the demand for safe financial assets.[7] However, in the absence of large trading costs and a high positive correlation between individual labor income and the stock market, these models generate the counterfactual prediction that stock holdings decline with age. Our contribution is that we provide an explanation for the large holdings of safe assets by young individuals.[8]

In a closely related paper, Gentry and Hubbard (1998) examine the saving, investment, and entry decisions of entrepreneurs. Among their findings, the authors show that costly external financing coupled with potentially higher returns on entrepreneurial investment lead to higher saving rates for business owners. Further, they provide evidence that financing constraints matter even for wealthy entrepreneurs. These results lend support to two basic premises of our paper: (1) that households face liquidity constraints in their entrepreneurial activities, and (2) that these activities yield high expected returns. The main difference between Gentry and Hubbard and our paper is that while they study the impact of entrepreneurial activities on saving rates, we study the impact of these activities on the optimal allocation of financial assets. Thus, the two papers are complementary.

Our paper is also related to papers on asset pricing models in which there is a combination of liquid and illiquid assets. Aiyagari and Gertler (1991) and Heaton and Lucas (1996) assume non-trivial transaction costs for capital and for a subset of financial assets. Cocco (1999) studies a model with owner-occupied housing and a set of liquid financial assets in a life-cycle context. Grossman and Laroque (1990) examine a model with an illiquid consumer durable good and a set of liquid financial assets. Our model differs from these in many respects. However, the most important difference is the multi-period structure of the personal projects in our model, in which illiquid physical assets are invested.

Our main findings can be summarized as follows. An important determinant of risk tolerance in portfolio choice is the possibility that the portfolio may be used to finance personal illiquid projects. If this is the case, the more productive the personal projects and the larger the penalty for discontinuing or under-investing in the final stages of these projects, investors will behave in a more risk averse manner in their financial portfolio choice. Using data from the 1995 SCF, we find that households that are saving to invest in their own homes or in their own businesses have significantly safer portfolios. The data also suggest that it is the younger households that tend to invest in these personal projects. Hence, our result helps explain why young investors and entrepreneurs have larger than expected holdings of safe financial assets.

The rest of the paper is organized as follows. In Section I, we present the theoretical analysis and the numerical results. In Section II, we employ the 1995 SCF to test some of the empirical implications of the model in Section I. A summary in Section III concludes the paper.

I. Theoretical Analysis

There are two types of financial assets: (1) Stocks which are risky and have a high expected return, and (2) cash which is safe and has a low return. Both assets are traded in a capital market without taxes or transaction costs. Individuals can also invest in highly productive personal projects which are costly to sell before completion. Due to a combination of legal constraints and information asymmetry, these personal projects cannot be financed by equity and individuals have limited access to borrowing. Hence, these projects must be partly self-financed. Further, individuals can engage in at most one personal project at a time. Each project takes several periods to mature. In some periods, the project yields no output, and the owner has to rely on his holdings of financial assets and limited access to credit for consumption and investment. Hence, financial assets provide a liquidity service to individuals engaged in these personal projects. To illustrate the theoretical predictions of our model, we employ a framework with a three-period horizon and linear utility. We assume that once a personal project is started, it must be continued at a given size or be abandoned. At the end of this section, we discuss some extensions to this setup.

A. The Model

An individual lives for three periods and is endowed with an initial liquid wealth, a_1, and the ownership of a personal project that is non-transferable. The personal project requires capital inputs, k_1 and k_2, in the first two periods and yields an output, y_3, in the third period:

$$y_3 = Q(k_1, k_2), \tag{1}$$

where Q is the gross production function describing the personal technology. For ease of notation, Q includes any undepreciated capital. Once k_1 has been committed, the project has to be continued at a given size that depends on k_1, or it will be abandoned:

$$Q(k_1, k_2) = \left\{ \begin{array}{cc} (R^k)^2 k_1 + R^k \gamma k_1 & \text{if } k_2 \geq \gamma k_1 \\ (R_0)^2 k_1 & \text{if } k_2 < \gamma k_1 \end{array} \right\}, \tag{2}$$

where γ is the required proportion between k_1 and k_2 to continue the project; R^k is the gross internal rate of return on a completed project; and R_0 is the gross rate of return on k_1 if the project is discontinued. We assume that $R^k > R_0$. With linear utility, as we assume here, adding a stochastic term to Q to capture the riskiness of the personal project would make no difference. With concave utility, this stochastic term would induce a diversification motive for holding financial assets.

In each of the first two periods, $t = 1, 2$, liquid wealth is allocated to consumption, c_t, capital for the personal project, k_t, stocks, s_t, and cash, b_t. The flow of funds constraint is:

$$a_t = c_t + k_t + s_t + b_t. \tag{3}$$

In the third period, all available wealth is consumed. Consumption, capital, and stocks in each period must be nonnegative. The lower bound on cash is minus the debt capacity of the individual. This capacity is assumed to be zero in the first period, and a fraction, δ, of k_1 in the second period, where $\delta \geq 0$. Therefore, $b_1 \geq 0$ and $b_2 \geq -\delta k_1$. The gross rate of return on stocks, R_t^s, is an i.i.d. positive stochastic variable with mean $\overline{R^s}$ and a continuous distribution function F. The gross rate of return on cash, R^b, is a constant positive real number.[9] We assume that $\overline{R^s} \geq R^b$.

The initial liquid wealth, $a_{1,}$ is given, and without loss of generality, it is normalized to unity. Liquid wealth in period two, a_2, is equal to the sum of the gross returns to the financial assets purchased in period one:

$$a_2 = s_1 R_1^s + b_1 R^b, \tag{4}$$

where R_1^s is the realized gross return on stocks at the end of period one. Liquid wealth in period three is equal to the sum of the gross returns to the financial assets purchased in period two and the output of the personal project:

$$a_3 = y_3 + s_2 R_2^s + b_2 R^b. \tag{5}$$

The utility function of the individual is:

$$U = E\left(c_1 + \xi c_2 + \xi^2 c_3\right), \tag{6}$$

where ξ is the discount factor.

For the analysis to be interesting, we assume that personal projects, if continued, are sufficiently productive to entice their owners to save and to invest in them. However, if abandoned, personal projects yield a lower return than financial assets.

Assumption 1. The rates of return obey: $R^k > \overline{R^s} > \xi^{-1}$ and $\overline{R^s} \geq R^b > R_0$.

The first inequality assumes that the return on completed personal projects exceeds the expected return on stocks. This inequality ensures that an individual with savings invests in the personal project. The second inequality assumes that the expected rate of return on stocks exceeds the subjective discount rate, so that liquid wealth is saved and accumulated until period three. The last two inequalities imply that it is better to invest in financial assets than to invest in a project that has to be abandoned. Also, we assume the individual is credit-constrained in period two.

Assumption 2. The portion of k_1 that can be used as collateral is smaller than the portion of k_1 that is required to continue the project. That is, $\gamma > \delta$, or to simplify notation, let $\mu \equiv \gamma - \delta > 0$.

The optimal investment plan for the individual can be solved recursively. In period three (the last period), the individual consumes the entire liquid wealth, so $c_3 = a_3$. In period two, the project is always continued if there is sufficient liquid wealth to cover the portion of k_2 that has to be self-financed, i.e., if $a_2 \geq \mu k_1$, because $R^k > \overline{R^s}$. However, the project is abandoned if $a_2 < \mu k_1$. Whether the project is continued or not, it is optimal for the individual to borrow up to the limit, i.e., $b_2 = -\delta k_1$, and then invest any residual funds in stocks to take advantage of the fact that $\overline{R^s} \geq R^b$.[10] Hence, the optimal plan in period two is:

$$k_2(k_1, a_2) = \begin{cases} \gamma k_1 \text{ if } a_2 \geq \mu k_1, \\ 0 \text{ otherwise.} \end{cases} \tag{7}$$

$$s_2(k_1, a_2) = a_2 + \delta k_1 - k_2(k_1, a_2). \tag{8}$$

Pursuing the optimal plan, the expected consumption in period three conditional on the information in period two, k_1 and a_2, is:

$$E(c_3|k_1, a_2) = \begin{cases} \left[(R^k)^2 + \gamma R^k - \delta R^b\right] k_1 + (a_2 - \mu k_1)\overline{R^s} & \text{if } a_2 \geq \mu k_1, \\ \left[R_0^2 - \delta R^b\right] k_1 + (a_2 + \delta k_1)\overline{R^s} & \text{otherwise.} \end{cases} \tag{9}$$

For ease of notation, this expected utility function is denoted as $v(k_1,\ a_2) \equiv E(c_3|k_1, a_2)$. The indirect utility function, v, is discontinuous at the point $a_2^* = \mu k_1$. See Figure 1.

[Figure 1]

The interesting portfolio choice occurs in period one. Due to the second inequality in Assumption 1, k_1, s_1, and b_1 are chosen to maximize the expected consumption in period three: $E(c_3) = E[v(k_1, a_2)]$. Using the budget constraint (3), the choice variables can be reduced to two: k_1 and the portion of cash in the financial portfolio, $\theta \equiv b_1/(s_1 + b_1)$. Let R^θ be the gross rate of return on the financial portfolio at the end of period one: $R^\theta \equiv (1-\theta)R_1^s + \theta R^b$. Hence, $a_2 = (1 - k_1)R^\theta$. (Since a_1 is normalized to one, $s_1 + b_1 = 1 - k_1$.) The probability of completing the project is

$$P = \Pr\left[(1 - k_1)\, R^\theta \geq \mu k_1\right]. \tag{10}$$

Using the definition of P to take expectations in (9), we have:

$$E(c_3) = k_1 \left\{\left[\left(R^k\right)^2 + \gamma R^k - \delta R^b - \mu\overline{R^s}\right] P + \left[R_0^2 + \delta(\overline{R^s} - R^b)\right](1-P)\right\} + (1-k_1)\overline{R^\theta}\,\overline{R^s} \tag{11}$$

where $\overline{R^\theta}$ is the mean of R^θ. The individual chooses k_1 and θ to maximize (11). Note that P depends on both choice variables as specified in (10).

The discontinuity in Q represents the penalty for failing to continue the project. If this penalty is large, avoiding it is a major concern in the individual's portfolio choice. For a given k_1, this concern has a non-monotonic effect on the choice of θ because the chance of continuing the project may increase or decrease depending on the size and the riskiness of the financial portfolio in period one. To see this, divide the indirect utility function in

Figure 1 into four regions.[11] The first region is where the individual has such a small financial portfolio $(s_1 + b_1)$ relative to k_1 that there is no chance the project can be continued in the next period. In this case, the individual is risk neutral, as there is nothing he can do to avoid the penalty. The second region is where the individual has a larger financial portfolio, but it is still insufficient to continue the project unless he invests some of it in stocks and hopes for abnormally high returns. In this case, the individual is risk loving. The third region is where the individual has a sufficiently large financial portfolio relative to k_1 for the continuation of the project to be assured by investing mostly in cash. In this case, the individual is risk averse because the downside risk of stocks may jeopardize the chance of continuing the project. The fourth region is where the individual has such a large financial portfolio relative to k_1 that the continuation of the project is assured for all portfolio choices. In this case, the individual is risk neutral. Therefore, the individual's risk preference depends on the size of his financial portfolio in period one. Note that the Friedman-Savage puzzle of why individuals are sometimes risk loving and other times risk averse does not apply here.

The following theorem summarizes the individual's optimal portfolio choice in period one for a given k_1. We formalize the idea that depending on k_1, the individual can exhibit a variety of behavior toward portfolio risk. To state this theorem, we define $k^b \equiv \left[1 + \mu \left(R^b\right)^{-1}\right]^{-1}$, where k^b is the level of k_1, such that in the absence of stocks $(\theta = 1)$, the individual's liquid wealth in period two is at the discontinuity point a_2^* in Figure 1.

Theorem 1. When the size of the personal project is given, the individual's attitude toward portfolio risk in period one depends on k_1. In particular, the following statements hold:

(i) If the continuation of the project is impossible because k_1 is too large, or if the continuation is assured for all portfolio choices because k_1 is sufficiently small, then the individual is risk neutral in the sense that he will maximize $\overline{R^\theta}$.

(ii) There is a $t_1 \in (0, k^b)$ such that in the interval $[t_1, k^b]$ the individual is risk averse, in the sense that his optimal portfolio contains cash even if $R^b < \overline{R^s}$, as long as the risk premium, $\overline{R^s} - R^b$, is not too large.

(iii) There is a $t_2 \in (k^b, 1)$ such that in the interval $(k^b, t_2]$ the individual is risk loving, in the sense that his optimal portfolio does not contain cash even if $R^b = \overline{R^s}$.

(See Appendix A for the proof.)

When k_1 is chosen optimally, the size of the financial portfolio is endogenous. If personal projects are as productive as stated in Assumption 1, k_1 is never chosen to be a value so small such that even if it were slightly increased the continuation of the project could still be guaranteed for all portfolio choices. At the same time, if the penalty for failing to complete the project is large, k_1 is never chosen to be a value so large that the continuation of the project becomes unlikely. Consequently, in the precise sense stated in the following theorem, the optimal choice of k_1 tends to make the individual averse to portfolio risk.

Theorem 2. When the size of the personal project is endogenous, the individual is averse to portfolio risk in period one in the following sense: His optimal portfolio does not contain stocks if $\overline{R^s} = R^b$, and it contains a positive amount of cash even if $R^b < \overline{R^s}$ when the risk premium, $\overline{R^s} - R^b$, is not too large.

(See Appendix A for the proof.)

Next, we construct a set of numerical examples to help quantify the effects of our model. According to standard portfolio theory, $\overline{R^s} > R^b$ implies positive holdings of stocks. This is not necessarily the case in the presence of the personal illiquid projects we consider here. The lumpiness in the second period investment breaks the concavity of the indirect utility function, v, and induces a tendency to extreme choices in θ. Using the log-normal distribution function for stock returns, we construct illustrative examples where θ takes on only the value of zero or one. (Interior solutions for θ may be obtained depending on the distribution of R^s. See Appendix B.) We present the numerical simulation results in Tables II and III.

[Table II and III]

When F is log-normal, at least for the range of parameter values we employ, the individual switches from holding only cash to holding only stocks, depending on the size of the risk premium. In Table II, we illustrate this effect by tabulating the lowest risk-free rate (or equivalently, the largest risk premium) at which a cash portfolio is still optimal. The distribution of R^s is set to be approximately equal to the historical distribution of stock returns in the United States over the last century (see Kocherlakota (1996)). If the personal project is highly productive, for example, $R^k = 1.15$, risk premia as large as those observed historically give rise to a cash portfolio for a wide range of parameter values. With lower R^k, the optimal portfolio tends to shift to stocks, for the following reason. As shown in Table III, in all instances, the individual seeks a very high probability for the continuation of his project. Since stocks are risky, the individual chooses a smaller personal project when he holds stocks so as to ensure its continuation. Hence, the higher expected return on stocks relative to cash comes at the expense of a smaller personal project. This sacrifice is acceptable only when the return on the personal project is relatively low. It is interesting to note that although the project technology and the stock market are uncorrelated, the fact that the project requires liquidity for completion induces a positive correlation between the two.

Quite naturally, for a given R^k, the tendency to hold stocks falls with the penalty associated with discontinuing the project. This penalty depends negatively on the salvage rate, R_0, and positively on the portion of capital that is jeopardized when the project is abandoned. This portion of capital depends negatively on the technological coefficient, γ, that dictates the amount of k_2 that is required to continue the project, and positively on the fraction, δ, that determines the individual's ability to borrow. Consequently, the tendency to hold stocks rises with R_0 and γ, and falls with δ. Paradoxically, when the borrowing constraint is partially relaxed, the individual behaves in a more risk averse fashion in his choice of financial assets. This is because an increase in δ induces the individual to invest in a larger personal project, which means more capital is at stake if he fails to complete the project.

B. Extensions

So far, we have assumed that the production function, Q, is nonconvex. The lumpiness embedded in (2) captures many investment projects, which have to be continued at a given size or be abandoned, once they are started. This lumpiness, though, is not essential to generate risk aversion. If $Q(k_1, k_2)$ is convex in its arguments k_1 and k_2 (for example, a Cobb-Douglas production function with equal weights), then the indirect utility function, $v(k_1, a_2)$, which the individual maximizes in period one, is a concave function (see Figure 2). For a given k_1, $v(k_1, \cdot)$ now has two regions: One that is strictly concave corresponding to a_2 small, and one that is linear corresponding to a_2 large. For a_2 small, all of the available funds are invested in k_2 and the marginal productivity of k_2 remains higher than the expected return on stocks. Investment in k_2 dos not increase because the individual is liquidity constrained in period two. For a_2 large, the investment in k_2 is not liquidity constrained. Hence, the amount of k_2 is chosen to equate its marginal product with the expected return on stocks. For a given k_1, the individual solves a standard portfolio problem in which the financial variables, s_1 and b_1, are chosen to maximize a concave function of the following period's portfolio value, a_2. If k_1 is so small that the individual will never be liquidity constrained in period two, the relevant portion of v is linear and the individual is risk neutral. Otherwise, the individual is risk averse. With a convex Q, risk-loving behavior never occurs. When k_1 is endogenous, as long as we assume that the personal project yields a higher expected return than stocks, the individual chooses a personal project that is sufficiently large so that he is liquidity constrained in period two with a nonzero probability. Otherwise, a shift from financial assets to k_1 would increase the expected consumption in period three. Therefore, the strictly concave region of $v(k_1, \cdot)$, which induces risk aversion, is the relevant one.

[Figure 2]

For simplicity, the analysis has been conducted with a linear utility function. With this functional form, any risk-averse behavior must be induced by the presence of the personal illiquid project. With a concave utility function, risk aversion in portfolio choice is unambiguously accentuated if consumption only takes place in period three. However, when the utility function is concave, consumption usually takes place in all periods. In this case, consumption serves as a buffer to ensure the continuation of the personal project. For this reason, if the personal project is small relative to consumption, small percentage variations in consumption are sufficient to ensure the continuation of the personal project, and the effects analyzed in our model are minimized. To obtain meaningful effects, we must consider personal projects that are large relative to consumption.[12]

Manipulating consumption in period two is not the only way to ensure the continuation of the personal project. The individual can also adjust the amount he consumes in period one. With a personal project of a given size, the individual has an incentive to save more at the initial stage to reduce the probability of abandoning the project at a later stage, without having to be very conservative in his portfolio choice. This is the savings effect studied by Gentry and Hubbard (1998), who also provide evidence on its empirical relevance. In the present context, it should be noted that this effect is attenuated when the size of the project is endogenous, because wealthier individuals tend to be more ambitious with their personal projects. Consequently, the degree to which endogenous savings weaken the interaction between personal projects and portfolio choice in this paper depends crucially on the technological characteristics of the personal project and on the timing of savings and investment.

II. Empirical Analysis

A. Description of Data

We employ data from the 1995 Survey of Consumer Finances (SCF). The SCF is a rich source of information on the financial characteristics of U.S. households. Detailed information is collected on household assets and liabilities, as well as accompanying household characteristics such as labor force activities, demographics, attitudes, income from various sources, and so on.[13] The SCF is conducted every three years. When we began this study in 1999, the 1995 SCF was the most recent survey with a complete public data set. In our empirical analysis, we employ the Repeated-Imputation Inference (RII) technique described in Montalto and Sung (1996). This estimation methodology takes into account the sample-selection bias in the SCF,[14] and incorporates the variability in the data due to missing information[15] (the standard errors are adjusted accordingly to generate the correct inference).

In the SCF, there is a section on miscellaneous opinion variables. The useful variables for our purpose are the questions on saving motives. Respondents are asked to choose from a list provided by the interviewer their top reasons for saving. We group the list of reasons into eight categories. Our hypothesis is that those categories that fit the description of an investment in a personal illiquid project will be significant for determining the amount of cash held in households' financial portfolios. The eight categories of saving motives are: (1) education (one's own, spouse's, children's, and grandchildren's), (2) invest in own home (purchase own home/cottage), (3) household purchases (appliances, furnishings, cars, special occasions, and hobby items), (4) travel (vacations, and time off), (5) invest in own business (purchase own business/farm and/or equipment for business/farm), (6) retirement (including burial expenses), (7) emergency (unemployment, illness, and "rainy" days), and (8) living expenses and bills (including tax and insurance bills, and other contractual commitments).

We convert each category into a dummy variable, assigning the value one if a respondent chooses it as one of his top three reasons for saving, and zero otherwise.[16] Of these categories, "invest in own home" and "invest in own business" best fit the description of an investment in a personal illiquid project. Also, there is information on whether or not the respondent already owns a home or a family business. We will also include them in the regression analysis.

B. Model and Results

In Table IV, we report the average age of the heads of household who chose the various categories as their top three reasons for saving. We also report the standard error of the mean and the sample count.

[Table IV]

From Table IV, we can see that younger households have a tendency to choose what we consider personal illiquid projects as their top saving motives. The average age for "invest in own home" and "invest in own business" - all in the thirties - are the lowest among the eight categories.

Using the Repeated-Imputation Inference (RII) technique for regression analysis (see Montalto and Sung (1996)), we estimate the following model:

$$Cash_i = \beta_0 + \beta_1 Age_i + \beta_2 Age_i^2 + \sum_{j=1}^{7} \beta_{3j} X_{ji} + \sum_{k=1}^{8} \beta_{4k} D_{ki} + \epsilon_i, \tag{12}$$

where i = the ith household, $Cash$ = percentage of (relatively) safe and liquid assets in the financial portfolio, X_j = explanatory variable in addition to Age, and D_k = dummy variable for the saving motive.

The types of financial assets that we include in $Cash$ here are the same as those in the introduction. To capture the nonlinear "age effect" depicted in Table I, we use Age and Age^2 in the regression. In addition to age and the dummy variables for saving motives, we employ seven other explanatory variables. They are: (1) X_1= financial net worth, (2) X_2 = financial net worth^2, (3) X_3 = relative housing value, (4) X_4= relative investment real estate, (5) X_5 = risk attitude, (6) X_6 = relative business value, and (7) X_7 = the log of labor income.

First, we use financial net worth to control for wealth in the portfolio decision.[17] Second, we include the square of financial net worth to account for possible nonlinearity in the relationship. For example, we may expect risk aversion to decline as financial net worth increases. However, households with very high financial net worth may be more risk averse if their financial net worth is a significant part of their total wealth and is highly correlated with consumption.[18] Third, we control for ownership of real estate using two variables. One is housing value relative to total net worth. Housing here refers to each household's primary residence only. The other is investment real estate relative to total net worth. We expect the sign of the parameter estimate for both to be positive. Not only is real estate a risky investment, but it is also a personal illiquid project that generates regular liquidity needs (e.g., mortgage, property tax, and utility payments, and maintenance costs), so households may prefer safer financial assets. Fourth, there is a self-reported risk attitude variable in the survey, based on a hypothetical investment question. This variable takes on four possible values, one to four. A larger number implies a higher degree of risk aversion. Past studies often use age as a proxy for risk aversion. It is interesting to note that in our sample, age and risk attitude have a correlation coefficient of only 0.04. Fifth, some households in the survey own private businesses, which are prime examples of personal illiquid projects that generate liquidity needs. We use private business value (which includes personal assets used as collateral for business loans) relative to total net worth as a proxy for this effect. We expect a positive sign for the parameter estimate. Last, we have labor income. Labor income consists of wages, salaries, and professional income including farm income. We use the log of labor income in the regression to dampen the effects of extreme values. This variable can be interpreted as a measure of human capital (holding other characteristics constant).[19] Since households with more human capital are less vulnerable to the risk of their financial portfolios, we expect a negative sign for the parameter estimate.

We impose the following two criteria in our sample selection. (As a result, we eliminate 39.72 percent of the observations in the 1995 SCF public data set.) First, since we are trying to analyze portfolio choice, we exclude households that do not have sufficient funds to form a reasonable portfolio. We exclude observations with financial net worth smaller than \$1000. We also screen out observations with zero or negative total net worth, particularly since this variable appears in the denominator of two explanatory variables.[20] Second, we exclude households that report zero labor income because we take the log of this variable to minimize the effects of outliers. The impact of this exclusion on our variables of interest is small: Estimating the model without any restrictions on labor income yields qualitatively similar results. The only major difference was in the parameter estimate of labor income. When households with zero labor income are included (without taking logs), the parameter estimate of labor income becomes statistically insignificant. This outcome is not surprising considering the effects of outliers and the fact that 18 percent of the sample has a value of zero for this variable.

We estimate three versions of (12) to show the reduction in the "age effect" as we add more explanatory variables. In Table V, we present the regression results. An asterisk denotes significance at the five percent level. The influence of the variable *Age* drops significantly as we include additional explanatory variables in the regression. The parameter estimate for *Age* is -0.0137 in model 1, and it is reduced to -0.0083 in the full model.

[Table V]

Let us now turn to the results of the full model. All of the X variables have the expected signs and are statistically significant at the five percent level, except for financial net worth. Consistent with past studies, we find a lot of noise in the household's portfolio decisions: The average adjusted R^2 across the five implicates is 8.29 percent. The results confirm a U-shape relationship for both $Cash$ and Age. They also show that a higher self-reported degree of risk aversion leads to a safer financial portfolio. In contrast, higher labor income, holding age, wealth, and other characteristics constant, tends to reduce the share of safe assets in a household's portfolio. In terms of the personal illiquid projects, a larger housing value, a bigger stake in investment real estate, and a greater business value all lead to a significantly safer financial portfolio. However, since real estate and private businesses are risky assets, there may be a diversification motive for holding safer financial assets, in addition to liquidity needs. This is particularly true for private businesses, which have a positive correlation with stock returns (see Heaton and Lucas (2000)). It is therefore difficult to disentangle between the two effects based on these results alone.

Looking at the saving motives allows us to focus on the liquidity effect. For example, when an entrepreneur is saving to invest in his private business (say, to expand his business or to buy a piece of equipment), he is doing so for liquidity reasons and not because of diversification. Out of the eight dummy variables, "invest in own home," "invest in own business," and "retirement" are statistically significant. The first two categories lend support to our theoretical hypothesis. In particular, the quantitative effect of "invest in own business" is very large: This motive increases household's cash holdings by 26 percent. Since we already control for business value in the regression, this result suggests that entrepreneurs may hold a safer financial portfolio beyond a pure diversification reason, and that the liquidity needs of a personal project are important for portfolio choice. Further, unlike the prediction of previous studies that examine the effects of liquidity constraints on portfolio choice, the strong liquidity effect that we observe does not apply only to households with low wealth. In fact, the average total net worth of the households who pick "invest in own business" as a top saving motive is close to $800,000. The average value of their financial portfolios is about $50,000, and their average cash holding is an astonishing 65 percent!

The results also suggest that saving for retirement actually leads to a riskier financial portfolio. Curiously, this is the only saving motive that has a significant negative sign. Note that education is not a statistically significant factor in explaining portfolio choice, even though one may argue that investment in human capital fits our description of a multi-period personal illiquid project. One reason could be that education expense is spread over a long time, and rarely constitutes a large portion of consumption. Another reason could be that the education loans provided by the government invalidate the financial constraints we model in this paper.

III. Conclusion

Our analysis of the 1995 SCF shows that when individuals save to invest in their own businesses or in their own homes, they hold a portfolio of financial assets that is safer than we would expect given their characteristics. These characteristics include measures of how exposed the individuals are to entrepreneurial risk and home ownership risk. Hence, we think that this result cannot be solely explained by a pure diversification motive. Instead, we propose an explanation based on the interaction of the liquidity needs of physical investment and the portfolio choice of financial assets along the lines of Froot, Scharfstein, and Stein (1993) and Holmström and Tirole (1998).

In our model, individuals engage in multi-stage personal projects in which there is a penalty for discontinuing them due to a lack of liquidity. A portfolio of financial assets is formed to meet the liquidity needs of these projects. We demonstrate that, for a given project, this interaction may lead to a variety of attitudes towards portfolio risk, including risk inclination and risk aversion. However, when individuals can simultaneously choose the size of their projects and their financial portfolios, they tend to be averse to portfolio risk. Numerically, our model predicts a large demand for safe financial assets, despite sizable risk premia when personal projects are highly productive. In this case, individuals do not rely on large holdings of financial assets to ensure the continuation of their projects. Instead, they rely on the safety of their holdings. The severity of the penalty for discontinuing a project is also important, but it need not be harsh for strong numerical effects.

Our inquiry contributes to the resolution of two puzzles in the portfolio selection literature. First, our theoretical model, with supporting empirical evidence, helps explain why cash holdings are much higher than what standard portfolio theory with reasonable coefficients of relative risk aversion would predict. Second, results from our empirical investigation help explain why young individuals hold more conservative financial portfolios than those close to retirement.

Appendix A: Proof of Theorems 1 and 2

Lemma 1: If stocks are not an available financial instrument, then $\theta = 1$ and the optimal k_1 is $k^b \equiv \left[1 + \mu \left(R^b\right)^{-1}\right]^{-1}$. In this case, c_3 is

$$c_3^b \equiv \frac{\left(R^k\right)^2 + \gamma R^k - \delta R^b}{1 + \mu \left(R^b\right)^{-1}}. \tag{A1}$$

Proof: If $\theta = 1$, there is no uncertainty about c_3. The condition $a_2 \geq \mu k_1$ that determines if the project can be continued simplifies to $(1 - k_1) R^b \geq \mu k_1$, or equivalently $k_1 \leq k^b$, where k^b is the level of $k_1$that equates $(1 - k_1) R^b$and μk_1. Likewise, equation (9) simplifies to

$$c_3 = \begin{cases} \left[\left(R^k\right)^2 + \gamma R^k - \delta R^b - \mu \overline{R^s}\right] k_1 + R^b \overline{R^s} (1 - k_1) & \text{if } k_1 \leq k^b; \\ \left(R_0^2 + \gamma \overline{R^s} - \delta R^b - \mu \overline{R^s}\right) k_1 + R^b \overline{R^s} (1 - k_1) & \text{if } k_1 > k^b. \end{cases} \tag{A2}$$

Assumption 1 implies that $\left(R^k\right)^2 + \gamma R^k - \delta R^b - \mu \overline{R^s} > R^b \overline{R^s}$, so the first row in (14) is maximized at $k_1 = k^b$, and hence $c_3 = c_3^b$. The maximum return in the second row is no greater than $\max\left[\left(R_0^2 + \gamma \overline{R^s} - \delta R^b\right) k^b,\ R^b \overline{R^s}\right]$. Assumption 1 implies that this upper bound is lower than $\left[\left(R^k\right)^2 + \gamma R^k - \delta R^b\right] k^b$, the maximum return of the first row, so $k_1 = k^b$ is the optimal choice. Q.E.D.

Lemma 2: Let $w(k_1, \theta, R^b)$ be the mapping of a policy (k_1, θ) and a cash return R^b onto $E(c_3)$. This mapping satisfies the following properties:

(i) As long as $\theta \in [0, 1)$, $w(k_1, \theta, R^b)$ is a continuous function.

(ii) For $\theta = 1$, $w(k_1, 1, R^b)$ is a continuous function of (k_1, R^b) in the set that satisfies $k_1 \leq k^b$.

(iii) For $\theta = 1$ and $k_1 = k^b$, $w(k^b, 1, R^b) = c_3^b$.

(iv) For $\theta \in [0, 1)$ and $R^b = \overline{R^s}$, $w(k_1, \theta, \overline{R^s}) < c_3^b$.

Proof: Because the distribution of R^s is continuous, the probability P defined in (10) is a continuous function of k_1, θ, and R^b as long as $\theta \in [0,1)$. Therefore, equation (11) implies (i). If $\theta = 1$, $w(k_1, 1, R^b)$ is the consumption c_3 in (A2). Hence, statement (ii) follows. Statement (iii) follows directly from Lemma 1 and the definition of w.

To prove statement (iv), let ρ be the ex-post return on the financial portfolio that is just sufficient to ensure the continuation of the project: $\rho \equiv \mu k_1/(1-k_1)$. Using the definition of ρ, equation (11) becomes

$$w(k_1,\theta,R^b) = \frac{\left[\left(R^k\right)^2 + \gamma R^k - \delta R^b - \mu \overline{R^s}\right] P + \left[R_0^2 + \delta(\overline{R^s} - R^b)\right](1-P) + \frac{\mu}{\rho}\overline{R^\theta}\,\overline{R^s}}{1+\mu\rho^{-1}}. \tag{A3}$$

Direct comparison of (A1) and (A3) implies that $w(k_1,\theta,R^b) < c_3^b$ if and only if the following inequality holds:

$$(1-P)\left\{\left[\left(R^k\right)^2 + \gamma R^k - \delta R^b\right] - \left(R_0^2 + \mu\frac{R_0^2}{R^b}\right)\right\} + \left[\left(R^k\right)^2 + \gamma R^k - \delta R^b\right]\left(\frac{\mu}{\rho} - \frac{\mu P}{R^b}\right) - \tag{A4}$$

$$\left[1+\frac{\mu}{R^b}\right]\left[\left(\frac{\mu\overline{R^s}\,\overline{R^\theta}}{\rho} - \mu\overline{R^s}P\right) - \delta(\overline{R^s} - R^b)(1-P)\right] > 0.$$

When $\overline{R^s} = R^b$, which implies $\overline{R^\theta} = \overline{R^s}$, the previous relation simplifies to:

$$\begin{aligned}&(1-P)\left\{\left[\left(R^k\right)^2 + \gamma R^k\right] - \left[R_0^2 + \mu\frac{R_0^2}{R^b} + \delta\overline{R^s}\right]\right\} + \\ &\left\{\left[\left(R^k\right)^2 + \gamma R^k\right] - \left[\left(\overline{R^s}\right)^2 + \gamma\overline{R^s}\right]\right\}\frac{\mu}{\rho}\left(1 - \frac{\rho P}{\overline{R^\theta}}\right) > 0.\end{aligned} \tag{A5}$$

Given Assumptions 1 and 2, the previous inequality holds if $\rho P < \overline{R^\theta}$, that is, if

$$\rho\int_\rho^\infty dF^\theta < \int_0^\infty R^\theta dF^\theta, \tag{A6}$$

where F^θ is the distribution function of R^θ, and it is related to F through the definition of R^θ. Because the random variable R^θ has positive support, we have $\rho\int_\rho^\infty dF^\theta \leq \int_\rho^\infty R^\theta dF^\theta \leq \int_0^\infty R^\theta dF^\theta$. Moreover, at least one of these two inequalities is strict as long as R^θ is a strict random variable, that is, if $\theta < 1$. Q.E.D.

Proof of Theorem 1:

(i) If $P = 0$ or $P = 1$ for all values of θ, then the maximum $E(c_3)$ in (11) is attained at the θ that achieves the highest expected return $\overline{R^\theta}$.

(ii) Using Lemma 2, $w(k_1, 1, R^b) - w(k_1, 0, R^b) > 0$ at $(k_1, R^b) = (k^b, \overline{R^s})$. Moreover, the functions $w(k_1, 1, R^b)$ and $w(k_1, 0, R^b)$ are both continuous with respect to (k_1, R^b) when $k_1 \leq k^b$. Therefore, as long as $\overline{R^s} - R^b$ is not too large and $k_1 \in [k^b - \epsilon, k^b]$ where $\epsilon > 0$ and is sufficiently small, the difference $w(k_1, 1, R^b) - w(k_1, 0, R^b)$ remains positive, so $\theta = 0$ cannot be optimal because it is dominated by $\theta = 1$.

(iii) If $k_1 > k^b$ and $\overline{R^s} = R^b$, then (11) simplifies to

$$E(c_3) = k_1 \left\{ \left[\left(R^k\right)^2 + \gamma \left(R^k - \overline{R^s}\right) \right] P + R_0^2 (1 - P) \right\} + (1 - k_1) \left(\overline{R^s}\right)^2. \tag{A7}$$

The expected value $E(c_3)$ is increasing in P, so the individual chooses θ to maximize P. If $\theta = 1$, $P = 0$ because $k_1 > k^b$. If $\theta < 1$, $P > 0$ in the interval $(k^b, k^b + \epsilon]$ where $\epsilon > 0$ and is sufficiently small, because R^s is stochastic. In this case, the probability P that $a_2 = (1 - k_1) \left[(1 - \theta) R_1^s + \theta R^b \right]$ is at least μk_1 is

$$P = \Pr \left\{ R_1^s \geq g(\theta) \right\} \text{ where } g(\theta) = \frac{R^b}{1 - \theta} \left[\frac{\mu k_1}{(1 - k_1) R^b} - \theta \right]. \tag{A8}$$

The function g is increasing in θ as long as $\mu k_1 > (1 - k_1) R^b$, which holds when $k_1 > k^b$. Therefore, P is decreasing in θ and the only optimal value of θ is zero in the interval $(k^b, k^b + \epsilon]$. Q.E.D.

Proof of Theorem 2: If $R^b = \overline{R^s}$, Lemma 2 implies that $c_3^b - w(k_1, \theta, R^b) > 0$ for all $\theta \in [0, 1)$, so the optimal θ is one. The function $w(k_1, 0, R^b)$ is continuous with respect to (k_1, R^b), and c_3^b is a continuous function of R^b. Therefore, as long as $\overline{R^s} - R^b$ is not too large, $c_3^b - w(k_1, 0, R^b)$ remains positive, so $\theta = 0$ cannot be optimal because it is dominated by $\theta = 1$. Q.E.D.

Appendix B: Interior Portfolio Solutions

When the distribution function, F, is differentiable, the first-order condition for an interior portfolio with $\theta \in (0, 1)$ can be obtained by taking the derivative of the objective (11) and equating it to zero:

$$\frac{dP}{d\theta}k_1\left[\left(R^k\right)^2 - R_0^2 + \gamma(R^k - \overline{R^s})\right] + (1-k_1)\overline{R^s}(\overline{R^s} - R^b) = 0. \tag{B1}$$

The second-order condition is:

$$\frac{d^2P}{d\theta^2}k_1\left[\left(R^k\right)^2 - R_0^2 + \gamma(R^k - \overline{R^s})\right] < 0 \tag{B2}$$

Using (10),

$$\frac{dP}{d\theta} = -\frac{R^b-\rho}{\theta^2}F', \text{ and } \frac{d^2P}{d\theta^2} = -\left(\frac{R^b-\rho}{\theta^2}\right)^2 F'' + 2\left(\frac{R^b-\rho}{\theta^3}\right)F' \tag{B3}$$

where $\rho \equiv \mu k_1/(1-k_1)$ and F' and F'' are evaluated at $\theta^{-1}\left[\rho - (1-\theta)R^b\right]$. For the first-order condition to hold, the difference $R^b - \rho$ must be positive. Hence, for the second-order condition to hold, F'' must be positive and sufficiently large. Even though F'' is positive at the lower tail of the log-normal distribution, numerically, we found no interior optimum in our simulations.

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Endnotes

1. In addition, there is human capital, which is not explicitly measured in the SCF. Kendrick (1976) estimates that human capital is roughly as large as non-human wealth.

2. Constantinides, Donaldson, and Mehra (1998) use this wealth diversification argument together with borrowing constraints of young investors to explain the equity premium puzzle. The problem with their explanation, which we attempt to address in this paper, is that young investors actually have safer portfolios than individuals close to retirement.

3. Bodie, Merton and Samuelson (1992) make a similar point, arguing that since young investors have greater labour supply flexibility, they can tolerate more risk in their financial portfolios.

4. There is an identification problem as to whether the observed age/risk profile is purely an age effect or partly a cohort effect. This distinction is beyond the scope of our paper. Interested readers should refer to Poterba and Samwick (1997) and Ameriks and Zeldes (2000).

5. Using monthly returns, the contemporaneous correlation between real stock returns and the rate of change in real housing prices is 0.11 from 1968(2) to 1994(8). When real stock returns are lagged one month, the cross-correlation increases to 0.17, but remains fairly low. These correlations were calculated using the following series from Citibase: HEMP (Median Sales Price of Existing Single-Family Homes), FSPCOM (S&P Common Stock Price Index), FSDXP (S&P Common Stock Dividend Yield), and PZUNEW (Consumer Price Index).

6. Similar effects can be generated with idiosyncratic shocks to labour income without the assumption of liquidity constraints (see Weil (1992)). What is important for risk aversion is that the consumption policy function is steeply increasing with liquid funds to induce a strong negative correlation between the marginal utility of consumption and the return to the portfolio of liquid assets.

7. Campbell and Viceira (2001) show that long-term bonds are especially suitable for this role when savings are to be invested over long horizons.

8. An alternative explanation is provided by Dammon, Spatt, and Zhang (2001). They argue that the presence of capital gains taxes and short-sale restrictions induces a positive

correlation between equity holdings and age. The reason is that in the U.S., capital gains taxes are "forgiven" at death.

9. We assume the same constant rate of return on cash and on debt. Since the personal project is risk-free and highly profitable if completed (see Assumption 1), the individual has no incentive to default.

10. When $R^b = \overline{R^s}$, the individual is indifferent between investing the residual funds in stocks or cash in the second period. For ease of exposition, we assume that in this case the individual invests in stocks.

11. These four regions may not be convex intervals if the distribution for stock returns, F, is not uniform.

12. We establish these consumption patterns with a battery of numerical simulations that were not reported here, because we were not able to obtain sharp analytical results with a concave utility function.

13. Each observation corresponds to a household. A household consists of an economically dominant single individual or couple and all other persons in the household who are financially dependent on that individual or couple. A financially self-sufficient grandparent, for example, would be excluded.

14. The survey is based on a dual-frame sample design, incorporating both a standard multi-period national area-probability design and a list-sample design. The list sample is selected from a set of tax returns. It is intended to provide a disproportionate representation of wealthy households, who own a large percentage of skewed assets such as stocks, options, and antiques. To compensate for this unequal probability in the sample design and for failure to obtain an interview with some of the selected households, a set of analysis weights is included in the data set.

15. The public data set consists of five implicates as a result of the multiple imputation technique used to handle missing data. (Some data may be missing because respondents are unable or unwilling to provide certain pieces of information. See Kennickell (1998) for a discussion of multiple imputation in the SCF.) Each implicate has 4,299 observations, corresponding to the number of households surveyed in 1995. We utilize information contained in all five implicates. Using the RII technique, we include both the within-imputation variance

and the across-imputation variance in generating inferences.

16. The 1995 SCF public dataset lists the top five reasons for saving for each respondent. We feel that, on the one hand, less important reasons may not have a significant impact on portfolio choice. On the other hand, including only the top reason may not generate enough non-zero observations for the dummy variables. As a tradeoff, we include the top three reasons from the list.

17. Financial net worth is defined as the difference between the value of the financial portfolio (as defined in the introduction) and the amount of financial debt (credit card balance, line of credit, and other loans not related to fixed assets).

18. As opposed to a household in which labour income, a proxy for human capital (holding other characteristics constant), is the significant part of total wealth. This household will be less risk averse in its portfolio choice as long as its labour income is not highly correlated with stock returns.

19. One might argue that education level can be used to control for human capital and knowledge of the capital market. Unfortunately, this variable is not included in the public data set of the 1995 SCF.

20. Other authors in this literature use more stringent sample selection rules. For example, Heaton and Lucas (2000) exclude households with less than $500 in stock holdings, and those with less than $10,000 of financial net worth.

Table I

Mean Percentage of Cash in Financial Portfolio, by Age

1995 Survey of Consumer Finances (SCF)

Cash refers to relatively safe and liquid assets. They include checking and savings accounts, call accounts at brokerages, and money market accounts either in deposits or in mutual funds. The financial portfolio includes, in addition to cash, stock and bond mutual funds, stocks and bonds directly held, IRAs and thrift-type accounts, cash value of whole life insurance, other managed assets (trusts, annuities, and managed investment accounts), and other financial assets (loan, future proceeds, royalties, futures, non-public stock-deferred compensation, and money in hand). The means and their standard errors are estimated using the Repeated-Imputation Inference (RII) technique (see Montalto and Sung (1996)). Sample weights provided in the public data set of the 1995 Survey of Consumer Finances are employed in the estimation.

Age	<25	25-34	35-44	45-54	55-64	65-74	75+
Mean	0.6417	0.4138	0.3801	0.3358	0.3730	0.4249	0.4745
Standard error of the mean	0.0073	0.0014	0.0030	0.0036	0.0032	0.0023	0.0066

Table II

Lowest Return on Cash at Which the Individual Holds only Cash in Period One

The portfolio of financial assets in period one contains either only cash or only stocks for all the following simulations. The numbers reported in the body of the table are the lowest gross rate of return on cash, R^b, for which the individual holds only cash ($\theta = 1$). The simulated distribution of the gross rate of return on stocks, R^s, is assumed to be log-normal. The gross rates of return on the personal project are R^k if the project is completed, and R_0 if the project is discontinued. To complete the project, the required ratio of second-period capital to first-period capital is γ. Borrowing in the second period is constrained to be at most δ times the first-period capital.

Parameters		Log-normal Distribution of Stock Returns with $\overline{R^s} = 1.07$ and Var($\ln R^s$) $= 0.0274$					
R^k	R_0	$\gamma = 0.5$		$\gamma = 1$		$\gamma = 2$	
		$\delta = 0$	$\delta = 0.25$	$\delta = 0$	$\delta = 0.5$	$\delta = 0$	$\delta = 1$
		(1)	(2)	(3)	(4)	(5)	(6)
1.09	0.75	1.051	1.048	1.055	1.051	1.059	1.055
	1	1.054	1.050	1.057	1.053	1.060	1.056
1.12	0.75	1.029	1.021	1.037	1.029	1.044	1.035
	1	1.033	1.026	1.041	1.033	1.047	1.038
1.15	0.75	1.010	0.998	1.022	1.009	1.031	1.018
	1	1.016	1.005	1.026	1.014	1.035	1.022

Table III

Solutions to the Individual's Problem for Alternative Sets of Parameter Values

In this table, we report the optimal choice for an individual faced with different sets of parameters. The gross rate of return on cash is R^b. The simulated distribution of the gross rate of return on stocks, R^s, is assumed to be log-normal with mean $\overline{R^s}$ and $\mathrm{Var}(\ \ln R^s\ ) = 0.0274$. The gross rates of return on the personal project are R^k if the project is completed, and R_0 if the project is discontinued. To complete the project, the required ratio of second-period capital to first-period capital is γ. Borrowing in the second period is constrained to be at most δ times the first-period capital. In period one, the portion of initial wealth invested in the personal project is k_1, and the fraction of cash in the portfolio of financial assets is θ. Expected consumption in period three is $E(c_3)$. The probability of completing the personal project is P. In the upper part of the table, R^b is set to be sufficiently low so that $\theta = 0$ for all parameter values. In the lower part of the table, R^b is the set at the lowest value that yields $\theta = 1$.

$\overline{R^s}$	1.07	1.07	1.07	1.07	1.07
R^b	1	1	1	1	1
R^k	1.15	1.12	1.12	1.12	1.12
δ	0.25	0.25	0	0	0
γ	0.5	0.5	0.5	1	1
k_1	0.791	0.789	0.592	0.429	0.413
θ	0	0	0	0	0
$E(c_3)$	1.329	1.264	1.223	1.211	1.209
P	0.994	0.995	0.988	0.980	0.993
$\overline{R^s}$	1.07	1.07	1.07	1.07	1.07
R^b	1.005	1.026	1.033	1.041	1.037
R^k	1.15	1.12	1.12	1.12	1.12
δ	0.25	0.25	0	0	0
γ	0.5	0.5	0.5	1	1
k_1	0.834	0.836	0.674	0.510	0.509
θ	1	1	1	1	1
$E(c_3)$	1.328	1.259	1.227	1.211	1.209
P	1	1	1	1	1

Table IV

Mean Age and Sample Count for Various Saving Motives

1995 Survey of Consumer Finances (SCF)

The means and the standard errors are estimated using the Repeated-Imputation Inference (RII) technique (see Montalto and Sung (1996)). Sample weights provided in the public data set of the 1995 Survey of Consumer Finances are employed in the estimation.

	Mean age	Standard error	Count
Education	38.9725	0.0202	1,716
Invest in own home	35.1804	0.2470	518
Household purchases	44.5382	0.0805	267
Travel	46.7434	0.1083	270
Invest in own business	37.1380	0.1438	74
Retirement	52.5223	0.0309	4,567
Emergency	50.5134	0.0370	3,527
Living expenses and bills	52.2474	0.1656	366

Table V
Regression Results
1995 Survey of Consumer Finances (SCF)

The full regression model is:

$$Cash_i = \beta_0 + \beta_1 Age_i + \beta_2 Age_i^2 + \sum_{j=1}^{7} \beta_{3j} X_{ji} + \sum_{k=1}^{8} \beta_{4k} D_{ki} + \epsilon_i.$$

Models 1 and 2 are subsets of the full model. Cash is the percentage of relatively safe and liquid assets in the financial portfolio. In addition to Age and Age^2, there are seven other control variables (X_j's). They are: (1) Financial net worth, (2) Financial net worth^2, (3) Relative housing value (value of primary residence divided by total net worth), (4) Relative investment real estate (investment real estate divided by total net worth), (5) Risk attitude (self-reported risk preference based on a hypothetical investment question - a larger number implies a higher degree of risk aversion), (6) Relative business value (value of private business including personal assets used as collateral for business loans divided by total net worth), and (7) the Log of labor income. The D_k's are dummy variables for eight saving motives: (1) Education, (2) Invest in own home, (3) Household purchases, (4) Travel, (5) Invest in own business, (6) Retirement, (7) Emergency, and (8) Living expenses and bills. The models are estimated using the Repeated-Imputation Inference (RII) technique (see Montalto and Sung (1996)). All five implicates and the sample weights provided in the public data set of the 1995 Survey of Consumer Finances are employed in the estimation. For the full model, the average adjusted R^2 across the five implicates is 8.29 percent. An asterisk denotes significance at the five percent level. In all three regressions, the F statistic is significant at the one percent level.

	Model 1		Model 2		Full Model	
	Mean	Prob.	Mean	Prob.	Mean	Prob.
Intercept	0.6222*	0	0.7030*	0	0.6093*	2.44E-5
Age	-0.0137*	1.31E-7	-0.0119*	1.31E-5	-0.0083*	0.0032
Age^2	0.0001*	1.71E-5	0.0001*	0.0005	6.17E-5*	0.0246
Financial net worth			-2.54E-6	0.1249	-3.17E-6	0.0569
Financial net worth^2			1.89E-11	0.1210	2.22E-11	0.0704
Relative housing value			0.0309*	0.0013	0.0361*	0.0002
Relative investment real estate			0.0790*	0.0005	0.0747*	0.0009
Risk attitude			0.0359*	8.17E-7	0.0337*	4.11E-6
Relative business value			0.1550*	9.75E-11	0.1512*	4.64E-10
Log of labor income			-0.0249*	4.60E-6	-0.0231*	2.02E-5
Education					-0.0358	0.1220
Invest in own home					0.1055*	0.0015
Household purchases					0.0078	0.8613
Travel					-0.0236	0.6109
Invest in own business					0.2521*	0.0014
Retirement					-0.0493*	0.0069
Emergency					0.0017	0.9342
Living expenses and bills					0.0011	0.9781

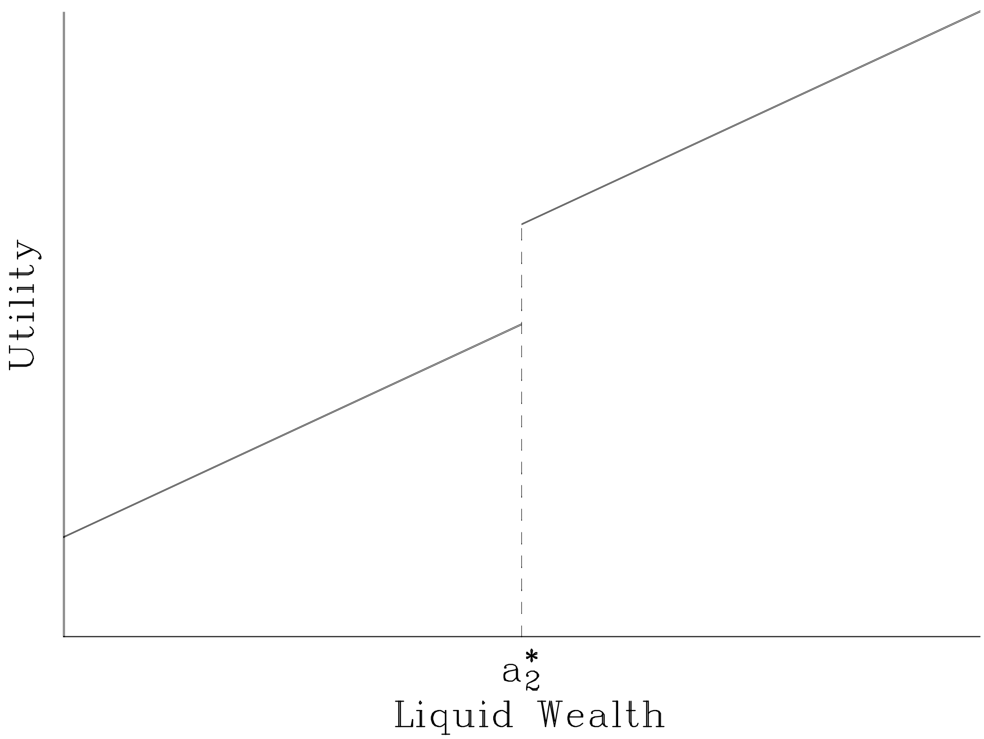

Figure 1: **Indirect utility of liquid wealth - the case of lumpy investment.** Liquid wealth in period 2, a_2, is equal to the sum of the gross returns on the financial assets purchased in period 1. If a_2 falls below the critical level a_2^*, the project has to be discontinued and the return on the project has a sudden drop.

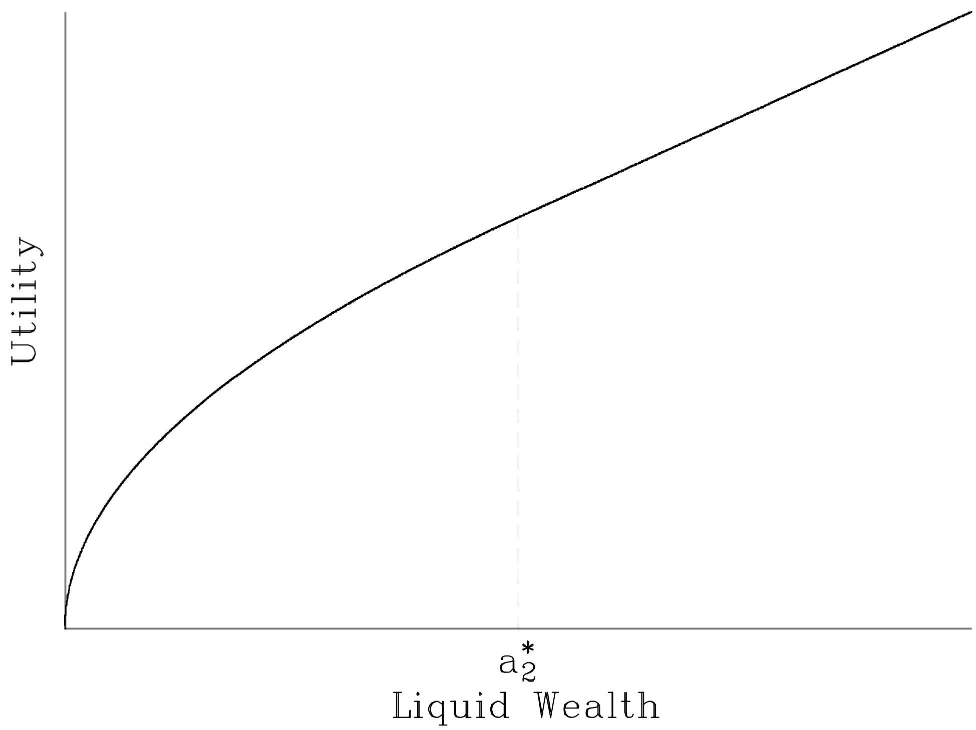

Figure 2: Indirect utility of liquid wealth - the case of convex investment. Liquid wealth in period two, a_2, is equal to the sum of the gross returns on the financial assets purchased in period one. If a_2 falls below the critical level a_2^*, the owner of the personal project is liquidity constrained.