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### *Stockholding: From Participation to Location and to Participation Spillovers*

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# ***Stockholding: From Participation to Location and to Participation Spillovers***

**Dimitris Christelis<sup>▼</sup>, Dimitris Georgarakos<sup>▲</sup> and Michael Haliassos<sup>◆</sup>**

### **Abstract**

This paper provides a joint analysis of household stockholding participation, stock location among stockholding modes, and participation spillovers, using data from the US Survey of Consumer Finances. Our multivariate choice model matches observed participation rates, conditional and unconditional, and asset location patterns. Financial education and sophistication strongly affect direct stockholding and mutual fund participation, while social interactions affect stockholding through retirement accounts only. Household characteristics influence stockholding through retirement accounts conditional on owning retirement accounts, unlike what happens with stockholding through mutual funds. Although stockholding is more common among retirement account owners, this fact is mainly due to their characteristics that led them to buy retirement accounts in the first place rather than of any informational advantages gained through retirement account ownership itself. Finally, our results suggest that, taking stockholding as given, stock location is not arbitrary but crucially depends on investor characteristics.

**JEL Classification:** G11, E21, D14, C35.

**Keywords:** Stockholding, asset location, retirement accounts, household finance, multivariate probit, simulated maximum likelihood.

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## 1. Introduction

In the past two decades, the US and major European countries have witnessed an expanded range of financial products such as mutual funds and retirement accounts, and a significant increase in household risk taking through investment in portfolios that could, inter alia, supplement the retirement income provided by underfunded social insurance systems. Stocks, owned either directly or indirectly through mutual funds or retirement accounts, represent a critical household investment vehicle, mainly because of their wealth generating potential over long investment horizons.

Observed household portfolios are very heterogeneous in terms of the list of included assets, in contrast to the implications of simple ‘two-fund separation’ theorems derived in textbook models of asset pricing. Overall stock market participation is limited to about half of the population in the US; much fewer households own stocks directly or through mutual funds. Stockholders choose various combinations of stockholding modes, i.e., they favor different patterns of stock location. Households who own retirement accounts in order to meet the financial challenges of old age exhibit higher stockholding participation rates than the population at large. It is unclear, however, if such stock market participation is due to retirement account ownership per se (e.g. because it confers some knowledge about investing in stocks) or rather to their own characteristics that are generally favorable to stockholding

These observations, documented below, pose a three-pronged issue relevant for research and policy: stock market participation, location of stocks, and participation spillovers from one asset (e.g. retirement accounts) to the other stockholding modes. Up to now, analysis of these three questions has been performed separately. The literature on participation has often studied overall stockholding without allowing for possible interactions across stockholding modes. On the other hand, the asset location literature, by definition, distinguishes across modes, but tends to analyze

each mode separately, due to the substantial technical difficulties associated with modeling numerous decisions jointly. The policy-relevant issue of participation spillovers is only recently starting to receive attention, mainly by focusing on suggestive descriptive statistics.

To the best of our knowledge, this paper represents the first integrated analysis of all three issues in the context of a unified model that allows for interrelationships among stockholding choices. Our model enables us to estimate the separate effects of a given household characteristic or attitude on various choices, both unconditionally and conditionally on particular investment patterns. Allowing for such differential effects is justified by the different properties of the three stockholding modes. Direct stockholding is quite liquid, management-intensive and typically quite risky, due to limited diversification. Stock mutual funds are also quite liquid, but tend to be well-diversified and professionally managed. They require payment of fees, complex choices among numerous alternative funds, and costly performance monitoring. Investment in stocks directly and through mutual funds is on an after tax basis, and dividends and capital gains are taxable (albeit favorably). On the other hand, retirement accounts are typically tax-deferred, though much less liquid.

Distinguishing across stockholding modes and allowing for correlations of their unobserved determinants is crucial for differentiating between conditional and unconditional probabilities of portfolio choices of interest; our approach is supported by economically and statistically significant estimates of such correlations, and by predicted participation rates that closely match the observed ones.

We find sizeable effects of educational attainment, financial sophistication, and financial information (acquired through the Internet or by working in the financial sector) on both direct stockholding and ownership of mutual funds and retirement accounts, in contrast to the popular belief that assets requiring less active management represent ‘easy’ investment choices. Our



results suggest that owning any mutual funds represents the major participation threshold for owning stock mutual funds: once it is crossed, education, financial sophistication, resources, race, and most financial attitudes are not relevant for investing in a stock mutual fund. In stark contrast, stock investment in retirement accounts, given that these are opened, is fostered by a set of characteristics similar to those inducing direct stockholding.

Our analysis of asset location provides further evidence of the powerful influence of gender on stockholding behavior. We find that, conditioning on ownership of stocks in any form, single males tend to invest in stocks directly, while females of similar characteristics tend to hold stock mutual funds. Overconfidence of males found in other contexts such as stock trading (Barber and Odean, 2001), could be relevant for this observed pattern.

When studying participation spillovers, we find that retirement account owners are more likely to invest in other forms of stockholding than the general population. Crucially, this result is due to the characteristics that led them to own retirement accounts in the first place rather than to any informational spillovers from retirement account ownership.

The issues studied in our paper are addressed in three separate strands of existing literature. The participation literature has attributed limited household participation in the stock market mainly to fixed entry/participation costs.<sup>1</sup> Possible factors that account for limited participation among well-to-do households (for whom such costs would not be a deterrent) include asset ignorance (Guiso and Jappelli, 2005), lack of trust (Guiso, Zingales and Sapienza, 2008), social interactions (Hong, Kubik and Stein, 2004), cognitive difficulties (Christelis, Jappelli and Padula, 2006), and lack of financial literacy (Van Rooij, Alessie, and Lusardi, 2006).

The importance of asset location has been stressed by Bergstresser and Poterba (2002) and Garlappi and Huang (2006), who put emphasis on tax considerations by studying possible

violations of optimal stock placement between taxable (such as directly held stocks and mutual funds) and tax-deferred vehicles (retirement accounts).

Asset participation spillovers have not been extensively studied up to now, but are starting to receive attention in view of population aging and increased ownership of retirement accounts. An important research and policy question is whether ownership of retirement accounts, which is induced by the need to finance retirement, will also promote other forms of stockholding. Retirement accounts are regarded as the main factor behind the spread of stockholding in the US. A 2005 report by the Investment Company Institute and Securities Industry Association stresses the role of defined contribution pension plans, especially 401(k)s in this context.<sup>2</sup> A positive view of their role in promoting stockholding in Sweden is provided by Karlsson, Massa, and Simonov (2007).

The rest of the paper is organized as follows. Section 2 presents descriptive statistics on participation in the different stockholding modes and on asset location among stockholders. Section 3 presents the estimation model. Section 4 presents econometric results on participation in direct stockholding, mutual funds, retirement accounts, and in stockholding through mutual funds and retirement accounts. Section 5 presents our findings concerning asset location. Section 6 discusses asset participation spillovers, while Section 7 offers concluding remarks.

## **2. Stockholding Modes in the Data**

We use data from four waves (1995, 1998, 2001, and 2004) of the Survey of Consumer Finances (SCF), which is the only US survey that is representative of the whole population and provides detailed information on all three possible stockholding modes as well as on investors' characteristics, attitudes and practices.<sup>3</sup> The dates chosen encompass the peak of the stock market

upswing of the middle and late nineties, the immediate aftermath of the stock market drop in 2000, and part of the subsequent market recovery.

Table 1 presents ownership rates in the data. Slightly more than half of households have retirement accounts, and more than three quarters of retirement account holders hold stocks in them. Stockholding through retirement accounts is the most widespread mode of stockholding, chosen by about 38% of the population (twice as much as direct stockholding). Approximately 15% of households invest in stock mutual funds.

Looking at trends over our sample period, stockholding participation in general rose above the 50% mark in 2001, but then fell below it by 2004; this development is also reflected in each of the stockholding modes. Among mutual fund owners, however, the share of those investing in stock mutual funds has slightly increased since 1998. Participation in the other two modes was higher in 2004 than in 1998, but the popularity of stocks fell among retirement account holders.

Table 2 refers to stock location, i.e., the use of the three (not mutually exclusive) stockholding options by stockholders. Approximately 80% of them have stocks in retirement accounts, which is by far the most popular location choice. About half as many stockholders invest in stocks directly, while under one third own stock mutual funds. The popularity of stock retirement accounts seems to have risen and then fallen over the period, as did that of stock mutual funds. However, direct stockholding kept rising throughout the period among those who owned stocks in any form.

Table 3 provides additional information on stock location by reporting the distribution of stockholders among all possible combinations of stockholding modes. By far the most popular choice of stockholders is to hold stocks only in their retirement accounts (more than 40% of stockholders in all years). A distant but clear second is the combination of stocks in retirement accounts with direct stockholding. Use of all three modes is observed among slightly more than

10% of households. Interestingly, while percentages differ across years somewhat, the ranking of these options has remained the same for households in the stock market, despite dramatic market swings.<sup>4</sup>

It is also instructive to contrast the distribution of demographic and economic characteristics of stockholders to that in the general population (shown in Table 4). Stockholding in any of the three modes, including the most common one, is undertaken by households quite different from the general population. Specifically, stockholders are more likely to be in a couple, college graduates, white, and in better health, and less likely to be unemployed. In terms of financial attitudes and practices, they are much more likely than the general population to assume a higher than average financial risk, to use the Internet for investing, and to consider leaving a bequest. Finally, stockholders tend to be far richer in terms of non-investment income and real and financial wealth, to be subject to a higher federal marginal tax rate and less likely to be credit constrained. Stockholders are more likely to work (or to have worked) in the financial sector, and less likely to work in an industry that exhibits high income risk.<sup>5</sup> All in all, the data in this section make it clear that the subsample of stockholders is substantially different in many important demographic and economic characteristics from the rest of the population.

To summarize, we observe that, while participation rates in mutual funds and retirement accounts differ, the vast majority of fund holders and account owners include stocks in them. As our econometric results will show, however, this similarity in observed patterns conceals important differences across mutual funds and retirement accounts. Participation in mutual funds paves the way for inclusion of stocks in them almost regardless of household characteristics, while such characteristics are important for determining which subset of retirement account owners includes stocks in them. As for asset location, our finding that roughly 9 out of 10

stockholders do not use all three stockholding modes points to the importance of understanding what lies behind asset location choices among stockholders .

### **3. The Model**

#### **3.1. Description**

We build a model of household stock investment that features the decision process shown in Fig. 1. Households face three (not mutually exclusive) investment choices: direct stockholding and investment in mutual funds and retirement accounts. If any of the latter two saving vehicles is chosen, then the household has to further decide whether to invest in stocks through them. This decision tree reflects observed participation patterns in the SCF, where holders of stock mutual funds are a subset of mutual fund owners, and the same is true for retirement accounts.

As pointed out, for instance, by Greene (1992), it is important for estimation to take into account the censoring in the data created by the fact that we do not observe stock investment in mutual funds (or retirement accounts) for those households that do not own any mutual funds (retirement accounts).<sup>6</sup> This goes beyond the logical necessity of having the broader instrument (e.g., mutual funds) in order to have the narrower instrument (e.g., stock mutual funds). Even in the absence of such logical necessity, a randomly drawn holder of, say, mutual funds would be more likely to own stock mutual funds than a household with similar characteristics chosen randomly from the whole population (comprising mutual fund owners and non-owners). This difference is due to the fact that, for any given configuration of observable characteristics, mutual fund owners have shown themselves to be willing to hold mutual funds in general; and they may have also acquired in the process specific information that facilitates ownership of stock mutual funds. As a result, a model that ignores the censoring issue and estimates the equation for stock investment in mutual funds on the whole sample can produce downward biased estimates of the

probability to invest in stock mutual funds conditional on mutual fund ownership. To put it another way, ignoring the censoring problem is akin to estimating a wage equation on the whole population, which includes not only those employed but also the unemployed and those out of the labor force.

A key aspect of our model is that it allows for separate hurdles to be cleared for participating in each stockholding mode, and for potentially different contributions of each household characteristic or attitude to overcoming such hurdles. We further allow for all possible pair-wise correlations among the unobservables of each investment decision. Such correlations among investment decisions can arise because of factors common to all of them, such as an understanding of stockholding risks, common monitoring costs, and appreciation of the benefits of diversification (see Alessie, Hochguertel and van Soest, 2004).

Our model could in principle be extended to include other household asset choices, e.g. housing, that might have unobservables correlated with those of stocks. Although this could be a worthwhile extension for future research, we chose not to go beyond the already involved task of integrating the three issues in this paper. First, adding a sixth or more equations makes our model even harder to estimate. Second, the considerable additional computational burden would not affect consistency of our estimates, but only potentially increase their efficiency, if unobservables are indeed correlated. As in a standard multivariate probit model, an added equation does not affect consistency but only efficiency.

Participation in mutual funds and retirement accounts is of interest in itself, but also as a first stage to the associated stockholding modes. The second stage decision may or may not be challenging, after the asset corresponding to the first stage has been chosen. For example, once somebody finds out about the nature, purpose, and rules of retirement accounts, the role and usefulness of stocks in these accounts may be quite clear. We would not, then, expect

characteristics that show financial sophistication or willingness to assume higher risks to have significant further roles in determining inclusion of stocks, conditional on having opened the retirement account.

Our multivariate probit model with selection integrates participation analysis with asset location. The latter refers to the choice of a given mode conditional on the household holding stocks in any form, while allowing for all possible correlations across different choices. We discuss results on location in section 5. The issue of participation spillovers from retirement account ownership to other stockholding modes is discussed in Section 6.

### **3.2. Econometric Specification**

The household decision process discussed above implies an empirical model that consists of a tri-variate probit with two further probit equations estimated on the selected samples of mutual fund and retirement account owners. The use of probit models adjusted for selectivity was pioneered by Van de Ven and Van Praag (1981). Another recent example of such models, in a different context from ours, is provided by Jenkins, Capellari, Lynn, Jäckel and Sala (2006). They use a bivariate probit specification with selection, i.e., with two equations for the selected samples, in order to study consent to give information during a survey interview.<sup>7</sup>

In Table 5, the three first-stage equations (1), (2), and (4) model, respectively, the decisions to hold stocks directly, to hold any kind of mutual funds, and to have a retirement account. The two probit selection equations, (3) and (5), model the decisions to hold stock mutual funds given ownership of any mutual fund and to have a stock retirement account given ownership of a retirement account. We allow for unrestricted correlations between error terms of the five underlying latent indices.

Table 4 shows summary statistics of our conditioning variables that have been found in the literature to be good predictors of stockholding (for examples that use the SCF see Bertaut and Starr-McCluer, 2001; Biliias, Georgarakos and Haliassos, 2008). An important addition is the usually omitted federal marginal tax rate, whose computation is described in the data appendix. We construct our sample by pooling the data from the 1995, 1998, 2001 and 2004 SCF waves (17,565 households).<sup>8</sup> In our specification we assume zero cohort effects and include time dummies.<sup>9</sup>

The likelihood function distinguishes between the four possible outcomes of the first stage equations that denote indirect investment in stocks (through mutual funds and retirement accounts). We use the indices  $T \in \{DS, M, MS, R, RS\}$ ,  $k_T = 2T - 1$ , and represent the  $q$ -variate normal distribution by  $\Phi_q(\cdot)$ .<sup>10</sup> The likelihood can be written as follows:

- 1) No investment in mutual funds, no investment in retirement accounts:

$$L_1 = \Phi_3(k_{DS}X'\theta, k_M Z'\alpha, k_R G'\gamma; k_{DS}k_M \rho_{uv}, k_{DS}k_R \rho_{ue}, k_M k_R \rho_{ve}) \quad (7)$$

with  $k_M = k_R = -1$  and  $k_{DS} = \pm 1$

- 2) Investment in mutual funds but not in retirement account(s):

$$L_2 = \Phi_4(k_{DS}X'\theta, k_M Z'\alpha, k_{MS}W'\beta, k_R G'\gamma; k_{DS}k_M \rho_{uv}, k_{DS}k_R \rho_{ue}, k_M k_R \rho_{ve}, k_M k_{MS} \rho_{vn}, k_{MS}k_R \rho_{ne}, k_{DS}k_{MS} \rho_{un}) \quad (8)$$

with  $k_M = 1$ ,  $k_R = -1$ ,  $k_{DS} = \pm 1$  and  $k_{MS} = \pm 1$

- 3) No investment in mutual funds but ownership of retirement account(s):

$$L_3 = \Phi_4(k_{DS}X'\theta, k_M Z'\alpha, k_R G'\gamma, k_{RS}Y'\delta; k_{DS}k_M \rho_{uv}, k_{DS}k_R \rho_{ue}, k_M k_R \rho_{ve}, k_R k_{RS} \rho_{\varepsilon\varepsilon}, k_{RS}k_M \rho_{e\varepsilon}, k_{DS}k_{RS} \rho_{ue}) \quad (9)$$

with  $k_M = -1$ ,  $k_R = 1$ ,  $k_{DS} = \pm 1$  and  $k_{RS} = \pm 1$



4) Investment in both mutual funds and retirement accounts

$$L_4 = \Phi_5(k_{DS} X' \theta, k_M Z' \alpha, k_{MS} W' \beta, k_R G' \gamma, k_{RS} Y' \delta; \\ k_{DS} k_M \rho_{uv}, k_{DS} k_R \rho_{ue}, k_M k_R \rho_{ve}, k_M k_{MS} \rho_{vn}, k_R k_{RS} \rho_{ee}, \\ k_{MS} k_R \rho_{ne}, k_{DS} k_{MS} \rho_{un}, k_{RS} k_M \rho_{ev}, k_{DS} k_{RS} \rho_{ue}, k_{MS} k_{RS} \rho_{ne}) \quad (10)$$

with  $k_M = k_R = 1$ ,  $k_{DS} = \pm 1$ ,  $k_{MS} = \pm 1$  and  $k_{RS} = \pm 1$

Thus the overall contribution to the log likelihood by any given household is:

$$\log L = (1 - MS) \cdot (1 - RS) \cdot \log L_1 + MS \cdot (1 - RS) \cdot \log L_2 + \\ (1 - MS) \cdot RS \cdot \log L_3 + MS \cdot RS \cdot \log L_4 \quad (11)$$

We use multiple imputation estimation methods to handle additional uncertainty induced by multiple imputation in the SCF (see Kennickell, 2000).<sup>11</sup> Given that multiple integrals appear in the likelihood terms,  $L_1, L_2, L_3, L_4$ , we evaluate them by simulated maximum likelihood using the Geweke-Hajivassiliou-Keane (GHK) simulator (see Geweke, 1989; Keane, 1994).<sup>12</sup> Our results are robust to many different initial conditions for the vector of parameters.

It is worthwhile to note that our full maximum likelihood estimation procedure does not require exclusion restrictions for identification, as is also the case with the standard multivariate probit model (see Greene, 2007). Our multivariate probit model with censoring consists, in effect, of four multivariate probit specifications estimated on four different subsamples, as can be seen from (7)-(10). Identification in our model is further assisted by the fact that different equations are estimated on different subsamples, unlike the case with a standard multivariate probit where all equations appear in all possible subsamples (see Schmidt, 1981, and Gao, Lahiri and Wixon, 2001, on the usefulness of sample separation information).<sup>13</sup>

Regression coefficients may give a misleading picture of the effect of a regressor in a non-linear multi-equation model with correlated disturbances. This result can obtain because coefficients do not reflect the regressor's influence that is due to its presence in the equations for the other choices and that could be transmitted to the equation of interest through the cross-

correlated disturbances. Therefore, we focus on the marginal effects of the regressors (coefficient estimates are shown in Table A.1). Given that correlations of disturbances can have substantial effects on calculation of probabilities, we check their joint statistical significance (Appendix B).

An attractive feature of the model is that it allows the computation of a wide range of probabilities pertaining to participation, location, and spillovers. A given asset combination reflected in a particular value of the five-element vector of choices (DS, M, MS, R, RS) has a probability given by:

$$\begin{aligned}
P(DS, M, MS, R, RS) &= \Phi_q(k_{DS}X'\theta, k_M Z'\alpha, l_{MS}W'\beta, k_R G'\gamma, l_{RS}Y'\delta, \bar{\rho}) \\
\text{where } M &\geq MS, R \geq RS, \\
\bar{\rho} &= (k_{DS}k_M\rho_{uv}, k_{DS}k_R\rho_{ue}, k_Mk_R\rho_{ve}, k_Ml_{MS}\rho_{vn}, \\
&\quad k_Rl_{RS}\rho_{ee}, l_{MS}k_R\rho_{ne}, k_{DS}l_{MS}\rho_{un}, l_{RS}k_M\rho_{ev}, k_{DS}l_{RS}\rho_{ue}, l_{MS}l_{RS}\rho_{ne}) \\
l_{MS} &= k_{MS} \text{ if } M=1, l_{MS} = 0 \text{ if } M=0 \\
l_{RS} &= k_{RS} \text{ if } R=1, l_{RS} = 0 \text{ if } R=0 \\
q &= |k_{DS}| + |k_M| + |l_{MS}| + |k_R| + |l_{RS}|
\end{aligned} \tag{12}$$

where  $l_{MS}W'\beta$  ( $l_{RS}Y'\delta$ ) does not appear in  $\Phi_q$  when  $M=0$  ( $R=0$ ). The same is true for all terms involving  $l_{MS}$  ( $l_{RS}$ ) in  $\bar{\rho}$ . We can express the probability of any asset choice as the sum of probabilities of all asset combinations in which this choice is observed, since asset combinations are mutually exclusive.<sup>14</sup> As an example, the probability of investing in stock mutual funds conditional on owning mutual funds can be expressed as

$$\begin{aligned}
P(MS=1 / M=1) &= \frac{P(MS=1, M=1)}{P(M=1)} = \frac{\sum_{DS=0}^1 \sum_{R=0}^1 \sum_{\substack{RS=0 \\ R \geq RS}}^1 P(DS, 1, 1, R, RS)}{\sum_{DS=0}^1 \sum_{MS=0}^1 \sum_{R=0}^1 \sum_{\substack{RS=0 \\ R \geq RS}}^1 P(DS, 1, MS, R, RS)} = \\
&\frac{\Phi_2(Z'\alpha, W'\beta, \rho_{vn})}{\Phi(Z'\alpha)}
\end{aligned} \tag{13}$$

The reduction in the dimensionality of the normal integrals implied by the last equality in (13) does not generally extend to more complicated choices of interest, e.g. to the probability of

owning stocks in mutual funds conditional on owning stocks in any form, which is equal to

$$\begin{aligned}
P(MS = 1 / AS = 1) &= \frac{P(MS = 1, AS = 1)}{P(AS = 1)} = \frac{P(MS = 1)}{P(AS = 1)} = \frac{P(MS = 1, M = 1)}{P(AS = 1)} = \\
&= \frac{\sum_{DS=0}^1 \sum_{R=0}^1 \sum_{\substack{RS=0 \\ R \geq RS}}^1 P(DS, 1, 1, R, RS)}{\sum_{DS=0}^1 \sum_{M=0}^1 \sum_{\substack{MS=0 \\ M \geq MS \\ DS+MS \\ +RS \geq 1}}^1 \sum_{R=0}^1 \sum_{\substack{RS=0 \\ R \geq RS}}^1 P(DS, M, MS, R, RS)} = \frac{\Phi_2(Z'\alpha, W'\beta, \rho_{vm})}{\sum_{DS=0}^1 \sum_{M=0}^1 \sum_{\substack{MS=0 \\ M \geq MS \\ DS+MS \\ +RS \geq 1}}^1 \sum_{R=0}^1 \sum_{\substack{RS=0 \\ R \geq RS}}^1 P(DS, M, MS, R, RS)} \quad (14)
\end{aligned}$$

where AS denotes investment in stocks in any form, and the summation in the denominator is over all asset combinations in which stocks are held in at least one mode.<sup>15</sup> Marginal effects are computed as the change in the probabilities when there is an appropriately defined change in the value of the regressor.<sup>16</sup> We estimate probabilities and marginal effects and their standard errors via Monte Carlo simulation (Appendix C).

### 3.3. Model Performance

In Table 6, we display predicted participation rates, both conditional and unconditional, generated by estimated probabilities. Our estimates match closely the corresponding participation rates observed in the data, although the model was not calibrated with this objective in mind. This suggests that our model has considerable predictive power for population stockholding choices.

Our model makes it possible to estimate also marginal effects regarding ownership of *any* type of stocks,<sup>17</sup> i.e. the question that existing participation literature normally addresses without differentiating across paths to stockholding. Marginal effects derived from our model are reported in Table 7, column 1, together with the corresponding ones (shown in column 3) from a ‘typical’ participation regression found in the existing literature on stockholding.

It is reassuring, both for the existing literature on stockholding participation and for our model, that estimated marginal effects for overall stockholding are very similar, in sign, size and

patterns of significance. For example, a college degree adds remarkably to the probability of stockholding, about 26 percentage points (pp). Having a high-school certificate rather than not adds about 15 pp. Being white, willing to take substantial risks, and having other than poor health contribute more than 10 pp each, using either our model or the simple participation regression.

The similarity of the results obtained from both models suggests that the standard practice of merging three different stockholding modes is not misleading when overall stockholding participation is of interest. However, our model allows a novel anatomical probe into influences of observables on the different paths to stockholding, the correlations between unobservable influences, the hitherto unexplored link between asset participation and asset location, and the issue of participation spillovers across assets, in the context of a single estimation model consistent both with the data and with existing findings on overall participation.

#### **4. The Different Paths to Stockholding**

Although direct stockholding, stock mutual funds, and stock retirement accounts all expose households to stockholding risk, they vary in their diversification properties, liquidity, and informational requirements on the part of investors. Given these differences, it is quite plausible that specific household characteristics will have differential contributions to participation across stockholding modes

In this section, we employ our model to estimate contributions of various household characteristics to the use of each possible stockholding mode, controlling for other observed factors and allowing for correlations across model nodes induced by unobserved factors. For stockholding through mutual funds and retirement accounts, this consists of two steps: the marginal contribution to opening the account, and that to including stocks in it given ownership of the account. Results are presented in Table 8.

#### **4.1. Direct Stockholding**

The first column presents marginal effects for direct stockownership. We observe that overall educational attainment and financial sophistication play a major role in the choice of this stockholding mode. The single most important contribution comes from having a college degree, which raises participation probability by more than 17 pp over that of a high school dropout.<sup>18</sup> This result is likely linked to lower entry and participation costs that result from greater knowledge of how the market works and ability to analyze new information.

Participation in direct stockholding is further increased by about 4 pp if a household member works in the financial sector. This finding likely arises partly from financial knowledge and information that this member brings home and partly from bonuses and payments in stocks.

Consistent with findings of Bogan (2008), use of the Internet makes a strong contribution of about 7 pp. This effect is likely to reflect the easier access to investment information and cheaper portfolio management available to Internet users, and it is net of education and financial information acquired through employment in the financial sector. Asking friends or relatives for investment advice does not affect the probability of direct stockholding. At first glance this result seems to contradict the findings of Hong, Kubik and Stein (2004) on social interactions. However, it is consistent with their conjecture that social interactions may not influence or may even hurt participation in assets not widely held, as is the case with directly held stocks; a random prospective investor would have about one chance in five to find direct stockholders in her social circle.<sup>19</sup>

Household attitudes, motives, and practices also have important effects, even after controlling for education, information and resources. The second largest marginal contribution to direct stockholding comes from willingness to undertake substantial financial risk (almost 9 pp).

Having a long investment horizon (more than 10 years) also contributes to direct stockholding by 2.6 pp.

Poor health has a sizeable negative contribution to direct stockholding of roughly 5 pp, which is consistent with existing findings (Rosen and Wu, 2004) and with the view that direct stockholding imposes considerable demands on investing households.

Household (taxable) resources play an important role in the decision to hold stocks directly. The semi-elasticity of real wealth is 2 pp while that of net financial wealth (directly held stocks excluded)<sup>20</sup> is .4 pp. Background income risk associated with working in a high-risk sector also lowers the chances of direct stockholding. Interestingly, the experience of binding borrowing constraints (or concern about being turned down) does not deter direct stockholding.

Finally, the estimated effect of the federal marginal tax rate is positive.<sup>21</sup> Given that we are controlling for resources, a higher marginal tax rate means that the household is able to take fewer income tax deductions, but this does not discourage it from taxable direct stockholding. The more favorable tax treatment of dividends, the fact that capital gains are taxed only at realization, and the possibility of foregoing capital gains tax if stocks are passed on to descendants ('step up of basis') apparently combine to encourage direct stockholding among households facing higher marginal tax rates. The importance of such considerations is corroborated by estimated marginal effects of variables more directly linked to bequest motives: having received inheritance and planning to leave a bequest contribute about 4.6 and 6.4 pp respectively.

#### **4.2. Stockholding through Mutual Funds**

Unlike direct stockholding, mutual funds are typically managed by professionals and are well-diversified. These features often lead to the presumption that mutual funds investments are

open to all households because they do not require considerable financial sophistication and information gathering. Our findings are not consistent with this view, as can be seen in column 3 of Table 8. Educational attainment makes a considerable contribution to participation in mutual funds, with estimated marginal effects of a college degree at least as large as those for direct stockholding. Internet use and having worked in the financial sector continue to play an important role, albeit somewhat smaller than for direct stockholding.

These findings are consistent with the view that the proliferation of mutual funds has reintroduced informational requirements from the back door: households now face a need to collect information on how to choose among the huge variety of mutual funds and on how to monitor those who run them.<sup>22</sup> More educated households are more likely to understand and appreciate their advantages including risk diversification, and may be more heavily targeted by marketing campaigns of mutual funds. Even if mutual funds do not require as much information gathering as direct stockholding does, the effects of the Internet and working in the financial sector are still important. Social interactions have no statistically significant effect. This is consistent with our findings for direct stockholding and the fact that mutual funds are not widely held.

Household investment attitudes and practices clearly induce investment in mutual funds. A long investment horizon matters a lot, as mutual funds that are professionally managed are suited for households that adopt a ‘buy and hold’ strategy for the longer run. The estimated effect is larger than that for direct stockholding. The choice to participate in mutual funds is also heavily influenced by expressed willingness to undertake substantial financial risk (6.5 pp). Interestingly, race is highly significant and quantitatively important in the mutual fund industry. A standard conjecture for interpreting such findings on race in the stock market participation literature is that

the financial services industry targets minorities less for its advertising. It should be recognized, however, that there is no direct evidence to substantiate this conjecture.

Column 5 in Table 8 reports marginal effects for the choice to hold stock mutual funds, given that the household owns any mutual funds at all. Interestingly, the only factor among those mentioned above that matters for this conditional choice of stockholding mode is willingness to assume financial risk. These results suggest that opening a mutual fund account represents the major participation threshold. Once it is crossed, education, financial sophistication, resources, race, and most financial attitudes are not relevant for the choice to invest in a stock mutual fund. This is a new result made possible by the design of our model.<sup>23</sup>

#### **4.3 Stockholding in Retirement Accounts**

Marginal effects for ownership of retirement account are shown in column 7 of Table 8. It is striking that education has a sizeable role to play in retirement account ownership, even after controlling for other household characteristics and attitudes. The estimated size of the marginal effect of a college degree is just less than 23 pp compared to a household where the financial decision maker is a high-school dropout, but even that of a high-school certificate is about 14 pp. It is also notable that being white increases the probability of participation in retirement accounts by 9 pp and that declaring poor health reduces it by 12 pp. These findings suggest that there are significant obstacles to opening retirement accounts that could in principle be alleviated by the financial industry itself, through more efficient and widespread advertising of this instrument, or by governments through more effective campaigns and specially designed ‘default options’.

Declared willingness to undertake significant risks for substantial returns contributes 9 pp to the probability of participation, an estimate greater than that for mutual funds and comparable to the risky option of direct stockholding. This finding suggests that the public perception



regarding retirement accounts is still that of a quite risky instrument. The effect of having a long investment horizon is indeed greater in size than those for the more liquid instruments of direct stockholding and mutual funds. Not surprisingly, having received a bequest, and expecting to leave a bequest all contribute significantly to owning a retirement account.

A difference from direct stockholding and mutual funds is found in the effect of social interactions, which is now positive and significant (at the 10% level). Given that the majority of households own retirement accounts, this positive effect is another indication that social interactions contribute to participation when asset ownership is widespread.

Richer households and those in a higher federal marginal tax bracket are substantially more likely to participate in retirement accounts. The latter is now partly due to gains such households could reap from tax deferrals. Being credit constrained reduces significantly the probability of investing in a retirement account. Given that we control for economic resources, this result is not simply due to being 'poorer'. Perceived inability to borrow probably discourages participation in plans that imply payment commitments over a prolonged period of time, for fear of being unable to meet them every period.

Interestingly, the conditional choice to include stocks in a retirement account deciding to invest in one is sensitive to a set of household characteristics very similar to those contributing to direct stockholding. As can be seen in column 9 of Table 8, stockholding through retirement accounts is fostered by being married, being more educated, being white, more willing to undertake risk, having a long investment horizon, using the Internet, having greater net real wealth, and declaring an intention to leave a bequest. It is also encouraged by social interactions, strengthening their role found in the participation equation.

The contrast with stocks in mutual funds is quite striking. While there are hardly any characteristics favoring the placement of stocks in mutual funds once such funds have been

opened, there is a distinct second participation hurdle to be overcome for including stocks in the retirement account, once households have opened such an account.

#### **4.4 Correlations between Unobserved Factors**

As already discussed, a key feature of our econometric model is that it allows estimation of correlations in participation decisions induced by unobserved factors. The bottom panel of Table 8 reports the matrix of estimates of these correlations. There is positive and significant correlation between unobserved factors influencing participation in mutual funds and stock investment in mutual funds. Thus, the sample of stock mutual fund investors is a selected one. We also find some evidence of selectivity (with a p-value of 0.075) in the equations for owning retirement accounts and stock investment in those accounts. The presence of selectivity in indirect stockholding choices makes it important that empirical specifications allow for it, so that inconsistent estimates can be avoided. Our choice to allow for possible correlations across other nodes, as well, is also supported by estimates of such correlations.<sup>24</sup> When we test for the joint significance of all the cross-equation correlations, we find that we can decisively reject the null of no significance (details can be found in Appendix B). This result is another indication that these correlations need to be taken into account when modeling household stockholding.

#### **5. Asset Location: What Influences where Stockholders Keep their Stocks?**

We now turn to the asset location issue, namely, to the factors that contribute to each of the three possible stockholding choices, conditional on the household holding any stocks (i.e. conditional on being in at least one of the three nodes involving stocks).<sup>25</sup> In terms of descriptive statistics, Table 3 shows the fractions of stockholders choosing each possible combination of stockholding modes, and allows us to see the most popular placement options. By adding the

relevant percentages in the last column, it can be seen that almost three quarters of stockholders hold combinations that include stocks in retirement accounts, about 40% hold combinations that entail direct stockholding, while about 30% place stocks in mutual funds.

Table 9 reports estimated marginal effects for all three stockholding modes, conditional on holding stocks in any form. Single males tend to locate their investments in stocks held directly, while their female counterparts in stock mutual funds. Financial sophistication, as captured by educational attainment, use of the Internet for financial information, and working or having worked in the financial sector, makes no contribution to the choice of stock retirement accounts among those who have mastered what is needed to acquire stocks in any form. By contrast, education and Internet contribute to the other two choices. Work in the financial sector induces direct stockholding only, possibly because such investment is the most information-intensive. On the other hand, social interactions induce stockholding only through retirement accounts that represent the most widely held mode.

Willingness to undertake substantial risk makes a greater contribution to direct stockholding than to the other two modes, while a long investment horizon favors indirect holdings. Race continues to matter even among stockholders: minority households exhibit on average lower probabilities of using the first two modes (by about 6 pp), and by about half of this for putting stocks in retirement accounts.

The pattern of marginal effects for direct stockholding is quite similar, whether they refer to participation or to asset location (as shown in Table 8, column 1 and Table 9, column 1). This implies that whether we draw from the general population or we condition on the household being a stockholder does not make a significant difference with respect to the hurdle the household needs to pass in order to hold stocks directly. Intuitively, given that most stockholders own stocks in retirement accounts, conditioning on stock ownership essentially picks out stock

retirement account owners. Our results, therefore, suggest that participation in stock retirement accounts does not particularly simplify the task of holding stocks directly.

As already discussed, passing the threshold for mutual fund ownership is very important for participation in stock mutual funds; household characteristics make a limited contribution to owning stock mutual funds, when the conditioning event is ownership of mutual funds. By contrast, the strong marginal effects for stock mutual fund ownership shown in col. 3 of Table 9 are due to the much weaker conditioning event of owning stocks in any form. Only about 36% of stockholders in our sample have also passed the participation threshold for mutual funds; therefore, there is considerable remaining room for characteristics to induce stock mutual fund ownership.

Finally, it is quite striking that we find a number of significant marginal effects for placing stocks in retirement accounts when conditioning on any stockholding, even though 80% of stockholders own stock retirement accounts. Obviously these effects regard the remaining 20%, who consider extending stockholding from taxable liquid accounts to the tax-deferred and less liquid retirement accounts. Our results imply that such an extension is significantly encouraged by characteristics like occupation (being an employee and not working in a high-risk sector), attitudes (expressing willingness to take above average financial risk, having a long investment horizon), race, and being subject to a higher marginal tax rate.

## **6. Asset Participation Spillovers**

In this Section, we explore the implications of having passed the ownership threshold of retirement accounts for each stockholding mode: direct, through mutual funds, and through retirement accounts. Table 6 reports observed participation rates and corresponding predictions of our model. Proportions of stockholders in any form are higher among retirement account owners

than in the general population. Among such owners, 75% own stocks in their retirement accounts, 30% own stocks directly, and 23% own stocks in mutual funds. The corresponding proportions in the general population are much lower: 38%, 19%, and 14%. As discussed above, our model matches quite well all conditional and unconditional participation rates observed in the data.

Based on these numbers, owning a retirement account implies higher probabilities of owning stocks in any form. Is this because the process of opening and maintaining a retirement account facilitates stock ownership, e.g. by familiarizing households with asset holding, investment opportunities, managed funds, etc? Or is it because households who have retirement accounts have characteristics and attitudes more conducive to stockholding anyway?

Table 4, which describes the various samples, shows that, relative to the general population, owners of retirement accounts are more likely to have a college degree, to be willing to assume above average financial risk, to have received inheritance and consider leaving a bequest, to have an investment horizon longer than 10 years, to be richer in income and wealth, to use the Internet to obtain financial information; and less likely to be liquidity constrained. In other words, summary statistics suggest that owners of retirement accounts are more likely to have characteristics that facilitate stockholding.

Is there anything beyond this? If the process of acquiring and owning a retirement account itself significantly facilitates stockholding either directly or through stock mutual funds, we would expect household characteristics and attitudes to make less of a difference to stockholding through these modes once we condition on having retirement accounts.<sup>26</sup> For example, having a college degree or using the Internet should make less of a difference to whether retirement account owners (rather than the general population) participate in directly held stocks or stock mutual funds. Technically, marginal effects on participation in these other forms of stockholding,

conditional on retirement account ownership, should be insignificant or much smaller than the unconditional ones which refer to an investor picked randomly from the whole population.

Conditional marginal effects are presented in Table 10, column 1 for directly held stocks and in column 3 for stock mutual funds. For comparison, column 1 in Table 8, and column 5 in Table 10 report the corresponding unconditional marginal effects. We observe that conditioning on participation in retirement accounts does not change the sign or significance of contributions of household characteristics, attitudes, and practices to participation in direct stockholding and in stock mutual funds; and, if anything, it increases the estimated size of such contributions, including those linked to financial awareness and sophistication. Having a college degree or more, using the Internet to obtain financial information, and working or having worked in the financial sector are estimated to contribute *more* to participation in directly held stocks or in stock mutual funds when conditioning on participation in retirement accounts. The above findings challenge the hypothesis that the participation process for retirement accounts provides sufficient information and awareness to facilitate other forms of stockholding.

All in all, our findings imply that retirement account owners represent a pool more likely to invest in other forms of stockholding than the general population, but this is mainly because of characteristics that led them to buy retirement accounts in the first place rather than of any informational advantages gained through retirement account ownership itself.

## **7. Concluding Remarks**

We have estimated an econometric model flexible enough to address in an integrated framework the interrelated issues of stock market participation, stock location, and participation spillovers. The model distinguishes between different stockholding modes and allows for

differential impact of household characteristics on participation in each of them and for correlations of unobservables across all asset choices.

Distinguishing stockholding modes is economically justified, in view of their differences in terms of riskiness, liquidity, diversification and management requirements. Importantly, making such a distinction and allowing for correlated choices are also supported by our econometric findings; predicted participation rates closely match the observed ones and correlations among unobservables are typically economically and statistically significant. While the model offers a number of insights into differences and correlations across modes, its results are consistent with existing studies when it is put to the simpler task of estimating overall stock market participation.

Our findings stress the importance of educational attainment and financial information (acquired through the Internet or by working in the financial sector), even for assets held in managed accounts. Still, we find a striking difference between stock mutual funds and stocks in retirement accounts. The probability that any mutual fund owner holds stock mutual funds is basically the same regardless of characteristics. In contrast, stock retirement accounts tend to be chosen by retirement account owners with characteristics similar to those favoring direct stockholding in the general population. This is despite the likely greater degree of diversification in stock retirement accounts compared to individual stocks.

On the issue of asset location, we find that household characteristics continue to matter for the choice of stockholding mode even among stock owners. The contribution of characteristics like education, willingness to assume higher risks, and information gained through the Internet to direct stockholding remains essentially the same, whether this choice is made by a stockholder or by a randomly picked person in the general population. There are also strong effects of these characteristics for stock mutual fund ownership conditional on owning stocks of any type. Investment attitudes, like willingness to assume higher risks and a longer investment horizon,

matter for locating stocks in retirement accounts when conditioning on stockholding, despite the fact that 80% of stockholders own stock retirement accounts.

Last but not least, the multivariate structure of our model also allows examination of participation spillovers. Our study confirms that retirement account owners represent a pool more likely to invest in other forms of stockholding than the general population. However, our findings imply that this propensity is mainly due to the characteristics that led them to own retirement accounts in the first place rather than of any informational or other advantages gained through retirement account ownership itself.

Our results have implications both for policy and for financial practice. First, the significant role that financial sophistication and information have in facilitating investment in all three stockholding modes,<sup>27</sup> as well as in influencing stock location and the extent of participation spillovers from retirement accounts to stocks held directly and through mutual funds, can provide further support to programs that promote household financial literacy (see e.g. Lusardi, forthcoming). Second, while owning retirement accounts makes stock ownership in all three modes more likely, the spread of retirement accounts does not guarantee investment in stocks, either within retirement accounts or outside them. For example, the less educated, less wealthy, more risk averse and those with shorter planning horizons are less likely to overcome the additional hurdle for stock ownership in any of the three modes, even if they own a retirement account. Appropriate use of default options in occupational retirement plans could steer households towards or away from stockholding, according to policy objectives. Finally, our findings on characteristics conducive to participation in certain assets, could be of use to financial practitioners interested in understanding how people decide to invest in a particular financial product, either independently of or, crucially, in conjunction with other such products.



## References

- Alessie R., S. Hochguertel, A. van Soest. 2004. "Ownership of Stocks and Mutual Funds: a Panel Data Analysis". *The Review of Economics and Statistics*, 86, pp. 783-796.
- Ameriks, J. and S. Zeldes, 2004. "How Do Household Portfolio Shares Vary with Age?". TIAA-CREF Working Paper.
- Barber, B. and T. Odean, 2001. "Boys will be Boys: Gender, Overconfidence, and Common Stock Investment". *Quarterly Journal of Economics*, 116(1), pp. 261-292.
- Bertaut, C. and M. Starr-McCluer, 2001. "Household Portfolios in the United States". In *Household Portfolios*, L. Guiso, M. Haliassos, T. Jappelli (eds.). Cambridge: MIT Press.
- Biliias Y., D. Georgarakos, and M. Haliassos, 2008. "Portfolio Inertia and Stock Market Fluctuations". Working paper, Goethe University Frankfurt.
- Bergstresser, D. and J. Poterba, 2004. "Asset Allocation and Asset Location: Household Evidence from the Survey of Consumer Finances". *Journal of Public Economics*, 88(9-10), pp. 1893-1915.
- Bogan, V., 2008. "Stock Market Participation and the Internet". *Journal of Financial and Quantitative Analysis*, 43(1), pp. 191-212.
- Campbell, J., 2006. "Household Finance", *Journal of Finance*, 61, pp. 1553-1604.
- Campbell, J. and L. Viceira, 2002. *Strategic Asset Allocation: Portfolio Choice for Long-term Investors*, Oxford: Oxford University Press.
- Cappellari, L. and S.P. Jenkins, 2006. "Calculation of Multivariate Normal Probabilities by Simulation, with Applications to Maximum Simulated Likelihood Estimation". *The Stata Journal*, 6(2), pp. 156-189.
- Carroll, C.D. and Andrew A. Samwick, 1997. "The Nature of Precautionary Wealth", *Journal of Monetary Economics*, 40(1), pp. 41-71.
- Christelis, D., T. Jappelli, and M. Padula, 2006. "Cognitive Abilities and Portfolio Choice". CSEF Working Paper No. 157.
- Christelis, D. and D. Georgarakos, 2008. "Investing at Home and Abroad: Different Costs, Different People?". Available at SSRN: <http://ssrn.com/abstract=1086040>
- Cocco, J., F. Gomes and P. Maenhout, 2005. "Consumption and portfolio choice over the life-cycle". *Review of Financial Studies*, 18, pp. 491-533.
- Gao, C., K. Lahiri and B. Wixon, 2001. "Value of Sample Separation Information in a Sequential Probit Model: Another Look at SSA's Disability Determination Process". Mimeo, University of Albany-SUNY.

- Garlappi, L. and J. Huang. 2006. "Are Stocks Desirable in Tax-Deferred Accounts?". *Journal of Public Economics*, 90, pp. 2257-2283.
- Geweke, J., 1989. "Bayesian Inference in Econometric Models using Monte Carlo Integration". *Econometrica*, 57, pp. 1317-1339.
- Gollier, C., 2001. *The Economics of Risk and Time*. Cambridge: MIT Press.
- Gomes, F. and A. Michaelides, 2005. "Optimal Life-Cycle Asset Allocation: Understanding the Empirical Evidence". *Journal of Finance*, LX, pp. 869-904.
- Greene, W., 1998. "Sample selection in credit-scoring models". *Japan and the World Economy*, 10, pp. 299-316.
- Greene, W., 2007. "Censored data and truncated distributions." In *The Palgrave Handbook of Econometrics Volume 1: Econometric Theory*, T.C. Mills. and C. Patterson, (eds.), pp. 695-736. Palgrave Macmillan.
- Guiso L., M. Haliassos, and T. Jappelli (eds.), 2001. *Household Portfolios*. Cambridge: MIT Press.
- Guiso, L., M. Haliassos, and T. Jappelli, 2003. "Household Stockholding in Europe: Where Do We Stand, Where Do We Go?". *Economic Policy*, pp. 117-164.
- Guiso, L. and T. Jappelli, 2005. "Awareness and stock market participation", *Review of Finance*, 9, 537-567.
- Guiso, L., P. Sapienza, and L. Zingales, 2008. "Trusting the Stock Market". *Journal of Finance*, 63(6), pp. 2557-2600.
- Haliassos, M. and C. Bertaut, 1995. "Why Do So Few Hold Stocks?" *The Economic Journal*, 105, pp. 1110-1129.
- Haliassos, M. and A. Michaelides, 2003. "Portfolio Choice and Liquidity Constraints". *International Economic Review*, 44, pp. 143-178.
- Heaton, J. and D. Lucas, 2000. "Portfolio Choice in the Presence of Background Risk". *The Economic Journal*, 110, pp. 1-26.
- Hong, H., J. Kubik, and J. Stein, 2004. "Social Interaction and Stock Market Participation". *Journal of Finance*, 59, pp. 137-163.
- Investment Company Institute and Securities Industry Association, 2005. "Equity Ownership in America", published report.

- Jenkins, S.P., L. Capellari, P. Lynn, A. Jäckel, and E. Sala 2006. "Patterns of Consent: Evidence from a General Household Survey". *Journal of the Royal Statistical Society A*, 169, Part 4, pp. 701-722.
- Karlsson, A., M. Massa, and A. Simonov, 2007. "Stock Market Participation and Pension Reform", in O.S. Mitchell, B.J. Soldo and B. Madrian (Eds.), *Transitioning to Retirement: How Will Boomers Fare?* Oxford: Oxford University Press.
- Keane, M., 1994. "A computationally practical simulation estimator for panel data". *Econometrica*, 62, pp. 95–116.
- Kennickell, A.B., 2000. "Wealth Measurement in the Survey of Consumer Finances: Methodology and Directions for Future Research".  
<http://www.federalreserve.gov/pub/oss/oss2/method.html>.
- Li, K. H., T. E. Raghunathan, and D. B. Rubin, 1991. "Large Sample Significance Levels from Multiply Imputed Data using Moment-Based Statistics and an F Reference Distribution". *Journal of the American Statistical Association*, 86, pp. 1065-1073.
- Lusardi, A., 2008. "Household Saving Behavior: The Role of Financial Literacy, Information and Financial Education Programs," *Implications of Behavioral Economics for Economic Policy*. Forthcoming.
- Moore, K., 2003. "The Effects of the 1986 and 1993 Tax Reforms on Self-Employment." Mimeo, Finance and Economics Discussion Series 2004-05, Board of Governors of the Federal Reserve System.
- Rosen, H. and S. Wu, 2004. "Portfolio Choice and Health Status", *Journal of Financial Economics*, 72(3), pp. 457-484.
- Rubin, D.B., 1987. *Multiple Imputation for Nonresponse in Surveys*. New York: John Wiley.
- Schmidt, P., 1981, "Further results on the value of sample separation information". *Econometrica*, 49(5), pp. 1339-1343.
- Train, K., 2003. *Discrete Choice Methods with Simulation*. Cambridge: Cambridge University Press.
- Van de Ven, W.P.M.M. and B.M.S.Van Praag, 1981. "The Demand for Deductibles in Private Health Insurance: a Probit Model with Sample Selection". *Journal of Econometrics*, 17, pp. 229–252.
- Van Rooij, M., R. Alessie, and A. Lusardi, 2006. "Financial Literacy and Stock Market Participation". MRRC Working Paper No. 2007-162.
- Viceira, L., 2001. "Optimal Portfolio Choice for Long-Horizon Investors with Nontradable Labor Income", *Journal of Finance*, 56, pp. 433-470.

## **Appendix A: Description of Assets and Variables**

### **I. Asset Categories (Table 1)**

#### **Directly held stocks: [1]**

[1] publicly traded stocks

#### **Mutual funds: [2] + [3] + [4] + [5] + [6] + [7]**

[2] money market mutual funds (money market accounts used for checking and other money market account held at institutions other than commercial banks, savings and loans, savings banks, and credit unions)

[3] tax-free bond mutual funds

[4] government bond mutual funds

[5] other bond mutual funds

[6] stock mutual funds

[7] combination and other mutual funds

#### **Stocks in mutual funds: [6] + $\frac{1}{2}$ \* [7]**

#### **Retirement accounts: [8] + [9] + [10] + [11]**

[8] quasi-liquid retirement accounts (IRAs and thrift-type accounts) individual retirement accounts/Keoghs

[9] account-type pension plans (included if type is 401k, 403b, thrift, savings, SRA, or if participant has option to borrow or withdraw)

[10] other managed assets (trusts, annuities and managed investment accounts in which household has equity interest)

[11] future pensions (accumulated in an account)

#### **Stocks in retirement accounts: [12] + [13] + [14]**

[12] IRAs/Keoghs invested in stock (full value if mostly invested in stock,

1/2 value if split between stocks/bonds or stocks/money market,

1/3 value if split between stocks/bonds/money market).

[13] thrift-type retirement accounts invested in stock (full value if mostly invested in stock, 1/2 value if split between stocks and interest earning assets)

[14] Other managed assets w/equity interest: annuities, trusts, MIAs (full value if mostly invested in stock, 1/2 value if split between stocks/MFs & bonds/CDs, or "mixed/diversified", 1/3 value if "other")

## **II. Definitions of Variables**

### **IIA. Economic Variables**

**Net Financial Wealth:** Total Financial Assets – Other lines of credit - Credit Card Debt - Installment loans - Other Debt (loans against pensions, loans against life insurance, margin loans, miscellaneous)

**Net Real Wealth:** [1] + [2] + [3] + [4] + [5] - [6] - [7] - [8]

[1] Wealth in Primary Residence: Gross value of primary residence

[2] Other Residential Real Estate (includes land contracts/notes household has made, properties - other than the principal residence - classified under certain codes for family residences, time shares and vacations homes)

[3] Gross equity in Non-residential Real Estate (real estate - other than the principal residence, properties classified under certain codes for family residences, time shares, and vacation homes)

[4] Business Equity (for businesses where the HH has an active interest, value is net equity if business were sold today, plus loans from HH to business, minus loans from business to HH not previously reported, plus value of personal assets used as collateral for business loans that were

reported earlier; for businesses where the HH does not have an active interest, market value of the interest)

[5] Other Wealth: value of vehicles plus other non-financial miscellaneous assets

[6] Principal Residence Debt (mortgage, home equity loans and HELOCs --mopup LOCs divided between HE and other)

[7] Debt for Other Residential Property (includes land contracts, residential property other than the principal residence, misc. vacation, and installment debt reported for cottage/vacation home)

[8] Debt for non-residential real estate mortgages and other loans taken out for investment real estate

**Income:** income from wages, salaries, professional practice or business unemployment compensation, social security, annuity, or other pensions.

All monetary values have been deflated using the CPI-U-Research Series index and are expressed in 2004 prices.

## **IIB. Household Attributes**

**No high school diploma** (omitted variable): Highest grade completed (X5901)<12 & No high school diploma or passed equivalent test (X5902=5)

**High school graduate:** Highest grade completed (X5901)<12 & Has got high school diploma (X5902=1) or passed equivalent test (X5902=2) OR Highest grade completed (X5901)=12 OR Highest grade completed (X5901)>12 & No college degree (X5904=5)

**College graduate:** Highest grade completed (X5901)>12 & Has got a college degree (X5904)=1

**Credit constrained:** Indicates household response that it has been turned down for credit in the past five years or did not receive amount originally requested or did not apply for credit because it thought it might be turned down.

**Willingness to take above average financial risk:** The survey question is “Which of the following statements comes closest to the amount of financial risk that you and your (spouse/partner) are willing to take when you save or make investments?”

1. take substantial financial risks expecting to earn substantial returns
2. take above average financial risks expecting to earn above average returns
3. take average financial risks expecting to earn average returns
4. not willing to take any financial risks”

The dummy represents those answering 1 or 2. (X3014=1 or X3014=2).

**Investment Horizon>10 years:** The dummy represents those declaring that a period longer than 10 years is important when making their family’s saving and spending plan (X3008)

**Health poor:** The survey question is “Would you say your health is excellent, good, fair, or poor?” Those describing their health as being poor are represented by the dummy (X6030=4).

**Bequest motive:** Yes to “Do you expect to leave a sizable estate to others?” (X5825=1).

**Has received inheritance:** Yes to “Have you ever received an inheritance, or been given substantial assets in a trust or in some other form?” (X5801=1).

**Asks Friends, Relatives, Work contacts for financial information / Uses Internet to obtain financial information:** when answering “7.Friend/Relative or 18.Material from work/business contacts” / “5.online service/internet” to the following question: “How do you make decisions about savings and investments?”

**Household work(s/ed) in the financial industry:** The dummy represents households in which any member of the couple works in the "Finance, Insurance & Real Estate" or "Business & Repair Services" sectors (x7402, x7412). The same applies to those who currently work full or part time in a different sector or they do not work (unemployed, inactive or retired) and they used to work in the past in one of these two sectors (x7406, x7416 / x7408, x7418 / x7410, x7420).

**Works in high-risk industry sector:** Head works in one of the following industry sectors (x7402): Agriculture, Forestry, Fishing, Mining & Construction

### **IIC. Federal marginal tax rate**

Household federal marginal income tax rates are computed by using the programs created by Moore (2003), which generate taxable income items from SCF data. The programs' output is then input to the NBER TAXSIM federal income tax model which produces the appropriate tax rate. To avoid endogeneity of the tax rate, we follow Alessie, Hochguertel and van Soest (2004) in replacing each household's dividend income from direct and indirect stockholding (x5708, x5710, x5712) with the average household dividend income computed from the relevant SCF wave.

### **Appendix B: Tests of Correlations Across Disturbances**

We use the F-test suggested by Li, Raghunathan and Rubin (1991) to account for the uncertainty induced by multiple imputation. We first perform the test by including all correlation coefficients except two, namely the correlations  $\rho_{vn}$  and  $\rho_{ee}$  of the errors that reflect selection within the two saving vehicles of mutual funds and retirement accounts. The value of the F-statistics is equal to 51.8 (p-value: 0), which strongly rejects the null hypothesis of zero correlation of the errors across the three saving vehicles (direct stocks, mutual funds and



retirement accounts) and the two second stage equations. When we add the correlation of the errors within the two saving vehicles of mutual funds and retirement accounts the F-statistic is equal to 43.4 (p-value: 0), again strongly rejecting the null. Thus, we cannot ignore the correlations of the unobserved factors across equations when computing the probabilities of asset choices of interest.

### **Appendix C: Estimates and Standard Errors of Probabilities and Marginal Effects**

Given that probabilities and marginal effects are non-linear functions of the estimated coefficients, we calculate them by simulation. We proceed as follows:

- i) We draw from the distribution of the maximum likelihood coefficients assuming that they are distributed normally with means and variance-covariance matrix equal to the maximum likelihood estimates.
- ii) For a given parameter draw we compute the probabilities and marginal effects for each household and then we take the weighted average of those magnitudes across households, i.e., we compute the average magnitude corresponding to that draw.<sup>28</sup>
- iii) The final estimate of the magnitude of interest and its standard error are then computed as the mean and standard deviation respectively of the distribution of the average magnitudes in ii) across all parameter draws.

**Table 1: Ownership Rates**

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<b>Year</b>	<b>Stocks Directly</b>	<b>Mutual Funds</b>	<b>Stocks in Mutual Funds [among Mutual Fund Owners]</b>	<b>Retirement Accounts</b>	<b>Stocks in Retirement Accounts [among Retirement Account Owners]</b>
<b>1995</b>	15.2	15.3	11.3 <i>[74.1]</i>	46.5	30.3 <i>[65.2]</i>
<b>1998</b>	19.2	19.5	15.2 <i>[78.0]</i>	50.8	39.2 <i>[77.0]</i>
<b>2001</b>	21.3	21.1	16.7 <i>[79.0]</i>	54	43.4 <i>[80.5]</i>
<b>2004</b>	20.7	17.9	14.3 <i>[79.9]</i>	52.1	39.6 <i>[76.0]</i>

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**Notes:** Data from the 1995, 1998, 2001 and 2004 waves of the SCF. The reported statistics are weighted and corrected for multiple imputation. Asset definitions are provided in the Appendix.

**Table 2: Stock Ownership Rates among Stocks Owners**

<b>Year</b>	<b>Stocks Directly</b>	<b>Stocks in Mutual Funds</b>	<b>Stocks in Retirement Accounts</b>
<b>1995</b>	37.7	28.0	75.0
<b>1998</b>	39.3	31.1	80.1
<b>2001</b>	41.0	32.1	83.6
<b>2004</b>	42.5	29.4	81.5

**Notes:** Data from the 1995, 1998, 2001 and 2004 waves of the SCF. The reported statistics are weighted and corrected for multiple imputation. Asset definitions are provided in the Appendix.

**Table 3: Combinations of Stock Investments Held by Stock Owners**

<b>Directly Held Stocks</b>	<b>Stocks in Mutual Funds</b>	<b>Stocks in Retirement Accounts</b>	<b>Proportion owning the Combination</b>
Yes	No	No	10
No	Yes	No	6.4
No	No	Yes	43.3
Yes	Yes	No	3.2
No	Yes	Yes	9.9
Yes	No	Yes	16.5
Yes	Yes	Yes	10.7

**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. The reported statistics are weighted and corrected for multiple imputation. Asset definitions are provided in the Appendix.

**Table 4: Household Characteristics by Asset Choice**

Variable	Whole sample	Owens stocks directly	Owens mutual funds	Has stocks in mutual funds	Owens retirement accounts	Has stocks in retirement accounts
Age (mean)	48.9	51.3	51.9	51.2	48.2	46.7
Couple	0.588	0.722	0.703	0.716	0.698	0.715
Single male	0.140	0.124	0.110	0.110	0.114	0.117
Has children	0.435	0.409	0.393	0.404	0.467	0.483
High school graduate	0.509	0.380	0.359	0.362	0.469	0.447
College degree or more	0.337	0.583	0.612	0.611	0.472	0.507
Self-employed	0.113	0.160	0.169	0.164	0.124	0.124
Retired	0.240	0.227	0.234	0.224	0.157	0.116
Unemployed/Inactive	0.051	0.025	0.025	0.024	0.022	0.018
White	0.762	0.897	0.910	0.908	0.841	0.851
Poor health	0.061	0.024	0.018	0.016	0.022	0.016
Willingness to take above average financial risk	0.205	0.365	0.359	0.375	0.288	0.334
Investment horizon > 10 yrs	0.143	0.214	0.245	0.252	0.196	0.217
Plans to leave a bequest	0.293	0.431	0.444	0.445	0.356	0.369
Has received inheritance	0.199	0.320	0.339	0.345	0.246	0.245
Credit constrained	0.224	0.124	0.085	0.089	0.167	0.166
Works/ed in the Financial Sector	0.204	0.289	0.280	0.280	0.251	0.267
Federal marginal tax rate (mean)	0.173	0.232	0.230	0.232	0.220	0.229
Asks Friends/Relatives/Work contacts for financial information	0.360	0.366	0.346	0.350	0.374	0.391
Uses Internet to obtain financial information	0.111	0.205	0.183	0.189	0.155	0.179
Works in high-risk industry sector	0.091	0.053	0.061	0.065	0.083	0.076
Non-investment income (median)	37,787.7	66,566.1	65,449.0	67,280.7	58,985.4	63,871.5
Net real wealth (median)	57,967.9	157,766.8	161,654.3	162,894.3	99,271.3	101,289.2
Net financial wealth (median)	9,943.3	146,726.3	168,318.1	176,365.1	61,122.7	68,987.8

**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. The reported statistics are weighted and corrected for multiple imputation. Asset definitions are provided in the Appendix.

**Table 5: Model Specification**

<b>Egn.</b>	<b>Outcome</b>	<b>Latent propensities</b>	<b>Observed binary outcomes</b>
For each respondent $i = 1, \dots, N$ :			
(1)	Owens stocks directly	$DS_i^* = X_i'\theta + u_i$	$DS_i = I(DS_i^* > 0)$
(2)	Owens mutual funds	$M_i^* = Z_i'\alpha + v_i$	$M_i = I(M_i^* > 0)$
(3)	Holds stocks in mutual funds	$MS_i^* = W_i'\beta + n_i$	$MS_i = I(MS_i^* > 0)$ if $M_i = 1$ , else unobserved
(4)	Owens retirement accounts	$R_i^* = G_i'\gamma + \varepsilon_i$	$R_i = I(R_i^* > 0)$
(5)	Holds stocks in retirement accounts	$RS_i^* = Y_i'\delta + e_i$	$RS_i = I(RS_i^* > 0)$ if $R_i = 1$ , else unobserved
(6)	Error terms	$(u_i, v_i, n_i, \varepsilon_i, e_i) \sim \Phi_5(0, \Omega)$ , where $\Omega$ is a symmetric matrix with typical element $\rho_{hj} = \rho_{jh}$ for $h, j \in \{u, v, n, \varepsilon, e\}$ and $j \neq h$ , and $\rho_{jj} = 1$ for all $j$ . The errors in each equation are assumed to be orthogonal to the predictors.	

**Notes:**  $I(\cdot)$  is an indicator function equal to one if its argument is true, and zero otherwise.  $\Phi_5(\cdot)$  denotes the five-variate normal distribution function.

**Table 6: Observed and Predicted Participation Rates**

Asset Choice	(1)	(2)	(3)	
	Observed Rate	Predicted Rate		
		Estimate	Std. Error	
<b>Owens stocks directly</b>	0.19	0.21	0.004	***
<b>Owens mutual funds</b>	0.18	0.20	0.005	***
<b>Owens retirement accounts</b>	0.51	0.51	0.005	***
<b>Owens stocks in mutual funds</b>	0.14	0.15	0.005	***
<b>Owens stocks in retirement accounts</b>	0.38	0.39	0.005	***
<b>Owens stocks in mutual funds   owens mutual funds</b>	0.78	0.78	0.020	***
<b>Owens stocks in retirement accounts   owens retirement accounts</b>	0.75	0.76	0.008	***
<b>Owens stocks directly   owens mutual funds</b>	0.45	0.48	0.013	***
<b>Owens stocks directly   owens retirement accounts</b>	0.30	0.33	0.007	***
<b>Owens stocks directly   owens stocks in mutual funds</b>	0.46	0.50	0.013	***
<b>Owens stocks directly   owens stocks in retirement accounts</b>	0.34	0.36	0.009	***
<b>Owens mutual funds   owens stocks directly</b>	0.44	0.44	0.012	***
<b>Owens mutual funds   owens retirement accounts</b>	0.29	0.31	0.007	***
<b>Owens retirement accounts   owens stocks directly</b>	0.81	0.78	0.010	***
<b>Owens retirement accounts   owens mutual funds</b>	0.81	0.80	0.010	***
<b>Owens stocks in mutual funds   owens stocks directly</b>	0.34	0.35	0.013	***
<b>Owens stocks in mutual funds   owens retirement accounts</b>	0.23	0.25	0.009	***
<b>Owens stocks in mutual funds   owens stocks in retirement accounts</b>	0.26	0.27	0.010	***
<b>Owens stocks in retirement accounts   owens stocks directly</b>	0.68	0.65	0.011	***
<b>Owens stocks in retirement accounts   owens stocks in mutual funds</b>	0.68	0.68	0.012	***
<b>Owens stocks in any form</b>	0.48	0.50	0.005	***
<b>Owens stocks directly   owens stocks in any form</b>	0.40	0.43	0.008	***
<b>Owens stocks in mutual funds   owens stocks in any form</b>	0.30	0.31	0.010	***
<b>Owens stocks in retirement accounts   owens stocks in any form</b>	0.80	0.79	0.007	***

**Notes:** All *unconditional* probabilities are average probabilities calculated over the full sample. All *conditional* probabilities are average probabilities calculated over the sub-sample we condition on. SCF pooled data from 1995, 1998, 2001, 2004 using survey weights and correcting for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

**Table 7: Average Marginal Effects on the Probability of Holding Stocks in Any Form, Computed from the Multivariate Probit with Selection and from a Simple Probit Model**

Variable	(1)		(2)		(3)		(4)	
	Multivariate probit with selection				Probit			
	M. Eff.	Std. Error			M. Eff.	Std. Error		
Age	0.002	0.000	***		0.001	0.000	***	
Couple	0.079	0.008	***		0.073	0.010	***	
Single male	-0.003	0.010			-0.010	0.013		
Has children	-0.012	0.006	*		-0.007	0.008		
High school graduate	0.154	0.012	***		0.145	0.012	***	
College degree or more	0.269	0.013	***		0.261	0.013	***	
Self-employed	-0.081	0.007	***		-0.087	0.010	***	
Retired	-0.035	0.010	***		-0.045	0.012	***	
Unemployed/Inactive	-0.089	0.016	***		-0.115	0.018	***	
White	0.113	0.008	***		0.111	0.010	***	
Poor health	-0.119	0.018	***		-0.112	0.019	***	
Willingness to take above average financial risk	0.121	0.006	***		0.136	0.008	***	
Investment horizon > 10 yrs	0.063	0.007	***		0.064	0.010	***	
Asks Friends/Relatives/Work contacts for financial information	0.017	0.006	***		0.030	0.007	***	
Uses Internet to obtain financial information	0.083	0.009	***		0.073	0.011	***	
Non-investment income	0.006	0.002	***		0.007	0.002	***	
Net real wealth	0.019	0.001	***		0.020	0.002	***	
Net financial wealth	0.004	0.000	***		0.004	0.000	***	
Intention to leave a bequest	0.067	0.006	***		0.065	0.008	***	
Has received inheritance	0.051	0.006	***		0.052	0.008	***	
Credit constrained	-0.045	0.008	***		-0.021	0.009	**	
Works/ed in the Financial Sector	0.028	0.006	***		0.039	0.008	***	
Works in high-risk industry sector	-0.065	0.010	***		-0.061	0.012	***	
Federal marginal tax rate	0.024	0.002	***		0.027	0.002	***	
Year 1998	0.053	0.007	***		0.049	0.009	***	
Year 2001	0.065	0.008	***		0.064	0.009	***	
Year 2004	0.057	0.009	***		0.051	0.010	***	

**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. The results for income, net real and non equity financial wealth represent median semi-elasticities, while for the remaining variables average marginal effects. All estimates are weighted and corrected for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.



**Table 8: Average Marginal Effects from Multivariate Probit Model with Selection**

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error
			Mutual Funds		Stocks in Mutual Funds (Conditional)		Retirement Accounts		Stocks in Retirement Accounts (Conditional)	
Age	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.000	-0.002	0.001
Married	0.052	0.008	0.017	0.008	0.039	0.024	0.076	0.010	0.051	0.015
Single male	0.027	0.010	-0.025	0.010	0.021	0.029	-0.029	0.012	0.019	0.020
Has children	-0.011	0.006	-0.007	0.006	0.002	0.014	-0.004	0.008	-0.013	0.011
High school graduate	0.078	0.008	0.084	0.008	0.017	0.044	0.141	0.012	0.061	0.026
College degree or more	0.165	0.010	0.191	0.009	-0.012	0.044	0.228	0.013	0.101	0.027
Self-employed	0.002	0.007	0.009	0.007	-0.024	0.017	-0.118	0.010	-0.084	0.014
Retired	0.036	0.010	0.049	0.011	-0.022	0.021	-0.059	0.014	-0.100	0.018
Unemployed/Inactive	0.028	0.017	0.021	0.017	-0.049	0.048	-0.140	0.019	-0.140	0.034
White	0.067	0.008	0.069	0.007	0.002	0.028	0.089	0.010	0.072	0.016
Poor health	-0.049	0.015	-0.068	0.015	-0.042	0.056	-0.123	0.018	-0.062	0.040
Willingness to take above average financial risk	0.088	0.007	0.064	0.006	0.024	0.012	0.086	0.008	0.089	0.009
Investment horizon > 10 yrs	0.026	0.007	0.044	0.008	0.008	0.013	0.061	0.010	0.037	0.009
Asks Friends/Relatives/Work contacts for financial information	0.002	0.006	0.000	0.005	0.007	0.015	0.015	0.008	0.025	0.010
Uses Internet to obtain financial information	0.069	0.009	0.051	0.009	0.009	0.017	0.066	0.011	0.040	0.013
Non-investment income	0.001	0.001	0.000	0.001	0.002	0.003	0.013	0.002	0.000	0.003
Net real wealth	0.020	0.001	0.010	0.001	-0.003	0.003	0.015	0.001	0.004	0.002
Net financial wealth	0.004	0.000	0.004	0.000	-0.002	0.001	0.002	0.000	0.000	0.000
Intention to leave a bequest	0.064	0.007	0.054	0.006	-0.006	0.015	0.042	0.008	0.029	0.010
Has received inheritance	0.046	0.006	0.044	0.007	0.017	0.012	0.038	0.008	0.012	0.010
Credit constrained	-0.007	0.008	-0.059	0.008	-0.012	0.031	-0.049	0.009	-0.011	0.015
Works/ed in the Financial Sector	0.039	0.007	0.023	0.007	-0.021	0.013	0.014	0.008	0.007	0.010
Works in high-risk industry sector	-0.046	0.009	-0.018	0.010	0.010	0.024	-0.044	0.012	-0.068	0.018
Federal marginal tax rate	0.013	0.002	0.012	0.001	0.003	0.004	0.026	0.002	0.011	0.003
Year 1998	0.015	0.008	0.016	0.008	0.056	0.018	0.011	0.009	0.109	0.014
Year 2001	0.012	0.008	0.014	0.007	0.056	0.019	0.018	0.010	0.139	0.016
Year 2004	0.005	0.008	-0.013	0.008	0.066	0.019	0.024	0.009	0.131	0.016

**Table 8. Average Marginal Effects from Multivariate Probit Model with Selection (continued)**

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Directly Held Stocks	Mutual Funds	Mutual Funds	Stocks in Mutual Funds (Conditional)	Stocks in Mutual Funds (Conditional)	Retirement Accounts	Retirement Accounts	Stocks in Retirement Accounts (Conditional)	Stocks in Retirement Accounts (Conditional)
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Correlation with Directly Held Stocks										
Correlation with Mutual Funds			0.233	0.015 ***	0.077	0.065	0.186	0.027 ***	0.188	0.030 ***
Correlation with Mutual Funds in Stocks					0.191	0.018 ***	-0.025	0.391	0.056	0.065
Correlation with Retirement Accounts							0.222	0.017 ***	0.058	0.056 *
Log likelihood									0.458	0.256 *
Number of observations										

**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. All estimates are corrected for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

**Table 9: Average Marginal Effects on the Probability of Using a Stockholding Mode, Conditional on Stock Ownership**

Variable	(1)		(2)		(3)		(4)		(5)		(6)	
	Directly Held Stocks				Stocks in Mutual Funds				Stocks in Retirement Accounts			
	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error	M. Eff.	Std. Error
Age	0.002	0.000	***		0.000	0.000			-0.001	0.000	***	
Married	0.052	0.014	***		0.002	0.015			0.037	0.010	***	
Single male	0.058	0.019	***		-0.035	0.018	**		-0.018	0.014		
Has children	-0.014	0.011			-0.004	0.010			-0.001	0.008		
High school graduate	0.071	0.020	***		0.089	0.018	***		0.016	0.016		
College degree or more	0.159	0.021	***		0.178	0.019	***		0.019	0.017		
Self-employed	0.059	0.013	***		0.047	0.013	***		-0.128	0.010	***	
Retired	0.093	0.018	***		0.084	0.019	***		-0.129	0.016	***	
Unemployed/Inactive	0.126	0.031	***		0.061	0.033	*		-0.202	0.028	***	
White	0.063	0.015	***		0.058	0.014	***		0.028	0.011	**	
Poor health	-0.016	0.029			-0.070	0.030	**		-0.055	0.025	**	
Willingness to take above average financial risk	0.084	0.010	***		0.048	0.010	***		0.039	0.007	***	
Investment horizon > 10 yrs	0.011	0.011			0.039	0.011	***		0.029	0.007	***	
Asks Friends/Relatives/Work contacts for financial information	-0.006	0.010			-0.005	0.009			0.020	0.008	***	
Uses Internet to obtain financial information	0.073	0.014	***		0.041	0.012	***		0.015	0.010		
Non-investment income	-0.002	0.002			-0.002	0.002			0.007	0.002	***	
Net real wealth	0.027	0.002	***		0.006	0.002	***		-0.002	0.001		
Net financial wealth	0.004	0.001	***		0.003	0.001	***		0.000	0.000		
Intention to leave a bequest	0.078	0.010	***		0.045	0.009	***		-0.006	0.007		
Has received inheritance	0.053	0.010	***		0.049	0.010	***		-0.007	0.008		
Credit constrained	0.018	0.014			-0.079	0.014	***		-0.012	0.011		
Works/ed in the Financial Sector	0.055	0.011	***		0.012	0.010			-0.012	0.008		
Works in high-risk industry sector	-0.053	0.016	***		0.009	0.018			-0.031	0.012	**	
Federal marginal tax rate	0.010	0.002	***		0.008	0.002	***		0.011	0.002	***	
Year 1998	-0.008	0.014			0.020	0.013			0.049	0.010	***	
Year 2001	-0.021	0.014			0.012	0.013			0.070	0.011	***	
Year 2004	-0.029	0.014	**		-0.022	0.012	*		0.081	0.011	***	

**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. The results for income, net real and non equity financial wealth represent median semi-elasticities, while for the remaining variables average marginal effects. All estimates are corrected for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

**Table 10: Average Marginal Effects on the Probability of Holding Stocks Directly or in Mutual Funds**

Variable	(1)			(2)			(3)			(4)			(5)			(6)		
	Directly Held Stocks, Conditional on Holding any Retirement Accounts						Stocks in Mutual Funds, Conditional on Holding any Retirement Accounts						Stocks in Mutual Funds, Unconditional					
	M. Eff.		Std. Error		M. Eff.		Std. Error		M. Eff.		Std. Error		M. Eff.		Std. Error			
Age	0.002	0.000	***	0.001	0.000	*	0.001	0.000	*	0.001	0.000	*	0.001	0.000	*			
Couple	0.065	0.011	***	0.023	0.011	**	0.021	0.008	***	0.021	0.008	***	0.021	0.008	***			
Single male	0.040	0.014	***	-0.020	0.013		-0.016	0.009	*	-0.016	0.009	*	-0.016	0.009	*			
Has children	-0.015	0.008	*	-0.007	0.008		-0.005	0.005		-0.005	0.005		-0.005	0.005				
High school graduate	0.100	0.013	***	0.092	0.011	***	0.068	0.007	***	0.068	0.007	***	0.068	0.007	***			
College degree or more	0.206	0.014	***	0.188	0.013	***	0.146	0.009	***	0.146	0.009	***	0.146	0.009	***			
Self-employed	0.013	0.010		0.014	0.009		0.003	0.006		0.003	0.006		0.003	0.006				
Retired	0.055	0.013	***	0.053	0.014	***	0.034	0.010	***	0.034	0.010	***	0.034	0.010	***			
Unemployed/Inactive	0.053	0.023	**	0.021	0.024		0.006	0.016		0.006	0.016		0.006	0.016				
White	0.086	0.011	***	0.071	0.010	***	0.054	0.007	***	0.054	0.007	***	0.054	0.007	***			
Poor health	-0.058	0.021	***	-0.077	0.021	***	-0.059	0.013	***	-0.059	0.013	***	-0.059	0.013	***			
Willingness to take above average financial risk	0.108	0.009	***	0.070	0.008	***	0.056	0.006	***	0.056	0.006	***	0.056	0.006	***			
Investment horizon > 10 yrs	0.030	0.009	***	0.045	0.009	***	0.036	0.007	***	0.036	0.007	***	0.036	0.007	***			
Asks Friends/Relatives/Work contacts for financial information	0.002	0.008		0.001	0.007		0.001	0.005		0.001	0.005		0.001	0.005				
Uses Internet to obtain financial information	0.085	0.012	***	0.053	0.010	***	0.042	0.007	***	0.042	0.007	***	0.042	0.007	***			
Non-investment income	0.000	0.002		-0.001	0.002		0.000	0.001		0.000	0.001		0.000	0.001				
Net real wealth	0.028	0.002	***	0.009	0.002	***	0.007	0.001	***	0.007	0.001	***	0.007	0.001	***			
Net financial wealth	0.005	0.001	***	0.003	0.001	***	0.003	0.000	***	0.003	0.000	***	0.003	0.000	***			
Intention to leave a bequest	0.083	0.009	***	0.053	0.007	***	0.041	0.005	***	0.041	0.005	***	0.041	0.005	***			
Has received inheritance	0.059	0.008	***	0.051	0.008	***	0.039	0.006	***	0.039	0.006	***	0.039	0.006	***			
Credit constrained	-0.005	0.011		-0.066	0.011	***	-0.048	0.007	***	-0.048	0.007	***	-0.048	0.007	***			
Works/ed in the Financial Sector	0.051	0.009	***	0.017	0.008	**	0.014	0.005	**	0.014	0.005	**	0.014	0.005	**			
Works in high-risk industry sector	-0.061	0.012	***	-0.014	0.013		-0.013	0.009		-0.013	0.009		-0.013	0.009				
Federal marginal tax rate	0.015	0.002	***	0.012	0.002	***	0.010	0.001	***	0.010	0.001	***	0.010	0.001	***			
Year 1998	0.020	0.011	*	0.034	0.010	***	0.023	0.007	***	0.023	0.007	***	0.023	0.007	***			
Year 2001	0.015	0.011		0.031	0.010	***	0.022	0.007	***	0.022	0.007	***	0.022	0.007	***			
Year 2004	0.005	0.011		0.003	0.010		0.002	0.007		0.002	0.007		0.002	0.007				

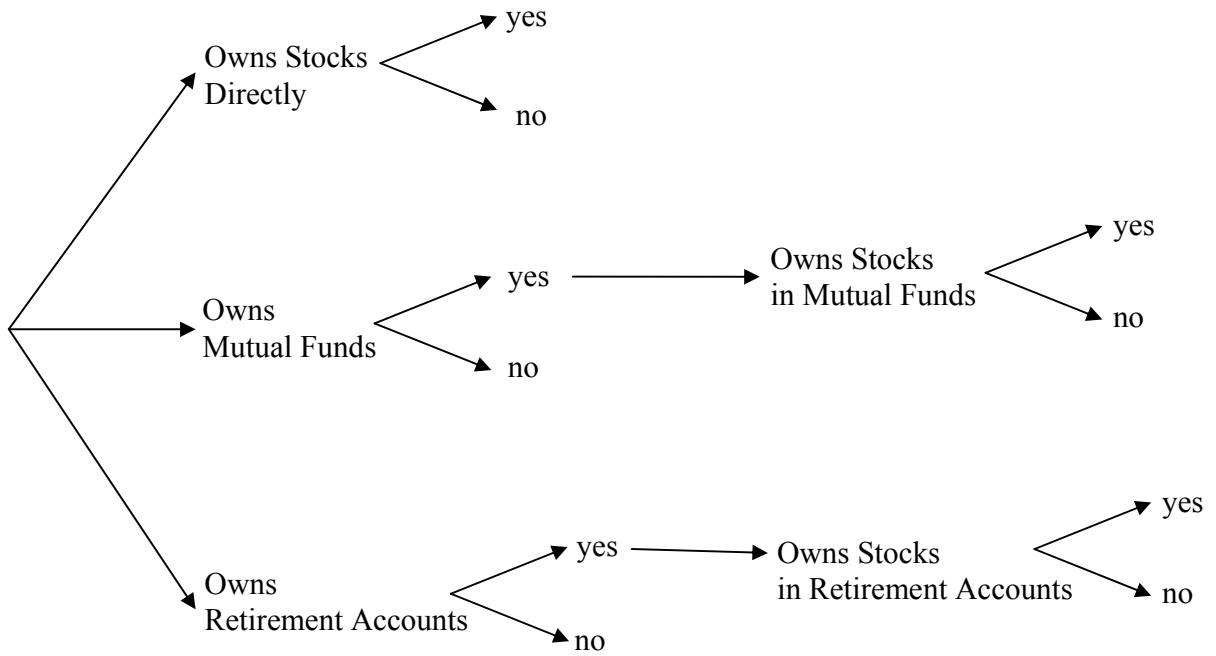
**Notes:** Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. The results for income, net real and non equity financial wealth represent median semi-elasticities, while for the remaining variables average marginal effects. All estimates are corrected for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

Table A.1. Regression Coefficients from the Multivariate Probit with Selection

Variable	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
Age	-0.032	0.050	0.124	0.050	**	-0.049	0.108	0.746	0.045	***	0.315	0.130	**							
Age squared	0.009	0.005	**	-0.008	0.005	*	0.000	0.009	***	-0.071	0.004	***	-0.036	0.012	***					
Married	0.236	0.036	***	0.076	0.036	**	0.129	0.071	*	0.252	0.031	***	0.235	0.050	***					
Single male	0.128	0.046	***	-0.122	0.047	***	0.067	0.094	**	-0.095	0.040	**	0.033	0.066						
Has children	-0.049	0.027	*	-0.034	0.027		-0.001	0.049		-0.014	0.026		-0.046	0.035						
High school graduate	0.420	0.056	***	0.501	0.060	***	0.051	0.214	***	0.456	0.041	***	0.318	0.091	***					
College degree or more	0.774	0.058	***	0.940	0.060	***	-0.048	0.307	***	0.734	0.043	***	0.520	0.114	***					
Self-employed	0.008	0.031	***	0.047	0.031	***	-0.082	0.053	***	-0.396	0.033	***	-0.374	0.054	***					
Retired	0.160	0.044	***	0.215	0.043	***	-0.077	0.087	***	-0.201	0.042	***	-0.364	0.054	***					
Unemployed/Inactive	0.117	0.074	***	0.090	0.075	***	-0.144	0.145	***	-0.467	0.064	***	-0.551	0.102	***					
White	0.314	0.038	***	0.335	0.039	***	-0.002	0.125	***	0.297	0.031	***	0.309	0.054	***					
Poor health	-0.235	0.075	***	-0.361	0.080	***	-0.125	0.185	***	-0.411	0.061	***	-0.313	0.114	***					
Willingness to take above average financial risk	0.361	0.026	***	0.275	0.026	***	0.079	0.077	***	0.289	0.028	***	0.382	0.037	***					
Investment horizon > 10 yrs	0.116	0.029	***	0.190	0.029	***	0.028	0.062	***	0.207	0.032	***	0.178	0.040	***					
Asks Friends/Relatives/Work contacts for financial information	0.010	0.026		0.000	0.026		0.028	0.046	**	0.049	0.025	**	0.093	0.033	***					
Uses Internet to obtain financial information	0.291	0.036	***	0.228	0.036	***	0.032	0.079	***	0.225	0.039	***	0.201	0.052	***					
Non-investment income	0.002	0.006	***	-0.002	0.006	***	0.006	0.009	***	0.039	0.006	***	0.012	0.010	***					
Net real wealth	0.086	0.005	***	0.044	0.005	***	-0.011	0.015	***	0.046	0.004	***	0.026	0.008	***					
Net financial wealth	0.020	0.002	***	0.020	0.002	***	-0.006	0.007	***	0.012	0.001	***	0.002	0.003	***					
Intention to leave a bequest	0.277	0.026	***	0.238	0.026	***	-0.025	0.073	***	0.146	0.026	***	0.135	0.032	***					
Has received inheritance	0.196	0.026	***	0.194	0.027	***	0.058	0.063	***	0.126	0.028	***	0.077	0.036	**					
Credit constrained	-0.032	0.038	***	-0.288	0.041	***	-0.040	0.133	***	-0.165	0.031	***	-0.080	0.053	***					
Works/ed in the Financial Sector	0.164	0.027	***	0.107	0.028	***	-0.069	0.051	***	0.046	0.028	*	0.031	0.034	***					
Works in high-risk industry sector	-0.219	0.045	***	-0.087	0.044	**	0.033	0.087	***	-0.147	0.039	***	-0.252	0.050	***					
Federal marginal tax rate	1.145	0.131	***	1.062	0.131	***	0.150	0.355	***	1.751	0.123	***	1.175	0.255	***					
Year 1998	0.069	0.034	**	0.067	0.033	**	0.173	0.058	***	0.037	0.032		0.330	0.045	***					
Year 2001	0.052	0.034	*	0.060	0.033	*	0.173	0.058	***	0.060	0.033	*	0.441	0.047	***					
Year 2004	0.020	0.035	*	-0.064	0.034	*	0.207	0.062	***	0.084	0.033	**	0.417	0.047	***					
Constant	-3.556	0.153	***	-3.283	0.153	***	0.893	1.236	***	-3.852	0.133	***	-2.079	0.775	***					

Notes: Pooled data from the 1995, 1998, 2001 and 2004 waves of the SCF. All estimates are corrected for multiple imputation. \*\*\*, \*\*, \* denote significance at 1%, 5% and 10% respectively.

**Figure 1: Graphical Presentation of the Model**



## Endnotes

<sup>1</sup> See Campbell (2006), Haliassos and Bertaut (1995), Heaton and Lucas (2000), Gollier (2001), Viceira (2001), Campbell and Viceira (2002), Haliassos and Michaelides (2003), Cocco, Gomes and Maenhout (2005), and Gomes and Michaelides (2005), the contributions in Guiso, Haliassos and Jappelli (2001), and Guiso, Haliassos and Jappelli (2003).

<sup>2</sup> The report states that “[t]he growth of equity ownership among America’s individual investors during the past 20 years has been fueled largely by the expansion of defined contribution retirement plans, particularly 401(k) plans, which widely use stock mutual funds and other types of mutual funds as investment options. [...] Between 1999 and 2005, the number of households owning equities through employer-sponsored retirement plans grew by 5.2 million. Over the same period, the number of households owning equities outside these plans increased by 2.4 million. [...] Defined contribution retirement plans also play an important role in introducing investors to equity investing and influence investors’ initial equity purchases. Today, nearly half of all equity owners began investing in equities by purchasing stock mutual fund shares through retirement plans at work. Among younger equity investors, the proportion is even greater.” (p. 2,3)

<sup>3</sup> For further details on the SCF see, for example, Kenickell (2000). More information on the construction of our variables can be found in Appendix A.

<sup>4</sup> For this reason we only report the proportions by pooling all four years together.

<sup>5</sup> Using findings in Carroll and Samwick (1997) we consider Agriculture, Forestry, Fishing, Mining and Construction as high income risk sectors.

<sup>6</sup> Greene uses a multivariate probit with censoring to study default in credit card loans. This model choice is dictated by the fact that defaults are observed only for the selected sample of credit card holders.

<sup>7</sup> We use those authors’ equation formulation and notation for our model setup. See also Christelis and Georgarakos (2008), who have used a multivariate probit with selection to study household investment in foreign assets.

<sup>8</sup> Information on some of the covariates we use in our estimation is available only since 1995

<sup>9</sup> This approach, commonly followed in the stockholding participation literature, was found by Ameriks and Zeldes (2004) to produce more plausible patterns of stock ownership than cohort effects.

<sup>10</sup> Since one cannot invest in stocks in mutual funds without owning mutual funds, we cannot have  $M=0$  and  $MS=1$ , and thus  $M \geq MS$  always. The same is true for retirement accounts, i.e.  $R \geq RS$ .

<sup>11</sup> We first perform the estimation and compute robust standard errors within each implicate, and then combine the estimates and standard errors across implicates using the rules described in Rubin (1987).

<sup>12</sup> We use 150 Halton draws and the Stata function `mnvp` to implement the GHK simulator, as described in Cappellari and Jenkins (2006).

<sup>13</sup> For example, in our model, the equation for mutual fund ownership can be separately identified from the equation for stock investment in mutual funds by using the subsample of those who do not own any mutual funds. The latter equation can be separately identified from the equation for stock investment in retirement accounts by using the subsample of those who own mutual funds but do not own any retirement accounts.

<sup>14</sup> We evaluate the probabilities of all asset combinations of interest for each household in the sample by using the GHK simulator and the same Halton draws used in the estimation of the model.

<sup>15</sup> Given that stock investment through mutual funds can only be achieved through the ownership of mutual funds,  $P(MS=1) = P(MS=1, M=1)$

<sup>16</sup> For dummy variables we consider a change from 0 to 1. For income- and wealth-related continuous variables we present median semi-elasticities (corresponding to a change of 5,000 dollars in 2004 prices). We choose the median since semi-elasticities involve multiplication by the amounts, which are very skewed. Hence the median is to be preferred to the mean in this case. The marginal effect of age is evaluated when age is incremented by one for all household heads, while the marginal effect of the federal marginal tax rate is evaluated when the rate is incremented by five percentage points for all households.

<sup>17</sup> This probability is equal to the sum of the probabilities of all asset combinations in which at least one stockholding mode is chosen.

<sup>18</sup> Even a high-school certificate makes substantial difference (just under 8 pp).

<sup>19</sup> SCF asks explicitly whether a household asks friends or uses the Internet to obtain financial information, allowing for a direct assessment of their contribution on stockholding.

<sup>20</sup> Net financial wealth enters in each equation after deducting the amount of the asset in question in order to avoid endogeneity problems.

<sup>21</sup> We modify the federal marginal tax rate as in Alessie, Hochguertel and Van Soest (2004), in order to avoid endogeneity issues due to dividend income (see Appendix A).

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<sup>22</sup> The finding is also consistent with results on the role of education in encouraging gains and avoiding losses in mutual funds in Biliias, Georganakos, Haliassos (2008).

<sup>23</sup> One might conjecture that the lack of significance of most variables might be due to the fact that roughly 80% of mutual fund investors also hold stocks in those mutual funds. As a result, the samples used in the estimation of the two choices are similar, potentially leading to this lack of significance in the second stage equation. However, samples are also similar in the case of retirement accounts, where we find very significant effects of numerous variables in the second stage equation (see below).

<sup>24</sup> We find statistically significant positive correlations between unobserved factors influencing participation in direct stockholding and each one of mutual funds, retirement accounts, and stocks in retirement accounts; but not with holding stock mutual funds. In addition, unobserved factors influencing participation in stock mutual funds are correlated with those influencing participation in retirement accounts.

<sup>25</sup> For example, the relevant probability for stocks in mutual funds is shown in (14).

<sup>26</sup> As regards stockholding through retirement accounts we have already seen that there is a distinct second threshold that owners of retirement accounts have to clear. We cannot compare conditional and unconditional marginal effects for stocks in retirement accounts because, by definition, one cannot hold stocks in this form without owning a retirement account.

<sup>27</sup> Indirectly for stock mutual funds, by facilitating investment in mutual funds.

<sup>28</sup> We do not evaluate marginal effects at sample means since this practice can lead to severely misleading results (see Train, 2003, pp. 33-34).