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Stock Market Participation and the Internet

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Abstract

Theory indicates that frictions (e.g., information and transaction costs) could account for the lower than expected stock market participation rates. This paper examines the hypothesis that there has been a fundamental change in participation and links this change to the reduction of these frictions by the advent of the Internet. Using panel data on household participation rates over the past decade, the results show computer/Internet using households raised participation substantially more than non-computer using households. The increased probability of participation was equivalent to having over $27,000 in additional household income or over 2.5 more mean years of education. (JEL: D14, G10)

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1 Introduction

The development and rapid growth of the Internet was one of the most significant technological advances of the last century. The Internet has the potential to affect almost every aspect of daily life and Internet related issues have been discussed in many areas within economic literature. Researchers have examined the effects of the Internet on taxes, price competition, U.S. productivity growth, and international trade.[1] However, despite the important connection between the Internet and many areas of finance, a number of important research questions remain open.

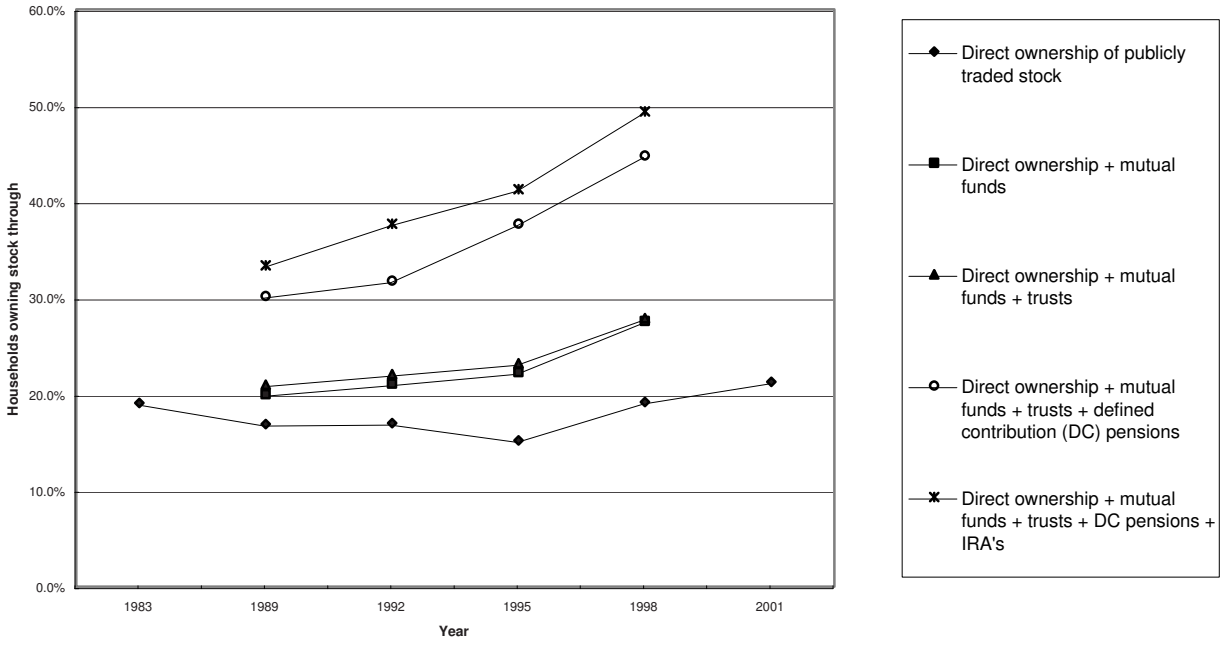
Individual stock market participation is much lower than would be predicted by the consumption Capital Asset Pricing Model (CAPM) and other models, given the risk-adjusted expected returns from holding stock. This is often referred to as the Stock Market Participation Puzzle, which has been linked to the equity premium puzzle.[2] Theory indicates that market frictions could account for the lower-than-expected stock market participation rates. Given that transaction costs and other stock market frictions were greatly affected by the Internet, we have an opportunity to find valuable evidence of the effects of these market frictions.

We are motivated by the fact that the advent of the Internet in the last ten years has provided an important change in the method by which investors can participate in the stock market. The Internet has mitigated three of the proposed causes for low stock market participation: transaction costs, information costs, and limited access. Thus, it represents a potentially fruitful area for finding evidence of the effects of market frictions different from those previously considered in the literature (bid-ask spreads, short-sale constraints, borrowing constraints, etc.) and for measuring their impact on the equity premium. Utilizing this technological event in history, this paper examines the effects of transaction costs on stock market participation.

[1] See Goolsbee (2000), Goolsbee and Chevalier (2003), Lal and Sarvary (1999), Goss (2001), and Freund and Weinhold (2000).

[2] See Mehra and Prescott (1985) for the original derivation of the equity premium puzzle and Cochrane (2001) for other references. See Mankiw and Zeldes (1991) and Vissing-Jørgensen (1997) for link between stock market participation and equity premium puzzle.

Figure 1: Percent of U.S. Households Owning Stock, 1983 - 1998



Historically U.S. stock market participation has been low, with fewer than one-third of U.S. households holding stock. This proportion was remarkably stable over time and across data sets.[3] According to data from the Survey of Consumer Finances, even during the economic boom of the 1980s, there was limited growth in stock ownership.[4] However, despite the historical stability, substantial growth in stock market participation was evident during the 1990s (See Figure 1).[5] The increase in computer usage and Internet access during the last decade also has been well-documented (See Figure 2).[6]

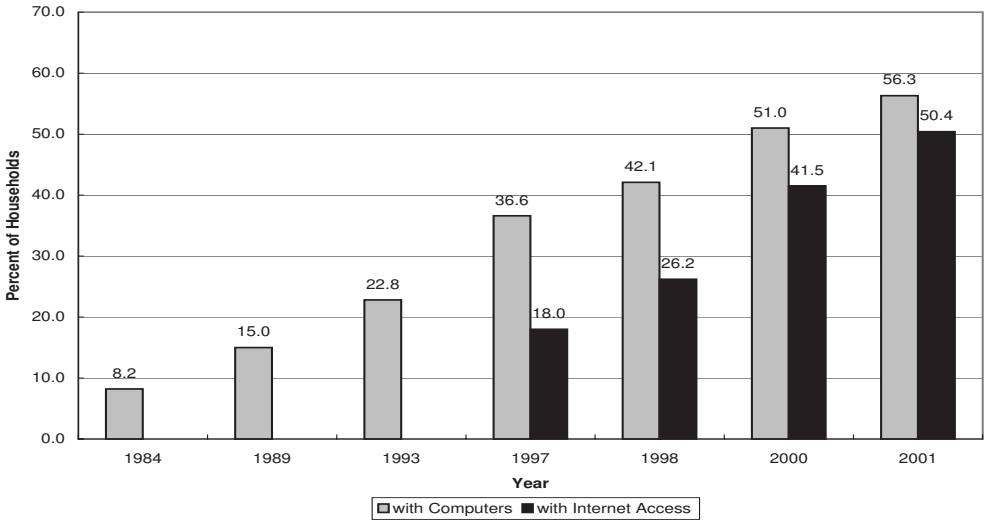
[3] Haliassos and Bertaut (1995)

[4] "Stock ownership, which includes holding of publicly traded corporate stock and of equity mutual funds, declined slightly.", Survey of Consumer Finances Report - Changes in Finances from 1983 to 1989: Evidence from the Survey of Consumer Finances, p. 9.

[5] See, for example, Ameriks and Zeldes (2001) and Survey of Consumer Finances data.

[6] Current Population Reports – U.S. Census Bureau.

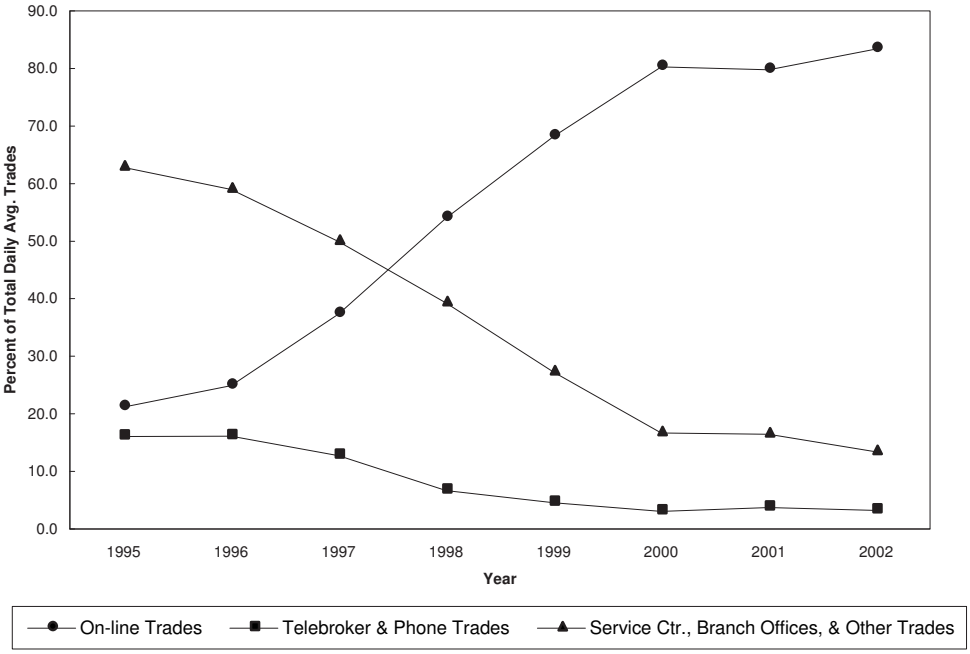
Figure 2: Trends in Computer Usage and Internet Access



The bull market of the 1990s, not transaction costs, initially may seem to account for the increase in stock market participation. However, evidence from other countries that have experienced similar bull markets suggests that a bull market alone is not sufficient to generate a significant increase in stock market participation. Guiso, Haliassos, and Jappelli (2003) document a number of differences in stock market participation between European countries. Their empirical results show that the Netherlands, a country with an average stock market return *above* that of the U.S. for the period from 1986 to 1997, did not experience any notable increase in stock market participation.

This paper examines the relationship between the decline in transaction costs due to the availability of on-line stock trading and stock information and the implications for the stock market participation puzzle. Since the on-line trading trend emerged in the 1990s, many major U.S. financial service firms have developed a sizeable on-line customer base while other companies have focused on providing on-line stock information and financial analysis tools. DLJ Direct (now CSFB Direct) pioneered on-line investing in 1988 and, ten years later, there were more than 50 other firms offering on-line investing to millions of customers. Numerous on-line companies now provide financial and investing data on stock prices, stock trends, corporate earning, etc. Consumers are heavily

Figure 3: Charles Schwab – Client Trading Activity



utilizing on-line trading, as can be seen at the Charles Schwab Corporation, a leading brokerage firm with over 8 million active client accounts in 2002. At Charles Schwab, the share of daily trades that are made on-line has increased from no on-line trades prior to 1992, to less than 25% in 1995, to over 80% in 2002 (See Figure 3).[7]

Overall, firms have increased the amount of investment information available, provided easier access to the market, and decreased transaction costs. The decreases in transaction costs have come in several forms:

- The costs for Internet trades are substantially lower than for broker-assisted trades.
- The competitive presence of Internet-based brokerage firms has driven down the cost of broker-assisted trades.
- Other rates and fees associated with stock purchases have declined (margin rates, service fees, etc.).

[7] 1995 - 2002 Annual Reports: The Charles Schwab Corporation.

Table 1: Equity Trading Costs

	Ameritrade	Datek	CSFB Direct	E*Trade	Schwab
Internet Costs for up to 1000 Shares	$8.00	$9.99	$20.00	$14.95	$29.95
Broker-Assisted Costs for up to 1000 Shares	$18.00	$25.00	$20.00	$29.95	$144.00
Internet Costs for up to 5000 Shares	$8.00	$9.99	$100.00	$14.95	$149.95
Broker-Assisted Costs for up to 5000 Shares	$18.00	$25.00	$100.00	$29.95	$265.00
Internet Costs for up to 10,000 Shares	$8.00	$9.99	$200.00	$64.95	$299.95
Broker-Assisted Costs for up to 10,000 Shares	$18.00	$25.00	$200.00	$79.95	$375.00

Table 1 provides an example of the magnitude of the difference in transaction costs.[8] We see that Internet trading costs were as much as 79% lower than broker-assisted trading costs. Since Internet users had the largest reductions in trading and information costs, it may be possible to connect the differing participation rates with these differing transaction costs.

There is relatively little literature related to the impact of the Internet on stock market participation. This paper provides evidence of declining transaction and information costs associated with the new information technology developed in the 1990s and the degree to which these costs affected market participation. An increase in stock-owning households is observed in the data. Taking computer usage as a proxy for Internet usage, the results of probit estimations indicate that households that are more comfortable using computers increased participation substantially more than households less comfortable using computers. In terms of the probability of holding stock, computer/Internet usage was equivalent to having over $27,000 in additional mean household income. These results are taken to support the idea that transaction costs are an important aspect of the stock market participation puzzle.

The remainder of the paper proceeds as follows. Section 2 reviews some of the existing literature on stock market participation. Section 3 describes the data. Section 4 presents the econometric analysis and discusses the main results. Section 5 summarizes key findings and provides concluding remarks.

[8] Ameritrade.com web page - Average rate comparison between competing firms (10/30/2000) and Schwab rate information pamphlet (October 2000). Note that CSFB Direct was formerly DLJ Direct.

2 Existing Literature

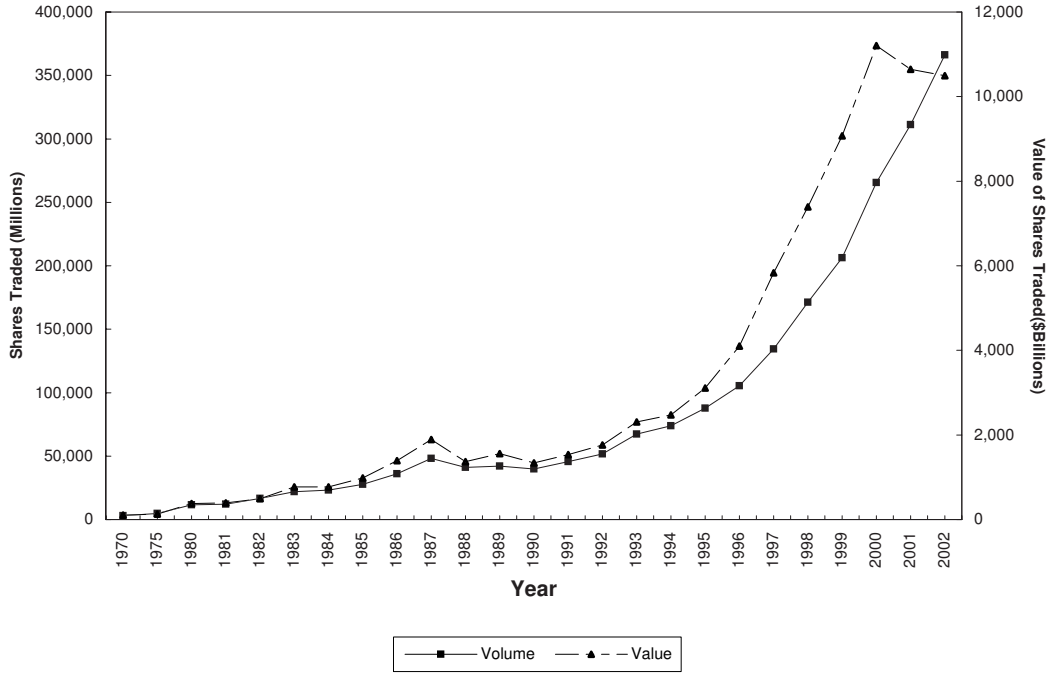
In contrast to the wealth of literature related to general stock market participation issues, there is a paucity of literature regarding stock market participation and the Internet. The work that has been done primarily focuses on the characteristics of the typical on-line stock trader. Barber and Odean (2002) found that young men who are active traders with high incomes and a preference for investing in small growth stocks with high market risk are more likely to switch to on-line trading. They also found that those who switch to on-line trading experienced unusually strong performance prior to going on-line. However, after going on-line, these participants traded more actively, more speculatively, and less profitably than before. Choi, Laibson, and Metrick (2002) also analyzed the impact of a Web-based trading channel on the trading activity of two corporate 401K plans. After 18 months of access, the inferred on-line effect was very large. Trading frequency doubled and portfolio turnover rose by over 50%. Choi et al., also found that young, male, wealthy participants were more likely to try the Web channel.

Their results are also consistent with the recent increase in stock market trading volume. Since Internet trading began, there has been a general upward trend in stock market volume and the total value of shares traded on the stock market. From New York Stock Exchange (NYSE) data,[9] it is quite apparent that the slope of the upward movement in the stock market is much bigger in the 1990s than in the 1980s (See Figure 4). Both a Chow and a Wald test are consistent with the hypothesis that there was a structural change in the stock market between the periods 1980 - 1993 and 1994 - 2001.[10]

[9] NYSE stock market data obtained from the Census Bureau's Statistical Abstracts of the U.S.

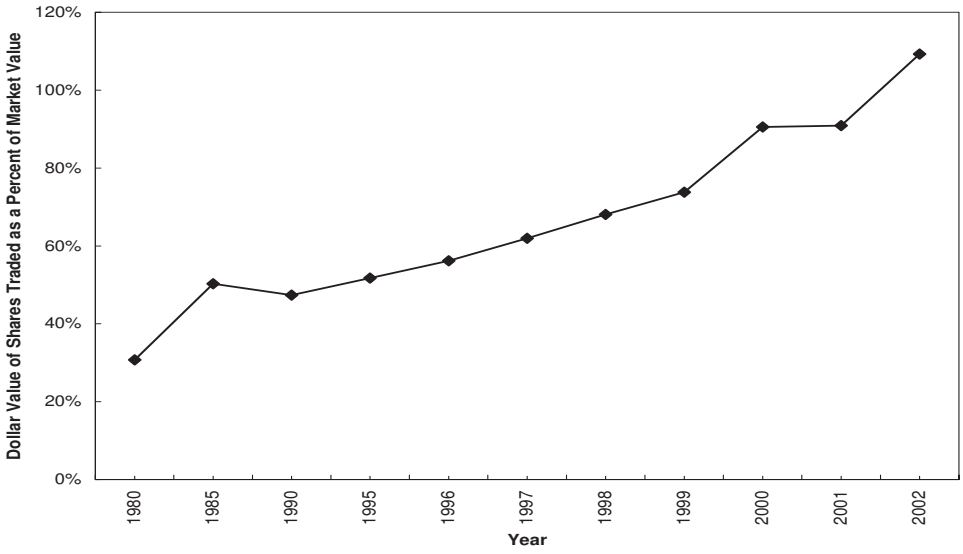
[10] Consider the function, $StockVolumePerCapita_t = \alpha_t + \beta * Year + \varepsilon_t$, along with the standard assumptions for the error term. A Chow test that compares the period 1980 - 1993 with the period 1994 - 2001 supports the hypothesis that there was a structural change in stock market volume per capita between the two periods: the F statistic is 256.99 and the critical value for a 95% confidence level with (2,18) degrees of freedom is 3.55. Thus, we could reject the hypothesis that both samples are the same. The Wald test of structural change, which is valid whether or not the disturbance variances are the same, also supports the idea that there was a structural change in stock market volume per capita between the two periods: the 5% critical value for two degrees of freedom is 5.99 and the Wald statistic generated is 341.77. Lastly, given the small sample limitations of the classical approach, a Bayesian approach was also implemented (Press, 1989). We find a posterior odds ratio that is very close to zero. Thus, given that it does not exceed unity, we cannot accept the original hypothesis that the estimates are the same in both samples.

Figure 4: New York Stock Exchange Historical Stock Volume and Value



Since stock market capitalization has increased and companies tend to split shares so that per share prices remain in a narrow band, the number of shares and the value of shares traded could have increased even if normalized turnover remained constant. Thus, the most economically relevant statistic that indicates if trading activity has actually increased on the NYSE is dollar turnover as a percent of market value. Figure 5 shows a large upward trend in turnover, with turnover increasing from 30.7% in 1980 to 109.3% in 2002.

Figure 5: New York Stock Exchange Historical Dollar Turnover



It is important to note that Barber & Odean and Choi et al. both analyze the behavior of individuals who were *already* participating in the stock market. The more fundamental question of whether participation increased, that is whether more people started participating in financial markets as a result of the new information technology, still remains an open question in the literature. To the best of our knowledge, no research to date has attempted to measure the extent to which more households are now participating in the stock market as a result of the advent of the Internet. This is the question that will be the focus of this paper.

As indicated earlier, the study of participation in markets with frictions is important for finance in general and the equity premium in particular. A primary component of the equity premium puzzle is that stock market participation is lower than would be predicted, given the risk-adjusted expected returns of the stock market. It has been argued that this non-participation phenomenon should be considered an important part of the potential solution to the equity premium puzzle because, the consumption growth of non-stockholders covaries substantially less with the stock market return than the consumption growth of stockholders. Mankiw and Zeldes (1991) first argued this aspect in their seminal paper based on 1984 Panel Survey of Income Dynamics (PSID)

Data. Vissing-Jørgensen (1997) continued to stress the importance of non-participation in her paper based on 1982-1994 Consumer Expenditure Survey (CEX) data. She generated a simple condition under which the equity premium predicted by the standard consumption capital asset pricing model (CCAPM) is only a fraction, λ, of the equity premium generated by the process for consumption, where λ is the fraction of stockholders in the population. Limited stock market participation is also relevant to issues beyond the equity premium puzzle. For example, limited market participation can amplify the effect of liquidity trading relative to full participation. Additionally, under certain circumstances with limited participation, arbitrarily small aggregate liquidity shocks can cause significant price volatility (Allen and Gale (1994)).

Haliassos and Bertaut (1995) found empirical support for the hypothesis that actual or perceived costly information about the stock market can account for agents who hold portfolios of riskless assets but not stocks. Bertaut (1998) also proffers the idea that most households persistently invest in riskless assets but not stocks because they perceive information required for market participation to be costly relative to expected benefits. This assertion is supported by Bertaut's finding that factors such as age, education, and inheritance of assets are significant in explaining the probability of holding stocks and have similar effects on the probability of ownership over the years studied.

Luttmer (1999) obtained a lower bound for the level of fixed transaction costs that is required for observations on consumption behavior to be consistent with data on asset returns. He estimated how large the transaction costs must be to rationalize the behavior of consumers with constant relative risk aversion (CRRA) preferences whose consumption choices are similar to U.S. per capita consumption. These estimates are useful in determining the lower bound on the level of transaction costs that allows the IMRS to satisfy the Hansen and Jagannathan (1991) bounds. Notably, the amount of frictions identified in Luttmer (1999), Luttmer (1996), and He and Modest (1995) meets only the weakest possible restrictions on the IMRS. Much greater frictions would be needed to meet more plausible restrictions on the IMRS. Additionally, (Peress, 2005) developed a theoretical model describing how changes in certain market frictions could affect stock market participation levels. Thus, the evidence that we present also may be relevant in this regard.

3 Data

The primary analysis in this paper focuses on testing for changes in individual stock market participation after the widespread availability of on-line trading. To test for changes in individual participation, we use the Health and Retirement Survey (HRS) which is a nationally representative longitudinal data set.[11] This panel data set, which previously has been used to examine the connection between peer effects and stock market participation (Hong, Kubik, and Stein (2004)), contains standard information about age, income, wealth, education, stock market participation, etc. In contrast to the Panel Study of Income Dynamics (PSID) and other data sets, the HRS has more recent information (2002) and, most importantly, the 1992 and 2002 surveys include questions regarding individual computer and internet usage that are relevant when considering the effect of the Internet on stock market participation. Both the 1992 HRS and the 2002 HRS ask respondents questions about working with computers. These questions allows us to divide the sample into computer using and non-computer using households. The 2002 HRS also asks questions about Internet usage. Thus for 2002, we can perform analysis on a smaller sample of Internet and non-Internet using households. In terms of stock market participation, the survey asks a question specifically about *stocks that are held outside of IRA and Keogh accounts and that are not part of a 401K or similar defined contribution pension plan.* Additionally, the panel aspect of the data can be exploited in some of the econometric analyses. In this sense, the HRS is preferable to the commonly used Survey of Consumer Finances (SCF) and other data sets.

[11] The HRS is sponsored by the National Institute of Aging and conducted by the University of Michigan.

Another relevant feature of the data set is that it tracks only one birth cohort and consequently is not a representative sample of the population. The individuals in the survey, who were born between 1931 and 1947, were between the ages of 45 and 61 at the time of the first study (1992). Since professional financial planners often advise that the fraction of wealth that people should hold in the stock market should decline with age, this may seem to be a drawback to the data set when testing for stock market participation over time. Yet, this is not an issue here for several reasons. First, Ameriks and Zeldes (2001) found that equity portfolio shares increase strongly with age. They followed the same individuals over time and observed that the vast majority of people invest contrary to the advice of financial planners. Most individuals in their sample, who already owned stock and made changes to their portfolio allocations, increased their allocations to equity as they aged. Second, the data set may be biased *against* finding an impact of the Internet on stock market participation since one might expect that the older population cohort surveyed would not typically begin participating in the stock market if they had not previously been participating. Also, and perhaps more importantly, this cohort of older individuals has been shown to be the *least likely* to invest in the stock market through the use of a new technology (Barber and Odean (2002)). These reasons indicate that the data set would seem to be biased *against* positive results due to the use of new technology. The panel nature of the survey, the questions asked in the survey, and the particular cohort of individuals used, combine to make this data set well-suited for the analysis. These features would, if anything, strengthen the results in the sense that the findings may be interpreted as a lower bound on the effects of the Internet on stock market participation.

Table 2: Summary Statistics – Household Characteristics

	2002
Average Age[†]	65
Avg. Years of Education[†]	12.7
% of Household Heads that are Male	51.7
Average Annual Household Inc.[††]	$58,500
Average Annual Household Net Worth[††]	$411,900
% of Household Heads that Use Computers in 1992	37.3
Households	3774

Table 2 presents the 2002 summary statistics of the panel data which shows that the average head of household in the sample is a male with 13 years of education. The average annual household income was over $58,000 per year and the average annual household net worth was over $400,000 per year.[††] Table 3 shows the differing yearly participation rates for the total sample in the HRS data set, the self-identified computer users and the non-computer users.[12] Similar to figures reported by both the SCF and ICI, the HRS data show an increase in stock market participation in the years following the bull market of the 1990s. As would be expected, a direct comparison of a balanced panel for the years 1992 and 2002 also shows substantial inertia in household stock holding patterns (See Table 4). Over 75% of the households did not change their stock holding pattern. Once a household participated in the stock market, it would most likely continue holding stock. Less than 11% of the households held stock in 1992 but did not hold stock in 2002.

[†]Head of Household

[††]Base Year 2002 $

[12]These figures are noticeably lower than figures commonly reported by both the SCF and the Investment Company Institute (ICI). The SCF reports the following statistics on stock market participation. 1992: 36.7% stock ownership; and 2001: 51.9% stock ownership. The ICI reports slightly higher participation rates. 1992: 34.6% stock ownership; and 2001: 52.7% stock ownership. This is consistent with the fact that both the SCF and ICI use a representative sample of the population and include retirement assets in the measure of participation. The HRS is limited to one age cohort of older individuals and does not include retirement assets in its measure of participation.

Table 3: Household Stockholding Statistics

	1992	2002
% of Households that Own Stock	31.2	34.7
% of Computer Using Households that Own Stock	42.5	46.6
% of Non-Computer Using Households that Own Stock	24.4	27.6

Table 4: Summary Statistics – Percentage of Household With Given Stock Holding Pattern

	Held Stock In 1992	Did Not Hold Stock in 1992
Held Stock in 2002	20.51	14.18
Did Not Hold Stock in 2002	10.65	54.66

4 Econometric Analysis and Empirical Evidence

4.1 Empirical Framework

In a standard frictionless consumption CAPM, agents maximize expected utility. The utility function is additively separable, and future utility is discounted at rate δ. Each agent can borrow or invest in two assets, one with a riskless rate of return and one with a stochastic return (stocks). The agent maximizes the expected value of the sum of discounted utility. The optimization problem is

$$\max_{c_t} E_t \sum_{t=0}^{T} \delta^t U(c_t) \tag{1}$$

s.t.

$$\begin{aligned} c_t &= W_t + y_t - s_t \\ W_{t+1} &= s_t(1+r) + \alpha_t z_t \end{aligned}$$

where c_t is real consumption in time t, y_t is exogenous real labor income in t, W_t is total wealth at time t, s_t is total real saving in t, α_t is the amount saved in the risky asset in time t, $1+r$ is the gross riskless return, and z_t is the excess return on stocks over the riskless rate.

If we consider a model with certain types of frictions (information costs, transaction costs, etc.), there is a cost of individual stock market participation, I_t. The lump-sum expense of purchasing investment information (investment guides, investment magazines, broker advice, etc.), the opportunity cost of the time spent in obtaining investment information, or transaction costs will result in the above optimization problem with following constraints

$$\begin{aligned} c_t &= W_t + y_t - s_t - I_t \\ W_{t+1} &= s_t(1+r) + \alpha_t z_t. \end{aligned}$$

The initial cost of acquiring the information necessary for market participation or the recurring

expense of maintaining the portfolio and investing in new opportunities could be large enough to make an individual persistently abstain from the market. Thus, if the cost of participating (I_t) is perceived to be sufficiently high to remove the expected utility gain, the household will not participate and the constraints become the same as in equation 1, with $\alpha_t = 0$.

Simulations of a calibrated life-cycle model, described in detail in Bertaut and Haliassos (1997), show that participation costs are affected by level of education, the degree of risk aversion, labor income risk, and a bequest motive. This paper conjectures that, due to the Internet, participation costs (I_t) may have declined more for computer/Internet users than for non-users. If this is the case, we should expect a larger rise in stock market participation among computer users. The empirical analysis below tests this hypothesis. Specifically, the analysis utilizes probit models to understand, at a micro level, the relationship between stock market participation and computer usage over time, while controlling for other factors that are known to impact stock market participation. The models are similar to those used by Hong, Kubik, and Stein (2004), Blume and Zeldes (1994), and Bertaut (1998).

4.2 Univariate Probit Models

In a standard consumption CAPM, households are assumed to maximize utility of consumption. For estimation purposes, we assume that the household's indirect utility function can be written as a linear function of household characteristics plus an error term, u_i. Consistent with Mankiw and Zeldes (1991), we assume that the consumption of stockholders and non-stockholders is different. Let $U_{Si} = X_{Si}\beta_S + u_{Si}$ be the indirect utility function when households invest in the stock market, and let $U_{NSi} = X_{NSi}\beta_{NS} + u_{NSi}$ be the indirect utility function when households do not invest in the stock market.

The u_i error terms include unobserved household-specific factors that may be important for the stockholding decision. The $X_i's$ are observable variables pertaining to household $i's$ characteristics. These include those variables previously demonstrated to be significant in explaining the probability of holding stocks such as risk attitude, age, education, income, wealth, and inheritance of assets (See, for instance, Bertaut (1998)). In practice, the indirect function is not observable. Only participation or non-participation can be observed. Let $D_i = 1$, if $U_{NSi} < U_{Si}$. That is, the household's utility is higher when holding stocks than when not holding stocks. Let $D_i = 0$ otherwise. Then, we have $P(D_i = 1) = P(U_{NSi} < U_{Si})$.

To properly document the effect of the Internet on stock market participation it is necessary to establish clearly a link between computer usage and increased stock market participation in our sample. As a first step, we use a univariate probit model where the dependent variable is a binary variable for stock market participation, and the independent variables are a computer usage dummy,[13] a risk attitude dummy, a received and inheritance dummy, a voluntary contribution pension dummy and control variables for age, years of education, household income, and household net worth.[14] A detailed description of all of the variables used and how they are constructed can be found in the appendix.[15] Similar to an approach taken in Hong, Kubik, and Stein (2004), the model specification is

$$OWNSTK_i = \beta_0 + \beta_1 COMPUTERDUMMY_i + \textstyle\sum_{k=2}^{K} \beta_k X_{ik} + \epsilon_i,$$

where X_{ik} is the set of household characteristic control variables.

With this model, we estimate a probit for the 2002 data. From the coefficient of the computer usage variable, we observe a strong relationship between computer usage and stock market partici-

[13] For an empirical justification of computer usage as a proxy for Internet usage, see Section 4.4.

[14] The voluntary contribution pension dummy is included to control for the fact that a household could hold stocks entirely in a retirement plan in 1992 (and thus be observed as non-stockholding) and after age $59\frac{1}{2}$ withdraw stocks held in the retirement account and reinvest them such that the household would be counted a stockholding in 2002. The education, income, and voluntary contribution pension variables also serve to control for aspects of a household head's occupation or training that could lead to increased stock market participation.

[15] Our probit models contain those variables previously shown to be significant in explaining the probability of holding stock in the U.S. (See, for example, Hong, Kubik, and Stein (2004), and Bertaut (1998)).

Table 5: Computer Usage and Stockholding in 2002 Sample

	2002 Sample	
	Coefficient	Std. Error
Dependent Variable: Own Stock		
Intercept	-7.5753	0.5454
1992 Computer User Dummy	0.0973	0.0536
Age of Household Head	-0.0055	0.0078
Avg. Years of Education of Household Head	0.0609	0.0105
Log of Household Income	0.0386	0.0286
Log of Household Net Worth	0.5067	0.0250
Have Voluntary Contribution Pension	0.0355	0.0647
Received Inheritance Dummy	0.2998	0.0573
Not Risk Averse Dummy	0.0616	0.0599

pation in 2002 (See Table 5). From the coefficients and sample mean values generated, we calculate that being a computer user in 1992 increases the probability of owning stock by 0.034 in 2002.[16] This helps us begin to establish the link between computer usage and the increase in stock market participation.

Another slightly different univariate probit model provides the most compelling evidence that the change in stock market participation can be linked to computer usage. This model has stock ownership in a year following the introduction of on-line trading (2002) as the dependent variable and the independent variables include stock ownership in 1992, a 1992 computer usage dummy, and a dummy variable for the interaction between 1992 computer usage and 1992 stock ownership (See Table 6). This model specification is

$$\begin{aligned} OWNSTK2002_i &= \beta_0 + \beta_1 OWNSTK1992_i + \beta_2 COMPUTERDUMMY_i \\ &+ \beta_3 OWNSTK1992 * COMPUTERDUMMY_i + \sum_{k=4}^{K} \beta_k X_{ik} + \epsilon_i, \end{aligned}$$

where X_{ik} is the set of household characteristic control variables.[17]

[16] With a 95% confidence interval of [0.00, 0.07].

[17] To avoid any endogeneity issues between household net worth in 2002 and stockholding between 1994 and 2000, we use the log of 1992 household net worth. However, the magnitudes of the coefficients and standard errors do not change significantly if the log of 2002 household net worth is used.

Table 6: Impact of Computer Usage on Stockholding in 2002

	(1)			(2)		
	Coeff.	Std. Error	t-ratio	Coeff.	Std. Error	t-ratio
Dependent Variable: Own Stock in 2002						
Intercept	-0.9977	0.0357	-27.98	-5.7474	0.5381	-10.68
Own Stock in 1992 Dummy	1.3519	0.0642	21.07	0.8352	0.0715	11.69
1992 Computer User Dummy	0.5001	0.0583	8.58	0.1794	0.0663	2.71
Own Stock in 1992*1992 Computer User	-0.3943	0.0953	-4.14	-0.1614	0.1005	-1.61
Age of Household Head				0.0002	0.0077	0.02
Avg. Years of Education of Household Head				0.0613	0.0105	5.86
Log of Household Income				0.1699	0.0283	6.01
Log of 1992 Household Net Worth				0.2046	0.0210	9.72
Have Voluntary Contribution Pension				0.0351	0.0639	0.55
Received Inheritance Dummy				0.2120	0.0569	3.72
Not Risk Averse Dummy				0.0152	0.0595	0.26
Log Likelihood			-2038.83			-1787.72

One of the key advantages of this model is that it controls for any omitted variables that might capture the "financial sophistication" of a household. If there were such a variable that increased the probability of holding stock (e.g., reading financial newspapers) then by including stock ownership in 1992 as an independent variable, we control for any such effects. Not surprisingly, we see from Table 6 that the primary determinant of stockholding in 2002 is stockholding in 1992. This result is also consistent with the data in Table 4. Yet, despite the addition of the stock ownership in 1992 variable, Equation 1 of Table 6 shows that the computer user dummy variable is positive and very significant. The coefficients and sample mean values generated imply that computer usage increases the probability of holding stock by 0.18. Even when other variables that are known to impact stock ownership are added to the model (Equation 2), we still observe the impact of computer usage on stock ownership. Computer usage increases the probability of holding stock by 0.07.[18] Equation 2 of Table 6 shows the 1992 computer usage dummy variable continues to contribute positively to stock ownership in 2002 and is significant.[19] The coefficients from the probit model show that computer usage affects stock ownership as much as having over $27,000 more mean household

[18] With a 95% confidence interval of [0.02, 0.11]

[19] Significant at the 1% level in both Equations 1 & 2.

income, or over 2.5 more mean years of education.[20]

Additionally from the Own Stock in 1992*1992 Computer User Dummy interaction term[21], we see that computer usage has a larger impact on stockholding among households that did not previously own stock in 1992. This is consistent with our hypothesis that the decrease in transaction costs would induce households to participate when they did not previously participate, and that this effect would be stronger for households in which transactions costs decreased the most (i.e., computer using households).

4.3 Robustness Checks

4.3.1 Non-Linear Stockholding-Income Relationship

The main model specification for Table 6 assumes a certain relationship between stockholding and the independent variables. To test that the computer usage coefficient is not picking up some other non-linear relationship between income or net worth and stock ownership, we also consider a variation of our model specification which includes quadratic terms for household income and household net worth. For this model specification, we do not observe a large change in the effect

[20]In a previous version of this paper we also performed a difference-in-differences analysis. Given our model specification, the possibility of other types of unobserved fixed effects was not a major concern. Although, in the interest of completeness, we utilized the panel nature of our data set to develop a model that partially controls for fixed effects. Since we did not have any variation over time in the key independent variables, a conditional logit model was not feasible. However, using a difference-in-differences approach with the pooled panel data from 1992 and 2000 allowed us to difference out some fixed effects. This model specification was

$$\begin{aligned} OWNSTK_{it} &= \beta_0 + \beta_1 COMPUTERDUMMY_i + \beta_2 YEARDUMMY_{it} \\ &+ \beta_3 COMPUTERDUMMY * YEARDUMMY_{it} + \sum_{k=4}^{K} \beta_k X_{itk} + \epsilon_{it}, \end{aligned}$$

where X_{itk} is the set of household characteristic control variables. The results from this model provided more evidence that computer usage contributes positively to the probability that a household will hold stock. Being a computer user increased the probability of owning stock by 0.07. However, this model did not provide additional information on the effects of computer use over time, since the coefficient of the 1992 Computer User*Year 2000 Dummy was not significant. However, this result should not be cause for concern. Given that the participation rate of non-computer users was very low, even a small increase in participation over time was enough to produce large percentage gains in stock ownership numbers of non-computer users.

[21]Significant at the 11% level.

of computer usage on stockholding.[22]

4.3.2 Interaction Effects

To eliminate any interaction effects with the Own Stock in 1992 variable and the control variables, we include Own Stock in 1992*Control Variable interaction terms in the specification used for Table 6 and the results are presented in Table 7. Since we add six interaction terms containing Own Stock in 1992, we naturally see a decline in the effect and significance of the Own Stock in 1992 variable. We see a slight increased significance for the computer user dummy variable. Thus the computer user dummy is still significant at the 1% level. Additionally, the education, income, and net worth variables are significant at the 1% level. Received inheritance and the Own Stock*Income interaction variable are significant at the 5% level. However, all of the other interaction terms are not significant with t-values ranging from -0.64 to 1.04. Thus, we ensure that there are no significant interaction effects affecting our results.

4.3.3 Age Effects

While we do control for age in all of the model specifications, we also test if there is an effect of becoming retired during the period studied. We perform an additional check to ensure that there are not discrete age effects (See Table 8). We create two age bands within our data set: band 1 contains households in which the head of household is between 45 and 52 in 1992; band 2 contains households in which the head of household is between 53 and 61 in 1992. The age groupings are done in this manner so that we can see any effect of becoming retired by the year 2002 and owning stock. Through the coefficient of the dummy variable for age band 2, we see that the age group that retires/becomes retirement age by 2002 is less likely to own stock in 2002. Thus, we verify that the older households are least likely to increase stock market participation.

[22]The point estimate for the computer usage variable increased only slightly, to 0.1853, while the standard error remained unchanged.

Table 7: Own Stock in 1992 Interactions

	Coefficient	Standard Error	t-ratio
Intercept	-5.7486	0.6922	-8.31
Own Stock in 1992	0.5760	1.1267	0.51
1992 Computer User Dummy	0.1849	0.0678	2.73
Own Stock in 1992*1992 Computer User Dummy	-0.1710	0.1069	-1.60
Age of Household Head	-0.0021	0.0099	-0.21
Years of Education of Household Head	0.0483	0.0126	3.82
Log of Household Income	0.2140	0.0372	5.75
Log of 1992 Household Net Worth	0.1895	0.0253	7.50
Have a Voluntary Contribution Pension	0.0402	0.0639	0.63
Received Inheritance Dummy	0.1780	0.0767	2.32
Not Risk Averse Dummy	0.0421	0.0773	0.54
Own Stock in 1992*Age of Head	0.0064	0.0160	0.40
Own Stock in 1992*Years of Education of Head	0.0410	0.0224	1.83
Own Stock in 1992*Log of Household Income	-0.1135	0.0580	-1.96
Own Stock in 1992*Log of Household Net Worth	0.0471	0.0455	1.04
Own Stock in 1992*Received Inheritance	0.0751	0.1151	0.65
Own Stock in 1992*Not Risk Averse	-0.0770	0.1209	-0.64
Log Likelihood			-1783.63

Table 8: Age Effects and Stock Market Participation

	Coefficient	Standard Error	t-ratio
Intercept	-6.0313	0.5713	-10.56
Own Stock in 1992	0.8380	0.0715	11.71
1992 Computer User Dummy	0.1797	0.0663	2.71
Own Stock in 1992*1992 Computer User Dummy	-0.1669	0.1006	-1.66
Age of Household Head	0.0053	0.0085	0.63
Years of Education of Household Head	0.0612	0.0105	5.85
Log of Household Income	0.1704	0.0283	6.02
Log of 1992 Household Net Worth	0.2047	0.0210	9.73
Have a Voluntary Contribution Pension	0.0373	0.0639	0.58
Received Inheritance Dummy	0.2109	0.0569	3.71
Not Risk Averse Dummy	0.0154	0.0595	0.26
Band 2 Dummy	-0.1751	0.1176	-1.49
Log Likelihood			-1786.61

Table 9: Impact of Internet Usage on Stockholding in 2002

	(1)			(2)		
	Coeff.	Std. Error	t-ratio	Coeff.	Std. Error	t-ratio
Dependent Variable: Own Stock in 2002						
Intercept	-1.1108	0.4077	-2.72	-7.4503	3.9044	-1.91
Own Stock in 1992 Dummy	1.5415	0.8524	1.81	1.6185	1.0183	1.59
Internet User Dummy	0.9406	0.4573	2.06	0.8433	0.5131	1.64
Own Stock in 1992*Internet User	-1.0158	0.9028	-1.13	-1.1729	1.0629	-1.10
Age of Household Head				0.0278	0.0509	0.55
Avg. Years of Education of Household Head				0.0543	0.0736	0.74
Log of Household Income				0.3564	0.2190	1.63
Log of 1992 Household Net Worth				0.0050	0.1268	0.04
Have Voluntary Contribution Pension				-0.4772	0.3995	-1.19
Received Inheritance Dummy				0.7104	0.3257	2.18
Not Risk Averse Dummy				0.0832	0.3514	0.24
Log Likelihood			-56.65			-49.29

4.4 2002 Internet Usage Question

As mentioned previously, the 2002 HRS also contains questions specifically regarding Internet usage. However, there was limited response (only 2.4%) in the sample to the Internet related questions. The small sample size does decrease the power of the test. Yet, we still can use this small sample data to give us some initial confirmation that our computer usage dummy variable is a reasonable proxy for Internet usage. Utilizing the data related to Internet usage to create an Internet usage dummy variable, we have the following model specification:

$$\begin{aligned} OWNSTK2002_i &= \beta_0 + \beta_1 OWNSTK1992_i + \beta_2 INTERNETDUMMY_i \\ &+ \beta_3 OWNSTK1992 * INTERNETDUMMY_i + \sum_{k=4}^{K} \beta_k X_{ik} + \epsilon_i, \end{aligned}$$

We see from Table 9 - Equation 2 that the Internet User Dummy variable is less significant but it is still significant at the 10% level. We also observe that magnitude of the effect on stock market participation is larger than our previous results using computer usage as a proxy for Internet usage. Within this sample, Internet usage increases the probability of holding stock by 0.31.

5 Conclusion

The stock market participation rates for the households in the HRS data set indicated an increase in the average overall participation rates. Further tests of household participation through the use of probit models confirm this fundamental change in stock market participation. After controlling for a number of relevant factors, the results conclusively support the idea that households that are use computers/Internet increased participation substantially more than households that do not use computers/Internet. Since information and transaction costs decreased more for computer savvy households, this finding is consistent with the hypothesis that these costs significantly contributed to the historically low rate of stock market participation.

In the HRS data, computer usage increases the probability of owning stock by 0.07. We also see that despite numerous robustness checks and variations of the main model specification, the computer/Internet usage dummy remains significant. Given that the data set is comprised of retirement age individuals who would *not* necessarily increase their stock market participation over time and who are *less* likely to use the Internet to trade (see Barber and Odean (2002) and Choi, Laibson, and Metrick (2002)), these results should be considered particularly strong. Data for 1992-2001 from the SCF confirms that households in which the head was less than 45 years old increased stock market participation substantially more than households in which the head was 45 years old or older.[23] In this sense, the participation increase due to computer usage that we observe may be considered to be a lower bound on the participation increase attributable to computer usage in the total U.S. population. It is likely that the percentage increase in average overall participation rates for computer/Internet users would be much larger in a representative sample of the population.

The bull market of the 1990s and the growth of tax deferred retirement savings vehicles in the U.S. have been offered as alternative explanations for the substantial participation increase that we observe in the data. However, since we define stock market participation to be ownership of

[23] 1992 Stock Market Participation for Age Cohort: less than 35 (28.4%), 35-44 (42.4%), 45-54 (46.4%), 55-64 (45.4%), 65-74 (30.3%), 75 or more (25.7%); 2001 Stock Market Participation for Age Cohort: less than 35 (48.9%), 35-44 (59.5%), 45-54 (59.3%), 55-64 (57.1%), 65-74 (39.3%), 75 or more (34.2%).

shares of stock in publicly held corporations, mutual funds, or investment trusts and do not include IRA account, Keogh accounts, stocks held in 401Ks or similar defined contribution pension plans, our documented increase in participation cannot be due to the growth of tax deferred retirement savings vehicles in the U.S. In regard to the above average stock market returns driving increased participation, evidence from countries such as the Netherlands indicates that a bull market does not necessarily generate increased stock market participation. Furthermore, we still observe increased participation in the U.S. even *after* the end of the bull market (2002 data).

This paper has empirically examined the hypothesis that there has been a fundamental change in stock market participation in the last decade and then linked this change to the Internet using several econometric tools. The relationship between on-line trading and lower transaction costs, lower information costs, and easier access to stock markets means that these types of frictions do significantly affect stock market participation and may be an important cause of the historically low stock market participation. Therefore, the observed increase in stock market participation after the introduction of on-line trading may be related to estimates of relative risk aversion.[24] Additionally, evidence of the relevance of market frictions other than those previously considered in the literature is valuable. Incorporating additional types of market frictions into the standard asset pricing models may enable the models to satisfy restrictions on the IMRS that are stronger than the weakest possible restrictions (Hansen-Jagannathan bounds) that have been studied in the literature thus far.

[24]For instance, Vissing-Jørgensen (1997) shows how estimates of the coefficient of relative risk aversion based on the CCAPM that include the consumption of stockholders and non-stockholders will lead to an upward biased estimate of risk aversion whenever the consumption of non-stockholders is less correlated with stock returns than that of stockholders. The relationship between this bias and the percent of stockholders in the population is $\frac{\gamma^*}{\gamma} = \lambda$, where γ^* is the coefficient of relative risk aversion that is generated for the entire population, γ is the "true" coefficient of relative risk aversion (for stockholders only), and λ is the percent of stockholders in the population. Given the evidence of increased stock market participation that we have obtained, we can see that the observed γ^*, in aggregate data, will be closer to the "true" coefficient of relative risk aversion, γ.

Appendix

A Description of Variables Used in Analysis

- Own Stock Dummy Variable - A dummy variable that is given a value of 1 if the household owns stock in a given year and is set to 0 otherwise. Stock ownership includes owning shares of stock in publicly held corporations, mutual funds, or investment trusts. It does not include assets in IRA accounts, Koegh accounts, 401Ks or similar defined contribution pension plans.
- 1992 Computer User Dummy Variable - A dummy variable that is given a value of 0 if the head of the household indicated that he/she did not work with computers. The variable is set to 1 otherwise.
- Age of Household Head - The age of the head of the household.
- Years of Education of Household Head - The years of education of the head of the household.
- Log of Household Income - The natural logarithm of the household income. Household income includes salary, wages, investment income, and other income. (Base year 2002 $s)
- Log of Household Net Worth - The natural logarithm of the household net worth. Household net worth includes financial assets, non-financial assets, and retirement accounts. (Base year 2002 $s)
- Voluntary Contribution Pension Dummy Variable - A dummy variable that is given a value of 1 if the household has a voluntary contribution pension and is set to 0 otherwise.
- Received and Inheritance Dummy Variable - A dummy variable that is given a value of 1 if the household has received any type of inheritance and is set to 0 otherwise.
- Not Risk Averse Dummy Variable - A dummy variable indicating if the household head is risk averse. The variable is given a value of 0 if the household head would prefer a certain salary to a lottery between a 50% chance of doubling their salary and a 50% chance of getting a 20% salary reduction. The variable is set to 1 otherwise.
- Internet User Dummy Variable - A dummy variable that is given a value of 1 if the household head indicated that he/she used the Internet at work or home. The variable is set to 0 otherwise.

References

Allen, F., & Gale, D. (1994). "Limited Market Participation and Volatility of Asset Prices." *American Economic Review*, *84*(4), 933-955.

Ameriks, J., & Zeldes, S. P. (2001). "How Do Household Portfolio Shares Vary with Age?" (Mimeo, Columbia University)

Barber, B. M., & Odean, T. (2002). "Online Investors: Do the Slow Die First?" *Review of Financial Studies*, *15*(2), 455-487.

Bertaut, C. C. (1998). "Stockholding Behavior of U.S. Households: Evidence From the 1983-1989 Survey of Consumer Finances." *Review of Economics and Statistics*, *80*(2), 263-275.

Bertaut, C. C., & Haliassos, M. (1997). "Precautionary Portfolio Behavior from a Life-Cycle Perspective." *Journal of Economic Dynamics and Control*, *21*, 1511-1542.

Blume, M. E., & Zeldes, S. P. (1994). "Household Stockownership Patterns and Aggregate Asset Pricing Theories." (Mimeo, The Wharton School of the University of Pennsylvania)

Choi, J. J., Laibson, D., & Metrick, A. (2002). "Does the Internet Increase Trading? Evidence From Investor Behavior in 401K Plans." *Journal of Financial Economics*, *64*(3), 397-421.

Cochrane, J. H. (2001). *Asset Pricing.* Princeton, N.J.: Princeton University Press.

Freund, C. L., & Weinhold, D. (2000). "On the Effect of the Internet on International Trade." *Board of Governors of the Federal Reserve System.* (Discussion Paper: 693)

Goolsbee, A. (2000). "In a World Without Borders: the Impact of Taxes on Internet Commerce." *Quarterly Journal of Economics*, 561-576.

Goolsbee, A., & Chevalier, J. (2003). "Measuring Prices and Price Competition Online: Amazon and Barnes and Noble." *Quantitative Marketing and Economics*, *1*(2), 203-222.

Goss, E. (2001). "The Internet's Contribution to U.S. Productivity Growth." *Business Economics*, *36*(4), 32-42.

Guiso, L., Haliassos, M., & Jappelli, T. (2003). "Equity Culture: Theory and Cross-Country Evidence." *Economic Policy*, 123-170.

Haliassos, M., & Bertaut, C. C. (1995). "Why Do So Few Hold Stocks?" *Economic Journal*, *105*, 1110-1129.

Hansen, L. P., & Jagannathan, R. (1991). "Implications of Security Market Data for Models of Dynamic Economies." *Journal of Political Economy*, *99*(2), 225-262.

He, H., & Modest, D. M. (1995). "Market Frictions and Consumption-Based Asset Pricing." *Journal of Political Economy*, *103*(1), 94-117.

Hong, H., Kubik, J. D., & Stein, J. (2004). "Social Interaction and Stock Market Participation." *Journal of Finance*, *59*(1), 137-163.

Lal, R., & Sarvary, M. (1999). "When and How Is the Internet Likely to Decrease Price Competition?" *Marketing Science*, *18*(4), 485-503.

Luttmer, E. G. (1996). "Asset Pricing in Economies with Frictions." *Econometrica*, *64*(6), 1439-1467.

Luttmer, E. G. (1999). "What Level of Fixed Costs Can Reconcile Consumption and Stock Returns." *Journal of Political Economy*, *107*(5), 969-997.

Mankiw, N. G., & Zeldes, S. P. (1991). "The Consumption of Stockholders and Nonstockholders." *Journal of Financial Economics*, *29*, 97-112.

Mehra, R., & Prescott, E. C. (1985). "The Equity Premium: A Puzzle." *Journal of Monetary Economics*, *15*, 145-161.

Peress, J. (2005). "Information vs. Entry Costs: What Explains U.S. Stock Market Evolution?" *Journal of Financial and Quantitative Analysis*, *40*(3), 563-594.

Press, S. J. (1989). *Bayesian Statistics: Principles, Models, and Applications.* New York: John Wiley and Sons.

Vissing-Jørgensen, A. (1997). "Limited Stock Market Participation." (Mimeo, Massachusetts Institute of Technology)

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