# Windfall Gains and Stock Market Participation*

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We estimate the causal effect of wealth on participation in several asset markets using data on Swedish lottery players. A $150,000 windfall gain increases stock ownership probability by 12 percentage points among pre-lottery nonparticipants, with no discernible effect on pre-lottery stock owners. The effect is immediate, heterogeneous in intuitive ways, and smaller than predicted by a plausibly calibrated life-cycle model. Additional analyses suggest limited roles for real estate, debt, and procrastination. However, many players eschew equities for bonds, especially following periods of negative equity returns. Overall, results suggest "nonstandard" beliefs or preferences contribute to equity nonparticipation across many demographic groups.

*This paper is part of a project hosted by the Research Institute of Industrial Economics (IFN). We are grateful to IFN Director Magnus Henrekson for his strong support of the project and to Marta Benkestock for superb administrative assistance. For helpful comments, we thank Steffen Andersen, Dan Benjamin, Claudio Campanale, David Laibson, Annette Vissing-Jørgensen, Enrichetta Ravina, Paolo Sodini, and Roine Vestman, as well as seminar participants at NYU Stern, IFN, Institute for International Economic Studies, London Business School, Copenhagen Business School, the Federal Reserve Bank of New York, the Federal Reserve Board of Governors, University of Southern California, the 2015 NBER SI (Household Finance), and the 2015 SED. We also gratefully acknowledge financial support from the Alfred P. Sloan Foundation through the NBER Household Finance small grant program (22-2382-13-1-33-003), the NSF (1326635), the Swedish Council for Working Life and Social Research (2011-1437), the Swedish Research Council (B0213903), Riksbankens Jubileumsfond (P15-0615:1), and Handelsbanken's Research Foundations (P2011:0032:1). The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Board of Governors.
JEL No: D1,D14,D91, G02,G11, G12

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# 1 Introduction

"The ideal experiment to answer the causality question would be to exogenously dump a large amount of wealth on a random sample of households and examine the effect... on their risk-taking behavior." - Carroll (2002)

Canonical life-cycle models of consumption and savings predict all individuals should invest a positive fraction of their wealth in equities (Samuelson (1969); Merton (1971)). However, a sizable fraction of households in developed countries do not own equity (Guiso, Haliassos and Jappelli (2002)). A large literature in household finance formulates and tests hypotheses about the causes of what has been dubbed the "nonparticipation puzzle" (Haliassos and Bertaut (1995); Vissing-Jørgensen (2003); Campbell (2006); Guiso and Sodini (2013)). Insights into the causes of nonparticipation in equity and other asset markets may guide efforts to more effectively promote efficient financial decision making (Campbell (2006)).

Limited stock market participation is often analyzed in models where agents weigh the benefits of participation against its costs (Mulligan and Sala-i Martin (2000); Vissing-Jørgensen (2002); Vissing-Jørgensen (2003); Paiella (2007); Attanasio and Paiella (2011)). A pioneer in this literature was Vissing-Jørgensen (2003), who proposed a simple framework with two types of fixed costs: per-period participation costs and a one-time entry cost. Since the gains from participation are increasing in wealth, whereas the costs are assumed fixed, these models provide a simple and plausible structural interpretation of the robustly documented positive correlation between wealth and stock market participation (Mankiw and Zeldes (1991); Poterba and Samwick (2003); Campbell (2006)). Vissing-Jørgensen (2003) showed that in a model calibrated using the US cross-sectional wealth distribution, per-period participation costs of a magnitude comparable to realistic estimates of the direct financial costs of participation could account for the majority of the nonparticipation for all but the wealthiest households. This framework has proven to be a valuable foundation and can be extended to account for housing (Cocco (2005); Flavin and Yamashita (2011); Vestman (2013)), outstanding debt (Davis, Kubler and Willen (2006); Becker and Shabani (2010)), private business equity (Heaton and Lucas (2000a)) and stochastic labor income (Viceira (2001)).

Although such models of equity market participation make precise, quantitative predictions about the effect of a windfall gain on risk-taking behavior, credibly testing these predictions is difficult, as the opening quote by Carroll illustrates. In this paper, we estimate the causal effect of wealth on participation in equity, bond, real estate and debt markets by exploiting the randomized assignment of wealth in three Swedish samples of lottery players who have been matched to administrative records with high-quality information about financial portfolios. The sample has a number of desirable characteristics. First, we observe the factors (e.g., number of tickets owned) conditional on which the lottery wealth is randomly assigned. Second, because the size of the prize pool is over 650 million dollars, our study has excellent power to detect even modest effects of wealth on participation over various time horizons. Third, the prizes won by the players in our sample vary in magnitude, allowing us to explore and characterize nonlinear effects of wealth. Finally, because our lottery and financial data are drawn from administrative records, our sample is virtually free from attrition.

A first contribution of this paper is to provide credible and precise estimates of how large wealth shocks affect stock market participation. The relationship between wealth and participation is usually estimated using observational data (Brunnermeier and Nagel (2008); Calvet and Sodini (2014)) where, even applying the best methods, it is difficult to completely eliminate concerns about omitted variables and simultaneity. In contrast, our research design closely approximates Carroll's ideal experiment: prizes are randomly assigned conditional on factors that we can observe and identifying variation primarily comes from large wealth shocks. We find that on average a positive net wealth shock of 1M SEK (approximately 150K USD) increases the participation probability in post-lottery years by 4 percentage points.[1] This effect is accounted for entirely by a 12 percentage-point increase in the stock market participation of households that did not participate in equity markets prior to the lottery. The positive effect in these households is precisely estimated, immediate, seemingly permanent, and heterogeneous in directions that are easy to reconcile qualitatively with the predictions of standard models: wealth effects are larger in households who are poorer, more highly-educated, debt-free, not self-employed, and win following a period of positive equity returns.

As noted in Kahn and Whited (2016), applying economic theory permits identification of relevant parameters and aids interpretation of causal estimates. A second contribution, therefore, is our use of a structural life-cycle model to identify implied costs of equity market entry and participation. This exercise both facilitates comparison to a comprehensive body of structural work (e.g., Gomes and Michaelides (2005); Cocco (2005); Alan (2006); Khorunzhina (2013); Fagereng, Got-

[1] All monetary variables presented in this paper are reported in year-2010 prices. When converting to USD, we use the Dec. 31, 2010 exchange rate of 6.72 SEK/1 USD.

tlieb and Guiso (2015)) and helps narrow the set of hypotheses about the causes of stock market nonparticipation. We show that under a wide range of calibrations, a life-cycle model systematically predicts effects of windfall gains on participation substantially larger than those we estimate. Estimating the fixed entry and participation costs needed to match our reduced form findings, we find that over 45 percent of nonparticipants have entry costs greater than 1M SEK (150K USD), whereas per-period participation costs are quite modest and exhibit little variation across households. The entry costs we estimate are consistently much larger than those typical in the structural literature and too large to realistically reflect financial costs of stock market entry.

A third contribution is demonstrating how wealth affects investment in a number of asset classes besides equities, including bond and structured products, real estate, and debt. While participation in equity markets is the most commonly studied household portfolio choice puzzle, participation in other markets has received recent attention (Becker and Shabani (2010); Célérier and Vallée (2015); Shiller (2007); Magri (2007)) and is of independent interest. We find that among players who did not own bonds or structured products prior to the lottery, a 1M SEK (150K USD) windfall gain increases ownership probability by 20 percentage points. Among players who did not own property, a 1M SEK (150K USD) windfall increases the probability of owning real estate by 7 percentage points. Strikingly, following periods of negative equity returns, windfall gains have significantly larger effects on bond and real estate market entry than after periods of positive equity returns. For equities, we observe the opposite – players who win during bear markets are less likely to acquire stocks. This suggests nonstandard belief-formation processes (Vissing-Jørgensen (2003); Malmendier and Nagel (2011); Greenwood and Shleifer (2014)) may contribute to the discrepancy between theoretical predictions and the reduced form estimates. The large effects on bond and structural product market participation show that the smaller-than-predicted effects on equity participation do not reflect a general aversion to (or lack of knowledge about) financial markets, but may reflect an aversion to stocks as a specific asset class. Finally, relatively modest effects on property ownership and debt market exit suggest a limited role for real estate purchases and debt reductions.

Most closely related to our work is a study by Andersen and Nielsen (2011) which makes sophisticated use of Danish administrative data to study how the receipt of inheritances caused by sudden deaths (as classified using conventional medical criteria using diagnoses codes from death certificates) impact subsequent stock market participation. Andersen and Nielsen (2011) compare the stock market participation of the beneficiaries of such inheritances to that of a set of individuals matched on age, sex, education and earnings deciles and wealth deciles. Our paper builds upon this prior study by using an alternative natural experiment to estimate the effect of wealth on equity market participation, using a structural model to estimate the cost distributions required to match our causal estimate, and considering the effect of wealth on asset classes besides equities.

There are also two key methodological differences between this study and Andersen and Nielsen (2011). First, a bequest from the sudden death of a relative is conceptually different from a windfall gain to lifetime wealth. Although unexpected inheritances clearly increase present liquid wealth, the net impact on lifetime wealth is difficult to quantify, perhaps even sign correctly, as it hinges critically on the parent's saving, investment and consumption decisions under the counterfactual scenario where the parent dies at an older age. Our study's estimates can be interpreted unambiguously as reflecting the causal impact of lottery-wealth induced positive shocks to lifetime wealth.[2] Second, vast bodies of epidemiological literature have documented risk factors for the sudden deaths studied in Andersen and Nielsen (2011) (e.g., World Health Organization (2004)). Interpreting their estimates as causal requires the additional, difficult-to-test, assumption that any risk factors that also influence stock market participation are balanced across treatment and controls. We show in a series of stringent quasi-randomization checks that the wealth shocks we exploit are independent of a large number of pre-lottery characteristics, as expected under our identifying assumptions.

Nonparticipation of the wealthiest households has been previously described as "a significant challenge to financial theory" (Campbell (2006), p. 1564) because, under standard calibrations, most models imply that households forgo large welfare gains by declining to own stocks. Taken altogether, our results suggest that the challenge extends to a substantial fraction of non-wealthy households too. In our heterogeneity analyses, we document an unwillingness to enter the stock market following large windfall gains that is pervasive across all considered subpopulations. Accounting for these observed rates of non-entry in standard theoretical frameworks requires much larger costs than are typically considered in the structural literature. Additional analyses suggest that many previously hypothesized extensions, such as allowing for uninsurable income risk, real estate investment, and procrastination, are unlikely to fully explain our results, though they

[2] Andersen and Nielsen (2011)'s treatment effect may also capture any direct effects that the sudden death may have on financial decision-making (e.g., because of direct effects of grief on attitudes or economic behavior), as well as the (potentially heterogeneous) impacts of the different types of wealth bequeathed. Some of these differences, as Andersen and Nielsen (2011) note, allow them to explore interesting hypothesis (for which our data are not suitable), e.g. about the differential impacts of different types of bequeathed wealth

all contribute to narrowing the quantitative discrepancy between theoretical predictions and our causal estimates. Our finding that many winners eschew equities altogether in favor of bonds – especially following periods of negative equity returns – suggests that aversion to equities as an asset class and nonstandard beliefs about the processes that determine equity returns may be important contributing factors. Overall, our results suggest that cognitive constraints, "nonstandard" beliefs, and alternative preferences are likely to play an important role in explaining the behavior of nonparticipating households (Vissing-Jørgensen (2003); Ang, Bekaert and Liu (2005); Barberis, Huang and Thaler (2006); Guiso, Sapienza and Zingales (2008); Biais, Bossaerts and Spatt (2010); Campanale (2011); Grinblatt, Keloharju and Linnainmaa (2011)).

The remainder of the paper is structured as follows. Section 2 describes the lottery and wealth data, our identification strategy, and addresses several issues regarding external validity that are often raised about studies of lottery players. Section 3 reports reduced-form estimates of the effect of wealth on equity market participation, while Section 4 uses a structural life-cycle model to interpret the causal estimates. Section 5 considers what households do with the windfall gain and how this might inform our findings regarding equity market participation. Section 6 considers the effect of wealth on participation in bond, real estate, and debt markets independently. Finally, Section 7 discusses our findings in the context of the literature on nonparticipation and concludes.

# 2 Data and Identification Strategy

Our analyses are conducted in a sample of lottery players who have been matched to administrative demographic and financial records using players' personal identification numbers (PINs).

## 2.1 Register Data

Our outcome variables are all derived from the Swedish Wealth Register, which contains high-quality information about the financial portfolios of all Swedes. The register was discontinued when Sweden abolished its wealth tax, but has annual year-end financial information for 1999-2007. This information includes aggregate assets and debt, and relevant subcategories such as bank account balances, mutual funds, directly held stocks, bonds, money market funds, debt, residential and commercial real estate, other financial, and real assets. The data have proven valuable in household-finance research beginning with a landmark paper by Calvet, Campbell and Sodini (2007). Calvet et al. (2007) estimate that included variables account for approximately 86% of wealth in Sweden, with a few notable data limitations. First, assets in private pension plans are not measured. Second, we do not observe the composition of capital insurance, a tax-favored asset either invested in mutual funds or insurance products guaranteeing a minimum fixed return.

In our analysis we combine bonds, interest funds, and structured products into a single category. A majority of structured products are equity or index linked in some fashion (e.g., index bonds). However, capital protection is included in the payoff formula for 98% of structured products in Sweden, resulting in credit risk as the only significant downside (Calvet, Célérier, Sodini and Vallée (2016)).[3] Because capital preservation is a dominant feature, we choose to group these products with bonds and interest funds.

Finally, we supplement the portfolio data from the Wealth Register with basic demographic information available in the Statistics Sweden administered database LISA. Our analyses are conducted at the household level, with a household defined as the observed winner and, if present, his or her spouse. We choose this definition because the wealth of spouses of winning players increases by about 10% of the prize won following the lottery event, thus suggesting some joint control over assets. All our analyses are based on players aged 18 and above, and we restrict the sample to lottery draws conducted no later than 2007, the last year for which we have financial data.

## 2.2 Lottery Data

Our identification strategy is to use the available data and knowledge about the institutional details of each of the lotteries to define cells within which the lottery wealth is randomly assigned. We then control for these cell-fixed effects in our analyses, thus ensuring all identifying variation comes from players in the same cell. Because the exact construction of the cells varies across lotteries, we describe each lottery separately. All prizes considered are paid as a one-time lump sum, and all amounts quoted in this section are after tax. For a detailed description of how the original lottery data were preprocessed and quality-controlled, we refer the reader to the Online Appendix of Cesarini, Lindqvist, Östling and Wallace (2015).

**Kombi –** Kombi is a monthly subscription lottery whose proceeds are given to the Swedish Social Democratic Party, Sweden's main political party during the post-war era. Subscribers choose their desired number of subscription tickets and are billed monthly, usually by direct debit. Kombi provided us with a longitudinal data set with information about all draws conducted between 1998

[3]Calvet et al. (2016) do note that 55% of capital protected products have issue prices higher than 100% (with an average price of 105% of the guarantee)

and 2010. For each draw, the panel contains an entry per lottery participant, with information about the number of tickets held, any large prizes won, and the player's PIN.

The Kombi rules are simple. In a given draw, each prize is awarded by randomly selecting a unique ticket. Two individuals who purchased the same number of tickets are equally likely to win a large prize. To construct the cells, each winning player is matched to (up to) 100 non-winning players with the same number of tickets in the month of the draw. To improve precision, we choose controls similar to the winner on sex and age whenever more than 100 matches are available. This matching procedure leaves a sample of 347 large prize-winners, matched to a total of 34,595 controls.

**Triss –** The second sample is a scratch-ticket lottery run since 1986 by Svenska Spel, the Swedish government-owned gambling company. Since 1994, Triss lottery players can win the opportunity to participate in a TV show where they can win substantial prizes. In a typical month, 25 Triss winners appear on the show and draw a prize by selecting a ticket from a stack. The tickets are shuffled and look identical. The prizes are distributed according to a known prize plan with prizes varying from 50K SEK to 5M SEK. The prize plan is subject to occasional revision.

Svenska Spel supplied the basic demographic information (name, age, region of residence, and often also the names of close relatives) about all individuals who participated in the TV show between 1994 and 2010. With the help of Statistics Sweden, we were able to reliably identify the PINs of 99% of show participants. Svenska Spel also listed cases in which the player shared ownership of the ticket. Our analyses are based exclusively on the 90% of winners who did not indicate they shared ownership of the winning ticket. Our empirical strategy makes use of the fact that, conditional on the prize plan, the nominal prize amount is plausibly random. Thus, two players are assigned to the same cell if they won in the same year and under the same prize plan, providing a final sample of 3,400 winners.

**PLS –** PLS accounts are savings accounts whose owners participate in regular lotteries with monetary prizes paid on top of (or sometimes in lieu of) interest payments. Such accounts have existed in Sweden since 1949 and were originally subsidized by the government. When the subsidies ceased in 1985, the government authorized banks to continue to offer prize-linked-savings products. Two systems were put into place, one operated by savings banks and one by all other banks. The two systems were approximately equally popular and participation was widespread across broad strata of Swedish society, with every other Swede owning an account.

The PLS sample was obtained by combining data from two sources of information about the PLS accounts maintained by the commercial banks and state bank. The first source is a set of printed lists with information about prizes won in the draws between 1986-2003. For each prize won in a draw, these sheets list the prize amount, type of prize won (described below), and the winning account number. The second source is a large number of microfiche images with information (account number, account owner's PIN, and number of tickets received) about all eligible accounts participating in the draws between December 1986 and December 1994 (the "fiche period"). Because the prize lists contain the winning account number, but not its owner PIN, the fiches are needed to identify winning players' PIN.

PLS account holders could win two types of prizes: odds prizes and fixed prizes. The probability of winning either type of prize was proportional to the number of tickets associated with an account: account holders assigned one lottery ticket per 100 SEK in account balance. Fixed prizes, which constitute the majority of prizes, were prizes whose magnitude did not depend on the balance of the winning account. Odds prizes, on the other hand, were awarded as a multiple of the balance of the prize-winning account.

For fixed-prize winners, our identification strategy exploits the fact that in the population of players who won exactly the same number of fixed prizes in a particular draw, the total sum of fixed prizes won is independent of the account balance. Previous studies of lottery players have used this identification strategy (Imbens, Rubin and Sacerdote (2001); Hankins, Hoestra and Skiba (2011)). Because the strategy does not require information about the number of tickets owned, it can be employed also during the post-fiche period, as long as the winning account was active during the fiche period so the account owner's PIN can be identified. We therefore assign two individuals to the same cell if they won an identical number of fixed prizes in that draw. Overall, we were able to reliably match 99% of the fixed-prize-winning accounts from the fiche era to a PIN.

To construct odds-prize cells, we match individuals who won exactly one odds-prize in a draw to individuals with a near-identical account balance who also won exactly one prize (odds or fixed) in the same draw. This matching procedure ensures that within a cell, the prize amount is independent of potential outcomes. After the fiche period, we do not observe account balances and therefore odds prizes are only included if won during the fiche period (1986-1994). In total, the sample includes 331,596 PLS prizes, of which 476 are larger than 1M SEK (150K USD).

**Table 1: Overview of Identification Strategy.**

| Lottery | Period | Prize Type | Cells |
|---|---|---|---|
| PLS | 1989-2003 | Fixed Prize | Draw × # Fixed Prizes |
| PLS | 1989-1994 | Odds Prize | Draw × Balance |
| Kombi | 1994-2007 | Fixed Prize | Draw × # Tickets |
| Triss | 1994-2007 | Fixed Prize | Year × Prize Plan |

## 2.3 Identification Strategy

Table 1 summarizes the previous section's discussion of how we construct the cell fixed effects in each of the three lotteries. Normalizing the time of the lottery to $s = 0$, our main estimating equation is given by,

$$Y_{i,s} = \beta_s \times L_{i,0} + \mathbf{X}_{i,0} \times \mathbf{M_s} + \mathbf{Z}_{i,-1} \times \boldsymbol{\gamma}_s + \eta_{i,s}, \tag{1}$$

where $i$ indexes households, $L_{i,0}$ denotes the prize size (in million SEK), $\mathbf{X}_{i,0}$ is a vector of cell fixed effects, and $\mathbf{Z}_{i,-1}$ is a vector of controls. Controls are included to improve the precision of our estimates and are always measured in the year before the lottery. Standard errors are clustered at the level of the player. The key identifying assumption needed for $\beta_s$ to have a causal interpretation is that the prize amount won is independent of $\eta_{i,s}$ conditional on the cell fixed effects.

We estimate Equation 1 in our pooled sample and the subsample of players who participated in draws conducted between 2000 and 2007. In what follows, we refer to these samples as the *all-year* and the *post-1999* samples. The post-1999 sample plays an important role in subsample analyses where we stratify players by their pre-lottery participation status, which is first observed in 1999. In the all-year sample regressions, we control for the following lagged baseline demographic characteristics: age, sex, marital status, higher education, household size, household income, and Nordic born. In the post-1999 sample regressions, we additionally control for the following lagged baseline financial characteristics: net wealth, gross debt, and an indicator for real estate ownership.

**Prize Variation –** To get a better sense of the source of our identifying variation, Table 2 provides information about the distribution of prizes. The total value of the after-tax prize money disbursed to the winners in our samples is almost 4.4 billion SEK (about 650M USD), 57% of which is accounted for by prizes whose value is greater than the median annual Swedish household disposable income in 1999 (160K SEK (24K USD)). Thus, although small prizes account for

**Table 2: Prize Distribution.** Included are the pooled all-year and post-1999 samples, and their respective lottery subsamples. Prize amounts are in year-2010 SEK and net of taxes.

| | A. All-Year | | | | B. Post-1999 | | | |
|---|---|---|---|---|---|---|---|---|
| **Prize Amount** | **Pooled** | **PLS** | **Kombi** | **Triss** | **Pooled** | **PLS** | **Kombi** | **Triss** |
| $L_i \leq 10K$ | 342,551 | 307,956 | 34,595 | 0 | 70,353 | 41,578 | 28,775 | 0 |
| $10K < L_i \leq 100K$ | 22,026 | 21,042 | 0 | 984 | 734 | 368 | 0 | 366 |
| $100K < L_i \leq 500K$ | 4,004 | 1,933 | 0 | 2,071 | 1,237 | 0 | 0 | 1,237 |
| $500K < L_i \leq 1M$ | 346 | 189 | 0 | 157 | 89 | 0 | 0 | 89 |
| $1M < L_i \leq 2M$ | 821 | 441 | 331 | 49 | 297 | 2 | 273 | 22 |
| $2M < L_i$ | 190 | 35 | 16 | 139 | 78 | 0 | 16 | 62 |
| Total | 369,938 | 331,596 | 34,942 | 3,400 | 72,788 | 41,948 | 29,064 | 1,776 |

**Table 3: Testing for Random Assignment.** Results are obtained by estimating Equation 2 in our all-year sample, in its lottery subsamples, and in the post-1999 sample.

| | All-Year | | Post-1999 | | | | |
|---|---|---|---|---|---|---|---|
| | Pooled | | Pooled | | PLS | Kombi | Triss |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Fixed Effects | Cells | None | Cells | None | Cells | Cells | Cells |
| Demographic Controls | | | | | | | |
| $F$-stat | .61 | 9.72 | .86 | 8.86 | .78 | .84 | 1.28 |
| $p$ | .79 | <.001 | .56 | <.001 | .60 | .58 | .24 |
| Financial Controls | | | | | | | |
| $F$-stat | | | 1.31 | 12.94 | 1.36 | .56 | 1.25 |
| $p$ | | | .27 | <.001 | .24 | .64 | .29 |
| Demographic+Financial | | | | | | | |
| $F$-stat | | | 1.10 | 14.52 | .74 | 1.12 | 1.39 |
| $p$ | | | .35 | <.001 | .66 | .34 | .16 |
| $N$ | 369,938 | 369,938 | 72,788 | 72,788 | 41,948 | 29,064 | 1,776 |

a relatively large fraction of prizes won, most identifying variation comes from the larger prizes in all three lotteries. All lotteries contribute substantial identifying variation to the all-year sample, whereas Kombi and Triss prizes jointly account for most identifying variation to the post-1999 sample.

**Testing for Random Assignment –** To test our key identifying assumption, we again normalize the time of lottery to $s = 0$ and run the following regression:

$$L_{i,0} = \mathbf{X}_{i,0} \times \mathbf{\Gamma}_0 + \mathbf{Z}_{i,-1} \times \boldsymbol{\rho}_{-1} + \epsilon_i. \quad (2)$$

Under the null hypothesis of conditional random assignment, the characteristics determined before the lottery ($\mathbf{Z}_{i,-1}$) should not predict the lottery outcome ($L_i$) conditional on the cell fixed ($\mathbf{X}_{i,0}$) effects. We run these quasi-randomization tests in the all-year sample, its lottery subsamples, and the post-1999 sample. As expected, Table 3 shows that the lagged characteristics have no statistically significant predictive power in the specifications that include cell fixed effects. If they are omitted however (columns 2 and 4), the null hypotheses of random assignment is rejected.

## 2.4 Generalizability

In this section we address two important concerns about the external validity of our sample. A first concern is that individuals who play the lottery may not be representative of the population at large. A second is that inferences from Swedish lottery players about the causes of nonparticipation may not generalize to other countries.

**Generalizing within Sweden –** To investigate the representativeness of our samples, we compare the lottery samples, weighted by prize size, to randomly drawn population samples of adult Swedes matched on sex and age.

Columns 1 and 2 of Table 4 show that the demographic characteristics of our lottery players closely resemble those of the representative sample. Columns 3 and 4 compare the financial characteristics of members of the post-1999 sample to the sex- and age- matched representative sample. The pooled lottery sample has slightly less wealth than the matched population sample, slightly more debt, and is slightly more likely to participate in equity and real estate markets. Columns 5-7 provide the corresponding descriptive statistics for the post-1999 sample broken down by lottery. PLS participants, who are selected on bank account ownership, have significantly more wealth than the representative sample.

Another way to gauge representativeness is to compare the cross-sectional relationships between stock market participation and household characteristics in our lottery samples to the relationships estimated in a representative sample. We conduct such a comparison by estimating the cross-sectional probit equation used by Calvet et al. (2007) in their study of a large sample of rep-

**Table 4: Representativeness of All-Year and Post-1999 Samples.** This table compares our prize-weighted all-year and post-1999 samples to representative samples matched on sex and age. The summary statistics shown are all means and measured at $s = -1$. All variables except female, age, and Nordic born are measured at the household level.

| | All-Year | | Post-1999 | | | | |
|---|---|---|---|---|---|---|---|
| | **Pooled** | **Pop** | **Pooled** | **Pop** | **PLS** | **Kombi** | **Triss** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| **Demographic** | | | | | | | |
| Female | .50 | .50 | .52 | .52 | .58 | .44 | .56 |
| Age (years) | 56.7 | 56.7 | 56.2 | 56.2 | 62.9 | 61.7 | 51.9 |
| Nordic Born | .96 | .94 | .96 | .93 | .95 | .98 | .94 |
| Household Members (#) | 1.86 | 1.87 | 1.97 | 1.97 | 1.75 | 1.75 | 2.14 |
| Household Income (K SEK) | 324 | 304 | 364 | 358 | 330 | 342 | 382 |
| Married | .56 | .56 | .52 | .53 | .52 | .48 | .54 |
| Higher Education | .35 | .35 | .39 | .45 | .39 | .34 | .42 |
| **Financial** | | | | | | | |
| Net Wealth (K SEK) | | | 879 | 1,131 | 1,484 | 829 | 851 |
| Gross Debt (K SEK) | | | 362 | 349 | 238 | 246 | 452 |
| Home Owner | | | .75 | .70 | .73 | .78 | .73 |
| Equity Owner | | | .59 | .57 | .68 | .62 | .56 |
| $N$ | 369,938 | 84,034 | 72,788 | 33,472 | 41,948 | 29,064 | 1,776 |

resentative Swedes. To avoid including wealth variation that was induced by the lottery, we restrict the estimation sample to the post-1999 sample and estimate the probit specification using the 1999 cross-sectional wealth data in (i) our post-1999 lottery sample and (ii) a sex- and age-weighted representative sample. The results, reported in Appendix Table B.2, show the overall pattern of conditional correlations are similar in our lottery sample and the reweighted representative sample.

**Generalizing beyond Sweden –** The processes that cause participation in Sweden may differ in important ways from the processes in other countries. An indirect way to evaluate generalizability beyond Sweden is to compare the cross-sectional relationships of financial variables with demographic characteristics in Sweden to other countries. Previous work has noted that the predictors of nonparticipation in Sweden and the United States are similar, as is the aggregate composition of household wealth in the two countries. For example, the Swedish participation rate was 62% in

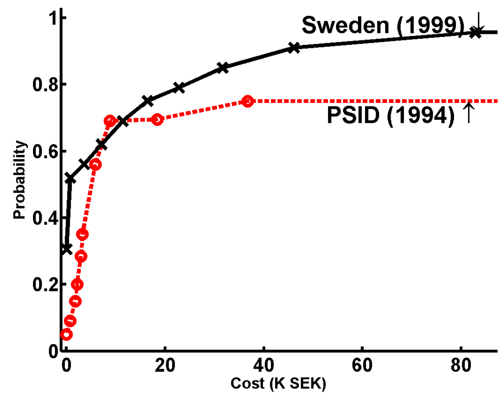



**Figure 1: Comparing CDFs of Estimated Per-Period Participation Costs in Sweden and the US.** For methodological details, see Exercise B of Vissing-Jørgensen (2003).

1999, compared to 59% in the United States (Campbell (2006), pp. 1572-1576).

To provide further indirect evidence on generalizability we compare the participation cost distribution implied by the 1999 cross-sectional wealth data in our post-1999 lottery sample with the distribution calculated by Vissing-Jørgensen (2003) using the 1994 PSID. In Vissing-Jørgensen (2003)'s framework, households decline to participate if at their level of wealth, the gains from participation are too small to offset the costs. The benefits are the expected equity premium for the share of the wealth that the household chooses to allocate to the risky financial portfolio. Assuming time separable and homothetic preferences, the per-period benefit of participation of household $i$ at time $t$ can be approximated by

$$Benefit_{i,t} = W_{i,t} \times \alpha_{i,t} \times (r^{ce}_{i,t} - r^{f}_{t}) \tag{3}$$

where $W_{i,t}$ is household $i$'s wealth at time $t$, $\alpha_{i,t}$ is the fraction of wealth household $i$ would invest in equities at time $t$ if they participate, and $r^{ce}_{i,t}$ is the certain return that would make a household indifferent between investing in risky equity and investing in an asset commanding a certain return of $r^{ce}_{i,t}$. An estimate of a households participation cost is then obtained from the dollar amount required to offset this benefit. Figure 1 shows that applying Vissing-Jørgensen (2003)'s methodology with $(r^{ce}_{i,t} - r^{f}_{t}) = .04$ to our Swedish sample results in cumulative distribution function (CDF) of participation costs similar to the 1994 PSID.

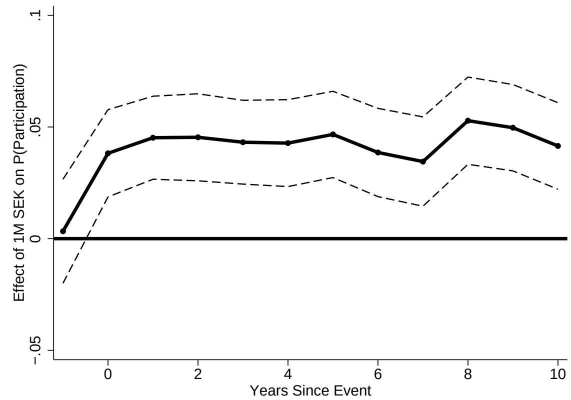



**Figure 2: Effect of Wealth (1M SEK) on Participation Probability.** Coefficients and 95% confidence intervals are obtained by estimating Equation 1 in the all-year sample. See Appendix Table B.3 for the underlying estimates.

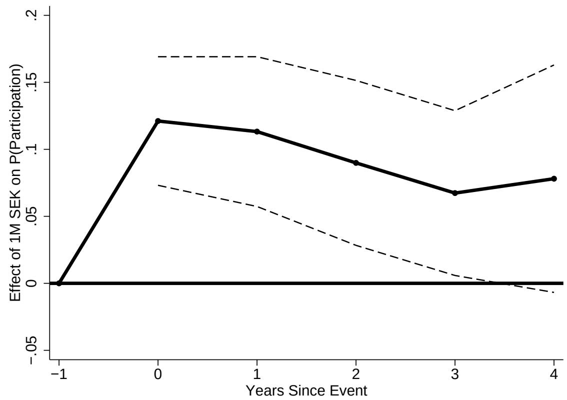
# 3 Empirical Results

We now turn our attention to analyzing the effect of wealth on equity market participation. In this section we present some selected reduced form analyses.

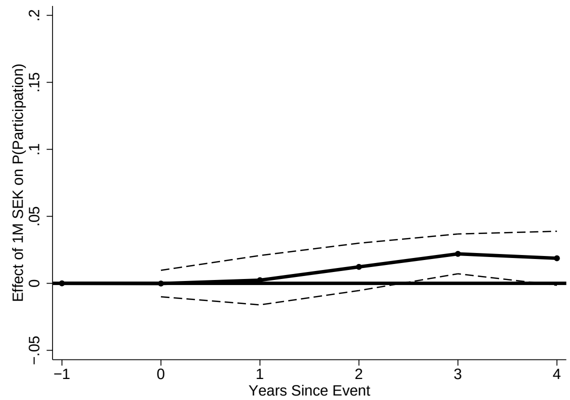
## 3.1 Participation in Equity Markets

Our primary outcome variable is year-end participation, defined as an indicator equal to 1 for individuals who own stocks either directly or indirectly via mutual funds. Figure 2 presents the estimated coefficients for $s = -1, ..., 10$ from the pooled lottery sample. We estimate that 1M SEK (150K USD) causes a near-immediate and permanent increase in the participation probability of around 3.8 percentage points. As expected, lottery wealth does not predict participation prior to the lottery. Effects are qualitatively similar if we define participation more narrowly to only include directly owned stocks (Appendix Table B.3, Panel B).

**Heterogeneity** We next investigate if the effects estimated in the pooled sample mask any treatment-effect heterogeneity. An obvious potential source of heterogeneity is equity market participation prior to the lottery. Figure 3 shows the estimated treatment-effects on participation probability in $s = -1, ..., 4$ in the post-1999 lottery sample stratified by pre-lottery participation status. The estimated effects of wealth differ dramatically between nonparticipants (a) and participants (b). In pre-lottery nonparticipants, we estimate that 1M SEK increases the participation probability




**(a) Nonparticipants**




**(b) Participants**

**Figure 3: Effect of Wealth (1M SEK) on Participation Probability by $s = -1$ Participation Status.** Coefficients and 95% confidence intervals are obtained by estimating Equation 1 in the post-1999 sample of nonparticipants (a) and participants (b). See Appendix Table B.4 for the underlying estimates.

by 12.1 percentage points. In pre-lottery participants, the estimated effect is small and usually not statistically distinguishable from zero. Hence, the aggregate effect of 3.8 percentage points we observe in the pooled sample appears to be driven nearly entirely by a positive effect on nonparticipants. This finding is consistent with the predictions of a model in which large, one-time, fixed costs of entry are a cause of nonparticipation (where "cost" is interpreted broadly to include not just financial costs). The estimated treatment-effect among nonparticipants is similar in the four years following the lottery, though less precisely estimated as we extend the time horizon.[4] In contrast to our baseline, we observe roughly equal effects among pre-lottery participants and nonparticipants when participation is more narrowly defined to only include directly owned stocks (Appendix Table B.4, Panel B.).

Given that the causal effects appear to be driven entirely by positive effects on pre-lottery nonparticipants, we conducted a suite of additional heterogeneity analyses in this subsample, stratifying the nonparticipants by pre-lottery debt, home ownership, net wealth, stock returns in the prior calendar year, self-employment, sex, age, and educational attainment.[5] Results from these

[4]There are two reasons for the widening of the confidence intervals. First, because participation is only observed during a nine year period and we condition on prior participation status, the sample size decreases as we expand the time horizon. Second, the predictive power of the lagged financial and demographic characteristics fall with time, increasing the standard errors.

[5]Procedurally, we run a single regression in which all regressors are interacted with an indicator variable for one

**Table 5: Heterogeneous Effect of Wealth (1M SEK) on Participation Probability** Coefficients are obtained by estimating Equation 1 at time $s = 0$ in the post-1999 sample of nonparticipants at time $s = -1$. Hetero $p$ obtained from an $F$-test of the null hypothesis that the two lottery-wealth coefficients are identical. Equity returns are based on the MSCI Sweden Index the calendar year prior to the lottery.

| | **Gross Debt** | | **Home Owner** | | **Net Wealth** | | **Equity Returns** | |
|---|---|---|---|---|---|---|---|---|
| | **$= 0$** | **$> 0$** | **Yes** | **No** | **High** | **Low** | **$\leq 0$** | **$> 0$** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Effect | .212 | .094 | .105 | .144 | .066 | .137 | .056 | .140 |
| SE | (.036) | (.026) | (.027) | (.051) | (.034) | (.029) | (.039) | (.029) |
| $p$ | <.001 | <.001 | <.001 | .004 | .081 | <.001 | .152 | <.001 |
| Hetero $p$ | .007 | | .496 | | .112 | | .081 | |
| $N$ | 9,763 | 10,150 | 11,652 | 82,61 | 4,780 | 15,133 | 10,573 | 9,340 |
| | **Sex** | | **Age** | | **Higher Education** | | **Self-Employed** | |
| | **Male** | **Female** | **$\leq 45$** | **$> 45$** | **Yes** | **No** | **Yes** | **No** |
| | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| Effect | .147 | .117 | .140 | .114 | .224 | .099 | .035 | .133 |
| SE | (.038) | (.031) | (.042) | (.031) | (.052) | (.026) | (.025) | (.026) |
| $p$ | <.001 | <.001 | .001 | <.001 | <.001 | <.001 | .348 | <.001 |
| Hetero $p$ | .555 | | .628 | | .032 | | .007 | |
| $N$ | 9,064 | 10,849 | 2,723 | 17,190 | 4,993 | 14,920 | 676 | 19,237 |

heterogeneity analyses for $s = 0$ are presented in Table 5.[6]

The heterogeneity analyses provide information about how participation costs are distributed across households with different observable characteristics, but are subject to the important interpretational caveat that only wealth is randomly assigned. To illustrate, consider the first dimension of heterogeneity: pre-lottery debt. Results in columns 1 and 2 show the estimated effect on participation probability is about twice as large in debt-free households. One theoretical mechanism that could account for this finding is that indebted households face interest rates that are substantially higher than the risk-free rate (Davis et al. (2006); Becker and Shabani (2010)), making debt reduction a more attractive way to spend the windfall gain than stock market entry. This is a plausible

of the subpopulations. The resulting coefficient estimates are identical to those obtained when Equation 1 is estimated separately in each subsample.

[6]Results for $s = 3$ are shown in Appendix Table B.6 and are broadly similar but less precisely estimated because the estimation sample size shrinks with time horizon.

explanation of the observed heterogeneity, but our data do not allow us to rule out the possibility that the observed heterogeneity arises because debt is correlated with other factors that shift participation incentives.

Next, we examine whether the effects differ by pre-lottery ownership of real estate. Theoretically, the net effect of real estate ownership on participation incentives is ambiguous. For example, homeowners may find participation less attractive because they have access to investment opportunities in their home, or prefer to pay off mortgage debt with higher interest rates. On the other hand, as several studies highlight (Grossman and Laroque (1990); Cocco (2005); Flavin and Yamashita (2011); Vestman (2013)), non-real estate owners may use the windfall gain to invest in real estate and this could crowd out stock purchases. In practice, we estimate effects of similar magnitude in owners and non-owners of real estate. Considering heterogeneity by pre-lottery wealth, we find that households with below-median financial wealth are more affected than wealthier households.

Fourth, we ask if the effect differs in years with positive equity returns, as indeed it may if individuals overweight recent events when forming subjective beliefs about future returns. Survey research has found investors and chief financial officers adjust their beliefs about the one-year equity premium downward (upward) following periods of negative (positive) market returns (Vissing-Jørgensen (2003); Greenwood and Shleifer (2014)). We estimate that in households who win the year after a year with negative equity return, 1M SEK (150K USD) increases the participation probability by .056, compared to .140 for households who win the year after a year with positive returns.

Our last four dimensions of heterogeneity are self-employment, age, sex, and educational attainment. If the self-employed face greater uninsurable idiosyncratic labor income risk than do regular salaried employees, the standard life-cycle model predicts the self-employed benefit less from participation (Heaton and Lucas (2000b); Viceira (2001)). Consistent with this hypothesis, we find no evidence of a positive effect of wealth on the participation probabilities of the self-employed. In our age analyses, our estimated effects are larger in younger players, but the difference is not statistically significant.

We similarly do not find a statistically significant difference in the effect on the participation probabilities of men and women, but do find significant differences by education level. The treatment-effect for higher-educated households is twice as large as for other households. One plausible interpretation of this finding is that higher-educated households face smaller information costs or experience less psychological discomfort from owning stocks (Grinblatt et al. (2011);

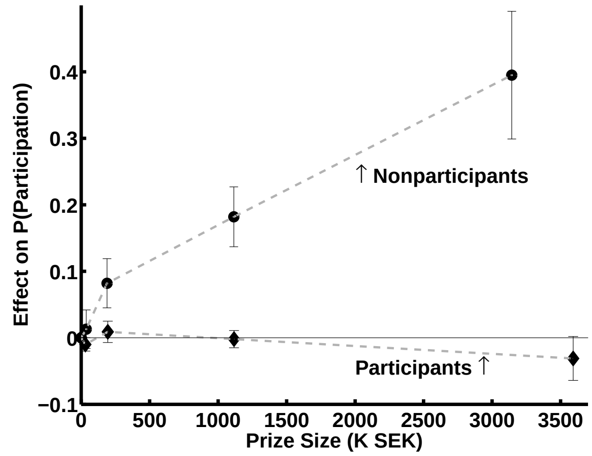



**Figure 4: Effect of Wealth on Participation Probability by Prize Size.** Coefficients are obtained by estimating Equation 1 in the post-1999 sample with the lottery wealth variable replaced by indicators for five mutually exclusive prize categories: 0 to 10K SEK (0 to 1.5K USD), 10K to 100K (1.5 to 15K), 100K to 1M (15 to 150K), 1M to 2M (150 to 300K), and 2M+ (300K+). Coefficient estimates and the 95% confidence bands are plotted at the mean prize in each category. See Appendix Table B.5 for the underlying estimates.

Van Rooij, Lusardi and Alessie (2012) ; Benjamin, Brown and Shapiro (2013)). Lower-educated households may also be deterred from entering in part because they perceive the gains of participation to be smaller, a perception that may have some basis in reality: Calvet et al. (2007) show that education is a strong predictor of the extent to which a household is able to capture diversification gains.

Overall, the results from these heterogeneity analyses show that the effect of wealth on stock market participation generally varies in intuitive ways that are easy to reconcile qualitatively with many of the proposed theories of nonparticipation.

**Nonlinearity** Under our identifying assumption, our linear estimator gives an unbiased estimate of a weighted treatment-effect. Because large prizes account for most of our identifying variation, the estimator will assign most weight to the marginal effect of wealth at modest to large levels of wealth. To test for nonlinear effects, we modify our basic estimating equation, replacing the lottery-wealth variable by indicator variables for prizes in five categories. We then run regressions with the smallest prize category omitted.

Figure 4 presents the estimated coefficients for each of these categories, with coefficients marked at the mean prize size in each category. Relative to small prize winners (<10K SEK, 1.5K USD), a prize in the range 10K-100K SEK (1.5 to 15K USD) increases the participation probability of pre-lottery nonparticipants by .014. The corresponding estimates for winners of prizes in the 100K-1M (15 to 150K), 1M-2M (150 to 300K), and 2M+ (300K+) are 0.082, 0.182 and 0.395. Thus, the marginal effect (defined as the slope between points in Figure 4) is everywhere positive, but strongest for winners of small prizes. Among pre-lottery participants, none of the prize-category coefficients are statistically distinguishable from zero.

**Robustness** We conducted a number of sensitivity checks to explore the robustness of our $s = 0$ results. The results from these analyses are summarized in Appendix Table B.1. The estimated effect of wealth on participation is similar across lotteries and is robust to excluding spousal equity ownership from our definition of participation. We also find that marginal effects from a probit estimator are substantively identical to the OLS estimates reported in the main text.

Because capital insurance likely entails some equity exposure, we expand the definition of equity market participation to include ownership of capital insurance and find a small increase on the effect on pre-lottery nonparticipants from 12 to 15 percentage points. Finally, in an attempt to find a subsample for whom previously proposed non-cost based theories of equity market non-participation are less relevant, we restrict our estimation sample to households with no self-employment income, debt less than 15K USD, and net wealth less than 1M USD. We find the effect of participation among pre-win non-participants increases to 17 percentage points per 1M SEK in this subsample, which we will revisit in the next section when we use a structural model identify costs of equity market participation and entry.

# 4 A Structural Model

The causal effects we estimate can be used to test the quantitative predictions of models in which the source of nonparticipation is modest per-period financial costs. Vissing-Jørgensen (2003) noted such financial costs were not a plausible explanation for nonparticipation among the wealthiest households, but that they could explain the nonparticipation of low- and medium-wealth households. Indeed, we find modest wealth shocks induce some households to enter equity markets, suggesting modest per-period costs plausibly explain some of the nonparticipation observed in low-wealth households. In this section, however, we show that quantitatively our estimates suggest more significant disincentives to participation are present for a substantial share of non-wealthy nonparticipants.

To provide intuition for this claim, consider the finding depicted in Figure 4 that a windfall gain greater than 2M SEK increases participation probability by 39 percentage points among nonparticipants. Evaluating Equation 3 at 2M SEK (300K USD) implies that an annual cost of at least 47K SEK (7K USD) is needed to explain continued nonparticipation.[7] This simple calibration suggests that annual per-period costs necessary to explain nonparticipation are an order of magnitude larger than the median of the participation cost distribution calculated in Section 2.4.

To provide more rigorous structural analysis and relate our estimates to the structural portfolio choice literature (e.g., Gomes and Michaelides (2005), Cocco (2005), Alan (2006), Khorunzhina (2013), and Fagereng et al. (2015)), we next turn to a richer life-cycle model of equity market participation. We first explore the model's predictions of the effect of wealth on stock market participation under a number of plausible calibrations, before using our causal estimates to identify the distribution of equity market participation and entry costs necessary for the model to match the causal estimates.

## 4.1 Model Predictions Under Plausible Calibrations

In this section we compare our empirical estimates with those predicted by a plausibly calibrated life-cycle model of equity market participation.

As a brief description, agents in the model are finitely lived, face an exogenous mortality probability and have time separable, CRRA preferences with risk aversion of 4. Each period an agent optimally chooses how much to consume, save, and invest in equity markets given the agent's age, wealth, and prior participation status. Agents who choose to participate in equity markets face two separate types of costs. Participation costs, denoted $\kappa$, are paid in each period an agent allocates non-zero wealth to equity holdings. Entry costs, denoted $\chi$, are paid whenever a previously non-participating agent decides to enter equity markets for the first time. Equity provides a risky return $r_s$ with $\mathbb{E}(r_s) > r_f$, where $r_f$ is the risk-free rate. Each period an agent is endowed with stochastic labor income $y_t$ drawn from an age-specific distribution. Both income and equity returns are calibrated to match historical Swedish observations, yielding a 6.7% baseline equity premium and the income profile presented in Appendix Figure A.2. For a full specification of the model, we refer the reader to Appendix A.

To compare the model's predictions to our causal estimates, we solve the baseline model, simulate a data set, and estimate the effect of lottery prizes on participation in the simulated data.

[7] This cost is likely an underestimate both because it does not take into account pre-lottery wealth and because all prizes in this category were in fact larger than 2M SEK (mean 3.1M SEK).

**Table 6: Comparison of Model-Predicted Effects of 1M SEK Windfall Gain to Lottery-Based Estimates.** This table compares the model-implied coefficients for the effect of wealth and for the effect stratified by pre-lottery participation status under various calibration with the causal estimates (Column 1).

| Effect | Causal Estimate (1) | Baseline (2) | High Per-Period Cost (3) | Correlated Income & Returns (4) | High Risk Aversion (5) | Lower Equity Premium (6) | High MPC (7) | All Disin-centives (8) |
|---|---|---|---|---|---|---|---|---|
| **Baseline** | .038 | .140 | .152 | .129 | .112 | .093 | .102 | .071 |
| **Participants** | -.001 | .104 | .117 | .099 | .093 | .073 | .075 | .052 |
| **Nonparticipants** | .121 | .224 | .232 | .193 | .169 | .149 | .163 | .124 |

Specifically, we draw lottery prizes identical to those in the data and assign these windfall gains to households with pre-lottery characteristics (including cells) identical to those in our post-1999 sample. We then solve for the optimal participation status of each household and estimate Equation 1. This permits a straightforward comparison of the model estimates to the causal estimates. In our calibration, we set entry costs ($\chi$) equal to zero and assume participation costs ($\kappa$) are distributed according to the cumulative distribution function pictured in Figure 1.

Table 6 compares the predicted effects of wealth (column 2) to the causal estimates (column 1) for the all-year sample (row 1) and the post-1999 sample stratified by participation status (rows 2 and 3). In the all-year sample, the model-generated coefficient is 0.140, roughly three times the magnitude of our causal estimate. For pre-lottery nonparticipants, the model-predicted effect is .224, again exceeding the causal estimate of .121. The number of nonparticipating households deterred from entering equity markets under the model's baseline calibration is thus too small to match the empirical estimates. For pre-lottery participants the model predicts, contrary to the causal estimates, a positive effect on continued participation. Intuitively, the calibrated costs cause some households with poor income or equity returns shocks to drop out of equity markets absent the windfall gain. In summary, the baseline model's predictions are generally qualitatively correct but overstate the effect of wealth on participation.

We also consider several extensions of our baseline model, the results of which are summarized in Columns 3-8 of Table 6. In Column 3 we consider the effects of multiplying each drawn per-period participation cost by two. Next, following Viceira (2001), we allow for a correlation of .25 between the random component of income and equity returns. Column 5 shows the results from a model calibrated with a risk-aversion parameter set to 10. Column 6 shows the predicted effects by a model which allows for the possibility that households may be unable to fully realize welfare gains of participation because of poor diversification and asset management fees (Calvet et al. (2007)). Following, Calvet et al. (2007), we impose a 1.5% management fee and scale the expected equity premium by 1/2, thus reducing the equity premium to 2.7%. Column 7 shows results obtained if the lottery windfall gain is rescaled by a factor of 0.6, an adjustment that may be appropriate if 40% of windfall gains are consumed or given away immediately. Finally, Column 8 shows that when all extensions are included simultaneously, the model matches our causal estimate from the subsample of nonparticipants quite well, but continues to substantially overpredict the response in the full sample and in pre-lottery participants. Although not exhaustive, overall these exercises suggest that under reasonable calibrations it is difficult to match the small effects of wealth on equity market participation.

## 4.2 Model Estimation

If standard calibrations can't replicate our causal estimates, how can we account for our empirical findings? To answer this question, we estimate the size and structure of costs necessary for the model to match causal estimates using the Method of Indirect Inference (Smith (2008)). Specifically, we specify entry and participation cost distributions, respectively denoted

$$\begin{aligned} \kappa_i &\sim F_{\theta_\kappa}(\kappa) \\ \chi_i &\sim G_{\theta_\chi}(\chi), \end{aligned} \tag{4}$$

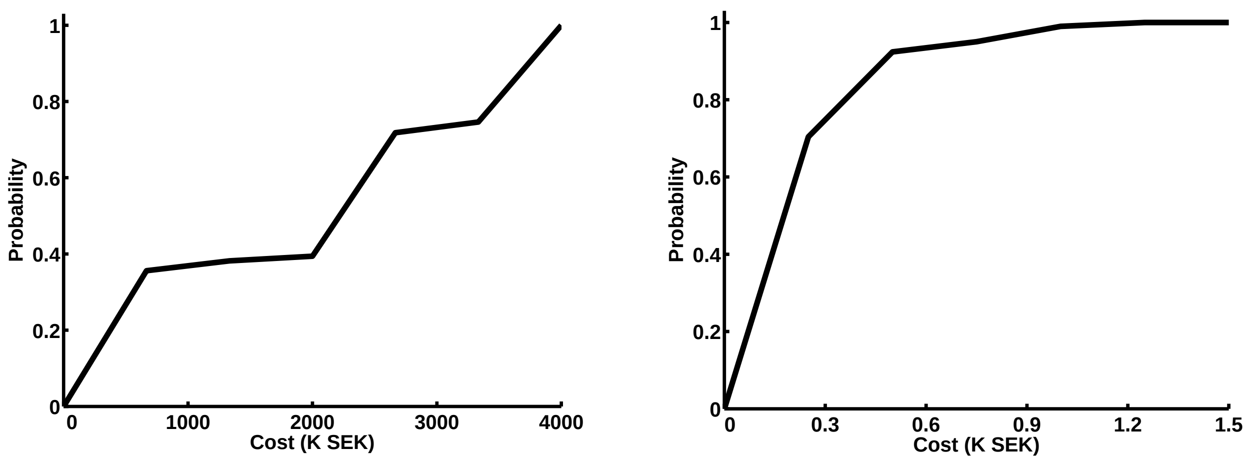
and estimate the cost distributions that align the model-implied coefficients with the causal estimates.[8] The resulting cost estimates can be interpreted as the financial equivalent of all disincentives necessary to match the causal estimates. For additional details regarding the estimation procedure see Appendix A.

Table 7 (a) presents the resulting model's predictions, showing that the model-implied effects of wealth on participation match the causal estimates at the estimated parameter set. Figure 5 shows the resulting estimated cost distributions. Fixed per-period costs of participation (Figure 5 (b)) are estimated to be quite small, with a median estimated cost of 200 SEK (30 USD) and almost all households having estimated participation costs less than 1000 SEK (160 USD). Intuitively, small estimated per-period participation costs are required to match the reduced form finding that wealth

[8]Specifically, our estimation matches the causal coefficients from the all-year sample, the coefficients from the post-1999 sample stratified by pre-lottery participation status, and the coefficients from the non-linear specification considered in Figure 4. The exact coefficients matched are listed in Column 1 of Table 7.

**Table 7: Structural Estimation Results, Model Fit.** Column 1 presents causal estimates while Column 2 presents the model-implied coefficients when using the estimated cost distributions for our post-1999 sample. Columns 3 and 4 present the corresponding coefficients for the estimation sample restricted to households with no self-employment income, debt less than 15K USD, and net wealth less than 1M USD

| | **(a) Baseline Sample** | | **(b) Restricted Sample** | |
|---|---|---|---|---|
| | **Causal Estimates** | **Model-Implied Estimates** | **Causal Estimates** | **Model-Implied Estimates** |
| **Effect** | **(1)** | **(2)** | **(3)** | **(4)** |
| **Baseline** | .038 | .040 | .066 | .066 |
| **Participants (NP)** | -.001 | .010 | .004 | .013 |
| **Nonparticipants (P)** | .121 | .129 | .175 | .167 |
| **15K-100K (P)** | -.011 | .009 | -.019 | -.005 |
| **100K-1M (P)** | -.005 | .022 | -.011 | .038 |
| **1M-2M (P)** | .002 | .008 | -.002 | .012 |
| **2M+ (P)** | -.027 | .019 | .028 | .064 |
| **15K-100K (NP)** | .014 | .015 | .060 | .048 |
| **100K-1M (NP)** | .082 | .069 | .098 | .131 |
| **1M-2M (NP)** | .182 | .175 | .209 | .266 |
| **2M+ (NP)** | .395 | .401 | .490 | .528 |




**(a) Entry** **(b) Participation**

**Figure 5: Structural Estimates of Fixed-Entry and Per-Period Participation Costs.**

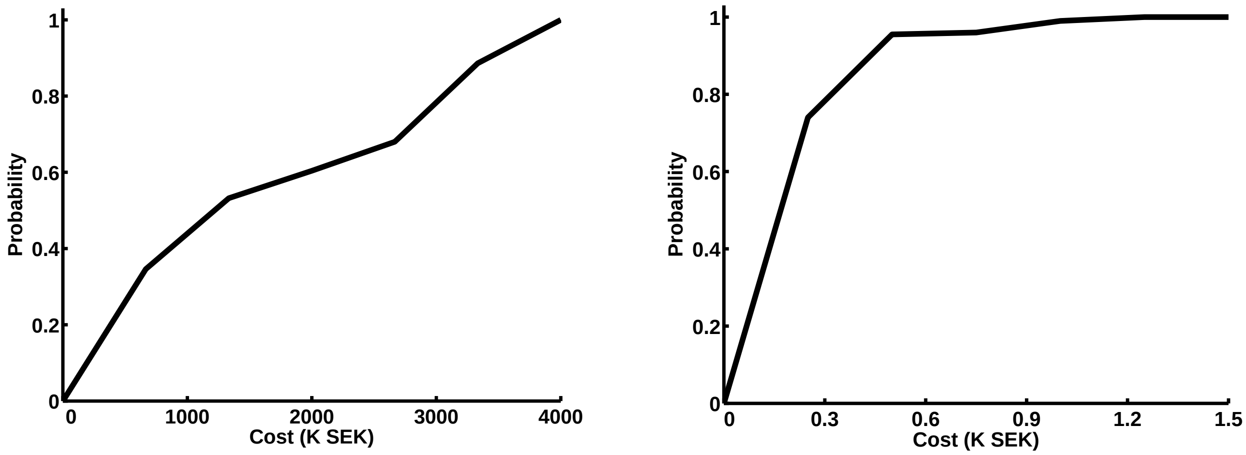
has no discernible effect on continued participation. The estimated entry costs for nonparticipants (Figure 5 (a)) are implausibly large, with 63% of entry costs estimated to be greater than 1M SEK (150K USD), 61% greater than 2M SEK (300K USD), and a 27% greater than 3M SEK (450K USD).[9] The entry cost distribution is quite polarized, with only 2% of the entry costs estimated to be between 1M SEK (150K USD) and 2M SEK (300K USD). The 37% of households estimated to have entry costs below 1M SEK (150K USD) roughly correspond to those whose participation status responds to the range of wealth shocks we consider, while the remainder reflect households whose behavior is not well captured by the mechanisms included in the model. The large costs for such households highlight the need for significant disincentives to account for the lack of entry following large windfall gains.

In the robustness analysis presented in the reduced form section, we considered an estimation sample restricted to households with no self-employment income, debt less than 15K USD, and net wealth less than 1M USD. The motivation behind these restrictions was to restrict attention to a sample whose investment decision more closely aligns with the model. Specifically, the model does not include a borrowing wedge, self-employment income, and prior research has noted that nonparticipation of the very wealthy is not accounted for by models of the type considered. Reduced form estimates were somewhat larger for this restricted sample, with an estimated effect of 17 percentage points among pre-lottery nonparticipants.

To explore whether the omission of these non-cost disincentives from the model explain our implausibly large estimated costs of entry, we re-estimate our structural model using this restricted sample and matching the larger effects of wealth on participation. Table 7 (b) includes the model fit for this sample as well, and again shows that the model matches the causal estimates with reasonable precision. The resulting cost estimates are presented in Figure 6, which exhibits notably smaller entry costs than our baseline estimates. For example, the median entry cost is about 1.2M SEK (179K USD) for the restricted sample as opposed to 2.1M SEK (313K USD) for the unrestricted sample. This suggests that un-modeled disincentives do contribute to low estimated effects on entry probabilities and high entry cost estimates. Still, for a majority of households entry costs remain implausibly large, suggesting that there remains substantial difference between model predicted and observed behavior.

Finally, in Appendix A.4.1, we allow entry costs to vary by the pre-lottery characteristics considered in the heterogeneity analyses presented in Table 5. The estimated costs, shown in Appendix

[9] The entry cost is modeled as a first-time cost of entry, and thus only affects decisions of pre-lottery nonparticipants.




**(a) Entry** **(b) Participation**

**Figure 6: Structural Estimates of Fixed-Entry and Per-Period Participation Costs in Restricted Sample**. Estimates are obtained using the estimation sample restricted to households with no self-employment income, debt less than 15K USD, and net wealth less than 1M USD.

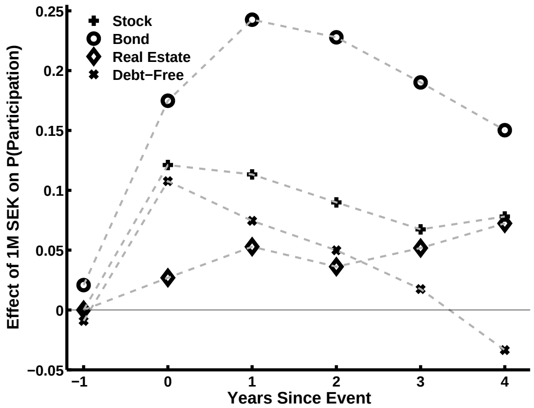
Table A.1, are intuitive given the reduced-form estimates, with costs estimated to be higher in sub-populations with smaller estimated causal effects. Estimates suggest that the entry costs exceed 1M SEK (150K USD) for the majority of households in all sub-populations considered Table 5.

The exercises considered in this section suggest that the causal estimates are puzzlingly small, and that accounting for these causal estimates will require a model with richer disincentives to stock market participation than fixed costs.

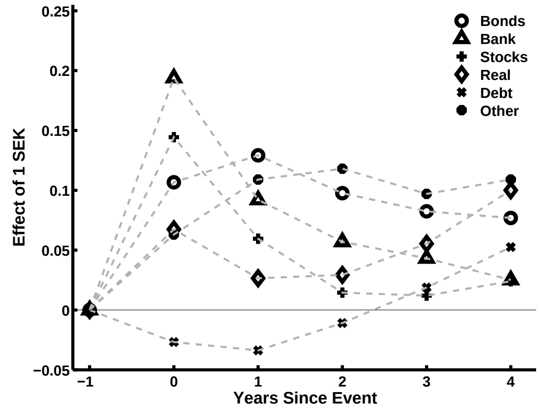
# 5 Whither the Windfall Gains?

Evidence on how households allocate the lottery wealth may provide important cues about how to interpret the results documented above. In this section we thus report the results of additional analyses of how lottery wealth is allocated, both on the extensive and intensive margin, to several asset classes besides equities. All analysis in this section focuses on the subsample of post-1999 equity market nonparticipants.

**Extensive Margin** We used our main estimating equation to examine the impact of wealth on bond and structured product market participation (defined as an indicator equal to 1 if the household's bond, interest fund, or structured product wealth was positive in a given year), real estate participation (defined analogously) and an indicator for being debt-free. To benchmark the esti-




**(a) Extensive**




**(b) Intensive**

**Figure 7: Effect of Wealth (1M SEK) on Wealth Categories for Nonparticipants in Equity Markets at $s = -1$.** Coefficients and 95% confidence intervals, are obtained by estimating Equation 1 in the post-1999 sample. Figure (a) considers the effects on the extensive margin of the indicated variable, while figure (b) considers the effects on the intensive margin. Bonds: interest rate funds, premium bonds, interest bonds and structured products. Stocks: directly and indirectly held stocks. Bank: bank account balances. Real Assets: property and land owned. Debt: gross debt. Other: capital insurance and other financial assets. See Appendix Tables B.7 and B.8 for the underlying estimates.

mates, we also plot the estimated effects on equity market participation (first presented in Figure 3 (a)). The results from these analyses are depicted in Figure 7 (a). First, we find that wealth causes a substantial increase in the probability of owning bonds or structured products. Specifically, the effect on bond or structured product market participation probability is larger than the effect on stock market entry probability at all horizons and approximately twice as large at horizons $s \geq 1$. We estimate that windfall gains cause modest increases in the probability of owning real estate, with the effect being smaller than that on stock market participation at all horizons. Finally, we find that in the short run, windfall gains cause an increase in the probability of being debt-free comparable to the magnitude of the effect on stock market participation. Over longer time horizons, the effect falls however and is below zero at $s = 4$.

**Intensive Margin** We also used our main estimating equation to examine how lottery wealth is allocated to six financial variables measured in the Swedish Wealth Register: bank account balances, stocks, bonds and structured products, debt, real assets, and capital insurance and other financial assets.[10] Figure 7 (b) graphically depicts the main results from these analyses (see the accompanying caption for details on variable definitions). The coefficients plotted for each variable are scaled so an estimate of 0.10 means that the total market value of the outcome (e.g., risky assets owned) increases by .1 for each 1 SEK won.

Pre-lottery equity market nonparticipants invest approximately 11% of lottery wealth in bonds and structured products in the year-of-win, and this fraction is stable over the five-year period. Unsurprisingly, year-end bank account balances increase substantially in the year-of-win, but less than 10% of the lottery wealth remains in bank accounts at year-end in $s = 1$ and less than 5% remains at year $s = 3$. Figure 7 (b) also shows that in both samples, the fraction of wealth allocated to real estate investment or to pay off debts is modest. Although lottery wealth causes an initial increase in equity wealth, the effect is modest at longer horizons. Finally, holdings of other financial assets, including capital insurance, increase by approximately 6-12 percent of the amount won. The intensive margin effects are thus broadly consistent with the extensive margin effects presented in Figure 7 (a): large windfall gains cause modest investment in equities, real estate, and debt reduction, but larger investment in safe assets.

**Interpretation** Several of the results in Figure 7 are potentially relevant for interpreting the puzzlingly small wealth effects on equity market participation. First, the fact that less than 10% of the lottery wealth remains in bank accounts at $s = 1$, coupled with the observation that bond and equity investments take place shortly after the lottery, suggests a limited role for procrastination. Second, the small effects on debt suggest that few households forgo equity market participation to pay off high-interest debt. Third, equity market nonparticipants are more likely to participate in bond markets than equity markets following windfall gains; they also allocate substantially more wealth to bonds and structured products than equities, especially after year $s = 1$. In fact, among nonparticipants the effect of wealth on the market value of stocks owned is negligibly small from $s = 2$ onward. The allocation to bonds and structured products shows that the small wealth effects on stock ownership we observe in equity market nonparticipants are unlikely to reflect a general aversion to financial markets, but may reflect an aversion to stocks as an asset class. Fifth, although some households are induced by the wealth shocks to purchase property, the magnitude of the effects implies that real estate investments are unlikely to explain the relatively high rates of

[10] All variables are measured at year-end market value. Real assets, which primarily consist of real estate, are possibly undermeasured for two reasons. First, investment in pre-existing real estate (e.g., home improvements) might not be reported to tax authorities. Second, moves to larger apartments within the local area are possibly unrecorded because valuation of apartments is determined by the average sales price in the building association.

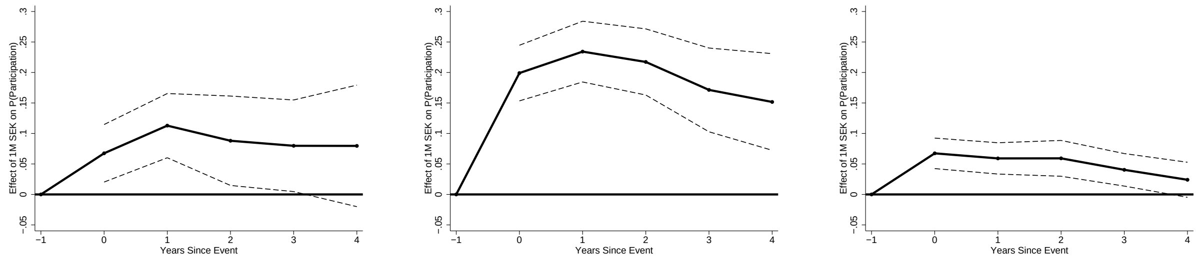
continued equity market nonparticipation.

# 6 Participation in Other Markets

Although the primary focus of this study and the broader literature has been stock market participation, our data permit us to characterize the effects of of wealth on participation in other markets. Thus, to examine whether the extensive margin findings presented in Section 5 hold in samples other than pre-lottery equity market nonparticipants and to provide descriptive statistics that might might provide further insight into household financial decisions beyond equity market participation, in this section we consider the effect of wealth on participation in real estate, bond and structured products, and debt markets.

**Real Estate** In the pooled all-year sample, a windfall gain of 1M SEK (150K USD) is estimated to cause a small increase in real estate market participation probability of about two percentage points (see Appendix Table B.9), with the effect driven nearly entirely by households who did not own property before the lottery event. Figure 8 (a) shows that in such households, 1M SEK (150K USD) is estimated to increase probability of owning a house or apartment by 7 to 12 percentage points in the post-lottery years. We find no evidence of a wealth effect on participation probability for households who were already property owners (Appendix Table B.10). The results are thus qualitatively similar to those found in the main analyses of stock market participation.

We also conducted a set of heterogeneity analyses in the subsample of households that did not own real estate at year-end in $s = -1$. Appendix Table B.11 shows the estimated coefficients, their 95% confidence intervals, and the $p$-value from a test of the null hypothesis of homogenous effects. We find clear evidence that the effects of wealth on real estate participation is stronger in households with below-median pre-lottery wealth, consistent with evidence that many low-wealth households are unable to purchase real estate because they face prohibitive down-payment constraints (Mayer and Engelhardt (1996); Fuster and Zafar (2014)). We also find clear evidence that winners are more likely to acquire real estate following years with negative equity returns (hetero $p = .01$). Finally, Appendix Table B.5 examines heterogeneity in the treatment effect by prize size and shows that among households that did not own property prior to the lottery and received more than 2M SEK (300K USD), real estate market participation probability increased by 18.4 percentage points.




**(a) Real Estate** **(b) Bond and Structured Prod.** **(c) Debt-Free**

**Figure 8: Effect of Wealth (1M SEK) on Real Estate Market, Bond, and Debt Market Participation Probability.** Coefficients and 95% confidence intervals, are obtained by estimating Equation 1 in the post-1999 sample of players who at year-end at $s = -1$ did not own real estate (a), did not own bonds or structured products (b), and had positive debt holdings (c). See Appendix Table B.9 for the underlying estimates.

**Bond and Structured Products Market** Next, we conduct an analogous set of analyses for participation in bond and structured product markets. In the all-year sample, we find that 1M SEK (150K USD) increases the probability of owning bonds, interest funds, and structured products 12.6 percentage points in $s = 0$, but this effect is weaker over longer time horizons (see Appendix Table B.9). Among pre-lottery bond nonparticipants, 1M SEK (150K USD) increases participation probability by approximately 20 percentage points (Figure 8 (b)), while the participation probability of pre-lottery bond owners is not affected by a windfall gain (Appendix Table B.10). Thus, just as with equity and real estate, the baseline effect is driven by market entry of pre-lottery nonparticipants. In heterogeneity analyses conducted in pre-lottery bond market nonparticipants (see Appendix Table B.12), we find clear evidence that winners are significantly more likely to enter bond markets following years with negative equity returns. This result, which parallels our findings for real estate participation, suggests that households pursue alternative investment opportunities following periods of low equity returns.

**Debt** In our final analysis, we estimate the effect of wealth on the probability of being debt-free. In our pooled all-year sample, we find that 1M SEK (150K USD) increases the probability of being debt-free by 5.1 percentage points in the year of win, with the effect diminishing over longer time horizons (Appendix Table B.9). When we stratify the sample by whether players had positive debt prior to the lottery, we find that the effect is present in both debt-free and indebted households (in contrast to the results from similar analyses of equity, bond and real estate participation).

In debt-free households, we estimate that 1M SEK (150K USD) causes an increase in the probability of remaining debt-free of 3 to 5 percentage points at horizons $s = 0, 1,$ and $2$ (Appendix Table B.10), while the estimated effects on indebted households are about twice as large (Figure 8 (c)). In heterogeneity analyses conducted in households which were indebted prior to the lottery, our estimates suggest that households are more likely to become debt-free following periods of negative equity returns, though we can not reject the null hypothesis of homogenous effects (see Appendix Table C.13). We also find larger effects on the probability of becoming debt free among households with above median wealth, that did not own homes, and that were not self employed.

# 7 Discussion

Our study contributes to a burgeoning household-finance literature (Campbell (2006); Guiso and Sodini (2013)) by providing credible and statistically precise estimates of the causal effect of wealth on equity market participation and interpreting these effects using a structural model, as well as considering how windfall gains affect investment in other asset classes.

The widespread nonparticipation in the stock market observed across Western countries is a much studied but imperfectly understood phenomenon (Vissing-Jørgensen (2003); Campbell (2006); Guiso and Sodini (2013)), partly because stringent testing of theoretical predictions is often challenging in observational data. In our main analysis of stock market participation, we find that 1M SEK (150K USD) increases the probability of owning stocks by 12 percentage points among pre-lottery nonparticipants, but has no effect on pre-lottery participants. The effect is near-immediate, seemingly permanent, and heterogeneous in intuitive ways. For example, we find larger rates of stock market entry among individual with higher education, consistent with theories in which cognitive constraints deter entry (Grinblatt et al. (2011); Christelis, Jappelli and Padula (2010); Benjamin et al. (2013)).

A structural life-cycle model makes qualitative predictions that align well with the reduced-form evidence, but predicts wealth effects substantially larger than those we estimate. Using the causal estimates to identify costs of entry and participation yields median entry costs far too large to realistically reflect financial costs of investment. Furthermore, these large costs are pervasive across all samples and demographic group considered, suggesting that the "nonparticipation puzzle" extends well beyond the wealthiest stock market nonparticipants.

In other analyses, we document substantial wealth effects on bond and structural product market participation and more modest effects on real estate and debt. Overall, our findings suggest that factors such as housing, a desire to pay off high-interest debt, aversion to financial markets, or procrastination are likely to account for at most a modest share of the quantitative discrepancy between the observed and predicted effects of windfall gain on equity participation. Notably, the larger effects on bond than equity market participation suggest preference-based explanations that generate a low tolerance for risk or aversion to ambiguity could be important.[11]

A striking finding is the clear evidence that following periods of negative equity returns, lottery winners substitute away from equities toward real estate and bond market participation. Such substitution may reflect extrapolative belief-formation processes that assign too much weight to recent equity returns (Vissing-Jørgensen (2003); Greenwood and Shleifer (2014)). This suggests further research on belief based explanations is potentially useful to improve understanding of asset market participation.[12]

In conclusion, our results provide new insights into how windfall gains are allocated across asset classes, and point to several promising channels for future research. A parsimonious interpretation of our overall pattern of results is that a substantial fraction of nonparticipating households have a strong reluctance to engage with stocks (though not bonds) as an asset class. It is plausible that models with nonstandard assumptions about preferences or beliefs are likely to play an important role in advancing our understanding of what may generate such reluctance, and our reduced form results may be valuable for testing and refining such theories.

[11] For example, loss aversion and narrow framing (Barberis et al. (2006)), disappointment aversion (Ang et al. (2005)), and ambiguity aversion (Epstein and Schneider (2010)) have been previously proposed as contributing to stock market nonparticipation.

[12] For example, Biais et al. (2010), Hurd, Van Rooij and Winter (2011), and Guiso et al. (2008) consider how alternative beliefs might affect stock market participation.

# References

**Alan, Sule**, "Entry costs and stock market participation over the life cycle," *Review of Economic Dynamics*, 2006, *9* (4), 588–611.

**Andersen, Steffen and Kasper Meisner Nielsen**, "Participation constraints in the stock market: Evidence from unexpected inheritance due to sudden death," *Review of Financial Studies*, 2011, *24* (5), 1667–1697.

**Ang, Andrew, Geert Bekaert, and Jun Liu**, "Why stocks may disappoint," *Journal of Financial Economics*, 2005, *76* (3), 471–508.

**Attanasio, Orazio P and Monica Paiella**, "Intertemporal consumption choices, transaction costs and limited participation in financial markets: reconciling data and theory," *Journal of Applied Econometrics*, 2011, *26* (2), 322–343.

**Barberis, Nicholas, M. Huang, and Richard H Thaler**, "Individual preferences, monetary gambles, and stock market participation: A case for narrow framing," *American Economic Review*, 2006, *96* (4), 1069–1090.

**Barillas, Francisco and Jesús Fernández-Villaverde**, "A generalization of the endogenous grid method," *Journal of Economic Dynamics and Control*, 2007, *31* (8), 2698–2712.

**Becker, Thomas A and Reza Shabani**, "Outstanding debt and the household portfolio," *Review of Financial Studies*, 2010, *23* (7), 2900–2934.

**Benjamin, Daniel J, Sebastian A Brown, and Jesse M Shapiro**, "Who is behavioral? Cognitive ability and anomalous preferences," *Journal of the European Economic Association*, 2013, *11* (6), 1231–1255.

**Biais, Bruno, Peter Bossaerts, and Chester Spatt**, "Equilibrium asset pricing and portfolio choice under asymmetric information," *Review of Financial Studies*, 2010, p. hhp113.

**Brunnermeier, Markus K and Stefan Nagel**, "Do Wealth Fluctuations Generate Time-Varying Risk Aversion? Micro-Evidence on Individuals' Asset Allocation," *American Economic Review*, 2008, *98* (3), 713–736.

**Calvet, Laurent, Claire Célérier, Paolo Sodini, and Boris Vallée**, "Financial Innovation and Stock Market Participation," *Working Paper*, 2016.

**Calvet, Laurent E and Paolo Sodini**, "Twin Picks: Disentangling the Determinants of Risk-Taking in Household Portfolios," *Journal of Finance*, 2014, *69* (2), 867–906.

**_ , John Y Campbell, and Paolo Sodini**, "Down or Out: Assessing the Welfare Costs of Household Investment Mistakes," *Journal of Political Economy*, 2007, *115* (5), 707–747.

**Campanale, Claudio**, "Learning, ambiguity and life-cycle portfolio allocation," *Review of Economic Dynamics*, 2011, *14* (2), 339–367.

**Campbell, John Y.**, "Household Finance," *Journal of Finance*, 2006, *61* (4), 1553–1604.

**Carroll, Christopher D**, "Portfolios of the Rich," in "Household Portfolios: Theory and Evidence," MIT Press, 2002.

_ , "The method of endogenous gridpoints for solving dynamic stochastic optimization problems," *Economics letters*, 2006, *91* (3), 312–320.

**Célérier, Claire and Boris Vallée**, "Catering to Investors Through Product Complexity," 2015.

**Cesarini, David, Erik Lindqvist, Robert Östling, and Björn Wallace**, "Wealth, Health, and Child Development: Evidence from Administrative Data on Swedish Lottery Players," *Quarterly Journal of Economics*, 2015, *Forthcoming.*

**Christelis, Dimitris, Tullio Jappelli, and Mario Padula**, "Cognitive abilities and portfolio choice," *European Economic Review*, 2010, *54* (1), 18–38.

**Cocco, Joao F**, "Portfolio choice in the presence of housing," *Review of Financial Studies*, 2005, *18* (2), 535–567.

**Davis, Steven J, Felix Kubler, and Paul Willen**, "Borrowing costs and the demand for equity over the life cycle," *Review of Economics and Statistics*, 2006, *88* (2), 348–362.

**Epstein, Larry G and Martin Schneider**, "Ambiguity and asset markets," *NBER Working Paper No. 16181*, 2010.

**Fagereng, Andreas, Charles Gottlieb, and Luigi Guiso**, "Asset market participation and portfolio choice over the life-cycle," *Journal of Finance*, 2015, *Forthcoming.*

**Flavin, Marjorie and Takashi Yamashita**, "Owner-occupied housing: life-cycle implications for the household portfolio," *American Economic Review*, 2011, *101* (3), 609–614.

**Fuster, Andreas and Basit Zafar**, "The sensitivity of housing demand to financing conditions: evidence from a survey," *FRB of New York Staff Report*, 2014, (702).

**Gomes, Francisco and Alexander Michaelides**, "Optimal Life-Cycle Asset Allocation: Understanding the Empirical Evidence," *Journal of Finance*, 2005, *60* (2), 869–904.

**Greenwood, Robin and Andrei Shleifer**, "Expectations of returns and expected returns," *Review of Financial Studies*, 2014, *27* (3), 714–746.

**Grinblatt, Mark, Matti Keloharju, and Juhani Linnainmaa**, "IQ and stock market participation," *The Journal of Finance*, 2011, *66* (6), 2121–2164.

**Grossman, Sanford J and Guy Laroque**, "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods," *Econometrica*, 1990, *58* (1), 25–51.

**Guiso, Luigi and Paolo Sodini**, "Household finance: An emerging field," *Handbook of the Economics of Finance*, 2013, *Part B*, 1397–1532.

**_ , Michael Haliassos, and Tullio Jappelli**, *Household portfolios*, MIT press, 2002.

**_ , Paola Sapienza, and Luigi Zingales**, "Trusting the stock market," *Journal of Finance*, 2008, *63* (6), 2557–2600.

**Haliassos, Michael and Carol C Bertaut**, "Why do so few hold stocks?," *The Economic Journal*, 1995, *105* (432), 1110–1129.

**Hankins, Scott, Mark Hoestra, and Paige Marta Skiba**, "The Ticket to Easy Street? The Financial Consequences of Winning the Lottery," *Review of Economics and Statistics*, August 2011, *93* (3), 961–969.

**Heaton, John and Deborah Lucas**, "Portfolio choice and asset prices: The importance of entrepreneurial risk," *Journal of Finance*, 2000, *55* (3), 1163–1198.

_ **and** _ , “Portfolio choice in the presence of background risk,” *The Economic Journal*, 2000, *110* (460), 1–26.

**Hurd, Michael, Maarten Van Rooij, and Joachim Winter**, “Stock market expectations of Dutch households,” *Journal of Applied Econometrics*, 2011, *26* (3), 416–436.

**Imbens, Guido W., Donald B. Rubin, and Bruce I. Sacerdote**, “Estimating the effect of unearned income on labor supply, earnings, savings and consumption: Evidence from a survey of lottery players,” *The American Economic Review*, 2001, *91* (4), 778–794.

**Kahn, R. Jay and Toni Whited**, “Identification with Models and Exogenous Data Variation,,” *Foundations and Trends in Accounting,*, 2016, *10*, 361–375.

**Khorunzhina, Natalia**, “Structural estimation of stock market participation costs,” *Journal of Economic Dynamics and Control*, 2013, *37* (12), 2928–2942.

**Magri, Silvia**, “Italian households debt: the participation to the debt market and the size of the loan,” *Empirical Economics*, 2007, *33* (3), 401–426.

**Malmendier, Ulrike and Stefan Nagel**, “Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?,” *The Quarterly Journal of Economics*, 2011, *126*, 373–416.

**Mankiw, N Gregory and Stephen P Zeldes**, “The consumption of stockholders and nonstockholders,” *Journal of Financial Economics*, 1991, *29* (1), 97–112.

**Mayer, Christopher J and Gary V Engelhardt**, “Gifts, down payments, and housing affordability,” *Journal of Housing Research*, 1996, *7* (1), 59.

**Merton, Robert C**, “Optimum consumption and portfolio rules in a continuous-time model,” *Journal of Economic Theory*, 1971, *3* (4), 373–413.

**Mulligan, Casey B and Xavier Sala i Martin**, “Extensive margins and the demand for money at low interest rates,” *Journal of Political Economy*, 2000, *108* (5), 961–991.

**Paiella, Monica**, “The forgone gains of incomplete portfolios,” *Review of Financial Studies*, 2007, *20* (5), 1623–1646.

**Poterba, James M and Andrew A Samwick**, "Taxation and household portfolio composition: US evidence from the 1980s and 1990s," *Journal of Public Economics*, 2003, *87* (1), 5–38.

**Rooij, Maarten CJ Van, Annamaria Lusardi, and Rob JM Alessie**, "Financial Literacy, Retirement Planning and Household Wealth," *The Economic Journal*, 2012, *122* (560), 449–478.

**Samuelson, Paul A**, "Lifetime portfolio selection by dynamic stochastic programming," *Review of Economics and Statistics*, 1969, *51* (3), 239–246.

**Shiller, Robert J**, "Understanding recent trends in house prices and home ownership," Technical Report, National Bureau of Economic Research 2007.

**Smith, Anthony**, "Indirect inference," *The New Palgrave Dictionary of Economics, 2nd Edition*, 2008.

**Vestman, Roine**, "Limited Stock Market Participation Among Renters and Home Owners," *SSRN No. 1573181*, 2013.

**Viceira, Luis M**, "Optimal Portfolio Choice for Long-Horizon Investors with Nontradable Labor Income," *Journal of Finance*, 2001, *56* (2), 433–470.

**Vissing-Jørgensen, Annette**, "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution," *Journal of Political Economy*, 2002, *110* (4), 825–853.

_ , "Perspectives on Behavioral Finance: Does Irrationality Disappear with Wealth? Evidence from Expectations and Actions," *NBER Macroeconomics Annual*, 2003, *18*, 139–208.

**Waldenström, Daniel**, "Swedish stock and bond returns, 1856–2012," *IFN Working Paper No. 1027*, 2014.

**World Health Organization**, "Risk Factors," in Margie Peden, Richard Scurfiled, David Sleet, Dinesh Mohan, Adnan A Hyder, and Eva Jarawan, eds., *World report on road traffic injury prevention*, World Health Organization, 2004, chapter 3, pp. 69–106.

# A Model

## A.1 Model Specification

Each period, an age $t$ agent chooses how much to consume, save, and invest in equity markets. An agent has a maximum lifespan of $T = 113$, but prior to reaching age $T$, faces mortality risk with an exogenous probability of surviving from period $t$ to $t + 1$ denoted by $s_t$. Upon death, an agent receives a terminal payout of zero. Agents who invest in equity face two separate types of costs. Participation costs, denoted $\kappa$, are paid in each period an agent allocates non-zero wealth to equity holdings. Entry costs, denoted $\chi$, are paid whenever a previously non-participating agent decides to enter equity markets for the first time. Entry and participation costs are drawn independently from the two distributions:

$$\begin{aligned} \kappa_i &\sim F_{\theta_\kappa}(\kappa) \\ \chi_i &\sim G_{\theta_\chi}(\chi), \end{aligned} \tag{5}$$

where $\theta_\kappa$ and $\theta_\chi$ are vectors that characterize the distribution of entry and participation costs. Equity provides a risky return $r_s$ with $\mathbb{E}(r_s) > r_f$, where $r_f$ is the risk-free rate. In addition, each period an agent is endowed with stochastic labor income $y_t$ drawn from an age-specific distribution.

For an agent who decides not to participate in equity markets in a given period, the decision problem reduces to deciding how much to consume and how much to save in the risk-free asset:

$$\begin{aligned} V_t^{NP}(W_t, \kappa, \chi) = \max_{c_t, W_{t+1}} & \; u(c_t) + \beta s_t \mathbb{E}_{y_{t+1}} \left[ V_{t+1}(W_{t+1}, I_t, \kappa, \chi) \right] \\ W_{t+1} &= r_f \left( W_t - c_t \right) + y_{t+1} \\ I_t &= 1, \end{aligned} \tag{6}$$

where $I_t$ is an indicator equal to 0 in year $t$ if the agent has never participated in equity markets, and 1 otherwise. An agent who participates in the equity market, decides how much to consume, and what fraction of wealth to allocate to stocks. This decision problem can similarly be expressed as:

$$
\begin{aligned}
V_t^P(W_t,\kappa,\chi) = \max_{c_t,W_{t+1},\alpha_t} & \; u(c_t) + \beta s_t \mathbb{E}_{y_{t+1},r_{s,t+1}}\left[V_{t+1}(W_{t+1},I_t,\kappa,\chi)\right] \\
& W_{t+1} = r_f\left(W_t - c_t - \kappa\right) + \alpha_t(r_{s,t+1} - r_f)\left(W_t - c_t - \kappa\right) + y_{t+1} \\
& I_t = 0.
\end{aligned} \tag{7}
$$

Subtracting the entry costs if the agent has not previously participated in equity markets yields the following decision problem:

$$
V_t(W_t, I_{t-1}, \kappa, \chi) = \max\{V_t^{NP}(W_t,\kappa,\chi)\ ,\ V_t^P(W_t - \chi I_{t-1},\kappa,\chi)\}. \tag{8}
$$

Each period, comparing the value function of nonparticipation against the value function of participation net any entry costs determines the agent's participation decision. We assume $s_t$, $r_s$ and $y_t$ follow known stochastic processes. Although our data are collected at the household level, we make the simplifying assumption $s_t$ as the survival probability as a function of an individual at age $t$. We assume the income process is age-dependent, with log income of an age-$t$ individual evolving according to the following process:

$$
\ln y_t = f(t) + \sigma_{y,t}\eta_t,
$$

where $f(t)$ is a quadratic in age and $\sigma_{y,t}$ is the age-specific standard deviation in earnings. Both the earnings and mortality processes are estimated using a cross section of the Swedish 1999 population. To match historical equity returns in Sweden (see Waldenström (2014)), we assume that equity returns are lognormally distributed, with location parameter set to 0.065 and scale parameter set to 0.21. We calibrate $r_f = 2\%$ to match historical yield on Swedish government bonds.

## A.2 Model Solution

The model solution algorithm uses the endogenous grid method to solve the savings problem and a grid search (100 grid points) to solve the optimal portfolio choice problem (Carroll (2006); Barillas and Fernández-Villaverde (2007)). Model solution algorithm summary and model code are both available on request.

## A.3 Exogenous Processes

The survival probability is calculated using the observed survival probabilities from years 1999-2000. We select 100,000 individuals in year 1998 from the Swedish population, and define a binary indicator equal to one if the individual is observed alive in 1999. We then regress a quartic in age on this indicator. We do not permit time or cohort effects in our estimation, and do not allow survival probabilities to vary with wealth, income, or sex. Note that there is no attrition or selection concerns in this sample as it is drawn randomly from the entire population. The resulting estimates are presented in Figure A.1.

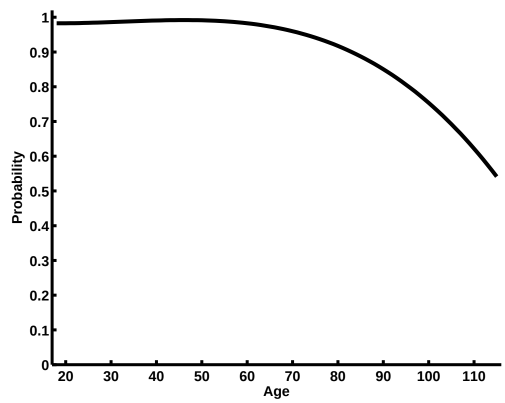



**Figure A.1: Survival Probabilities.** This figure presents the estimated one year survival probability for each age.

Income is calculated using the observed incomes in 1999. We select 100,000 individuals in year 1999 from the Swedish population, and combine with partners to get a measure of after tax household income. We then regress a quartic in age on this variable. We do not permit time, cohort, or sex effects in our estimation. Using our estimated income process, we then calculate the residual for each household. We then regress a quartic in age on the squared residual to obtain an age specific standard deviation of income realizations. In column 4 of Table 6 we consider the effect of allowing for correlation between income risk and equity returns. The resulting income estimates are presented in Figure A.2.

## A.4 Model Estimation

We estimate the distribution of individual costs of cost of entry and participation that most closely replicate the empirical estimates presented in column 1 of Table 7. As shown in equation 4, these

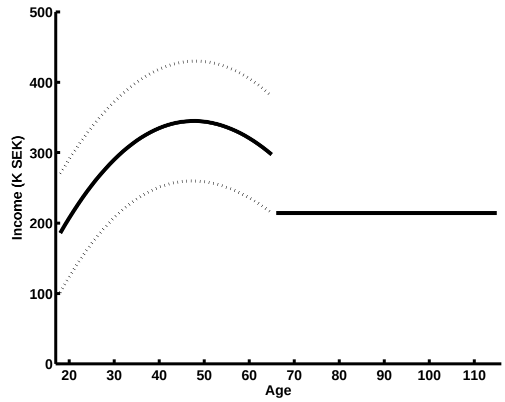



**Figure A.2: Average Income Profiles.** For ages below retirement, we also present the high and low income states.

cost distributions are parametrized by vectors $\theta_\kappa$, and $\theta_\chi$. Defining $\Theta = (\theta_\kappa, \theta_\chi)$, we estimate

$$\hat{\Theta} = \arg\min_{\Theta} (\hat{\beta} - \tilde{\beta}(\Theta))' W (\hat{\beta} - \tilde{\beta}(\Theta)) \tag{9}$$

where $\hat{\beta}$ represents the the vector of empirical estimates and $\tilde{\beta}(\Theta)$ represents the vector of coefficients implied by the model. $W$ could be any positive semi-definite matrix, but in all estimations we use the identity matrix.

The cost distributions are estimated non-parametrically by defining $\theta_\kappa$, and $\theta_\chi$ as points on the CDF. We first bound the set of feasible costs by assuming $F_{\theta_\kappa}(\overline{\kappa}) = 1$ and $G_{\theta_\chi}(\overline{\chi}) = 1$. Assuming $F_{\theta_\kappa}(0) = 0$ and $G_{\theta_\chi}(0) = 0$, we construct a linearly spaced grid consisting of 7 points denoted as $x^n_\kappa$ and $x^n_\chi$, respectively. We assume the CDFs are piecewise linear between these points and define

$$\theta_\kappa = \{\theta^n_\kappa | F_{\theta_\kappa}(x^n_\kappa) = \theta^n_\kappa\}$$
$$\theta_\chi = \{\theta^n_\chi | G_{\theta_\chi}(x^n_\chi) = \theta^n_\chi\}.$$

The cost distributions are thus characterized by the estimates $\theta^n$ corresponding to the evaluation of the CDF at each point $x^n$. $\overline{\kappa}$ and $\overline{\chi}$ are not known prior to estimation, but are chosen such that the next-to-last point on each respective grid is reasonably close but not equal to 1.

To simulate the model and generate coefficients $\tilde{\beta}(\theta)$, we first solve the model over a grid of participation and entry costs and then proceed in several steps:

1. Take parameter set $\Theta$ as given.
2. From the time $s = -1$ data set sample for all lottery players all relevant variables, including observed wealth, participation decisions, and time invariant covariates included in Table 4. From the time $s = 0$ data set, sample the amount won.
3. For each sampled observation, draw two uniform random variables. Using CDFs parametrized by $\Theta$, map these random variable to a realized $(\kappa_i, \chi_i)$.
4. According to $(\kappa_i, \chi_i)$, interpolate over grid of participation and entry costs to calculate for optimal decision rules.
5. Taking the time $s = -1$ data set as given, assign lottery wealth and calculate the optimal $s = 0$ saving and participation decisions.
6. Repeat reduced form estimation on the model simulated data set to obtain coefficients $\tilde{\beta}(\theta)$.

Following each of these calculations the objective function presented in Equation 9 is calculated. A numerical optimization algorithm is utilized to find the global minimum of this objective function.

### A.4.1 Estimation with Heterogeneous Costs

To understand how participation disincentives vary among subpopulations, we repeat our structural estimation, now allowing cost distributions to vary with characteristics included in Table 5. To identify these differences, we augment our baseline coefficient target $\hat{\beta}$ to include coefficients presented in Table 5, and re-estimate Equation 9, thus matching the heterogeneity in the effect of wealth on entry.

In implementing this estimation, we make two additional assumptions. First, because continued participation effects are negligible and no evidence of heterogeneity in the effect on continued participation exists, we do not allow for heterogeneity in per period costs of participation. Instead, for all households, we calibrate $\kappa$ to 200 SEK (30 USD), roughly the median per-period participation cost in our baseline structural estimation. Second, to maintain computational feasibility, we assume a parametric cost distribution. Specifically, we assume costs of entry $\chi_i$ are distributed normally with truncation at zero to ensure non-negativity. We assume mean $\mu_\chi x_i$, where $x_i$ is a vector of indicator variables corresponding to the characteristics in Table 5 (plus a constant) and $\mu_\chi$ is a coefficient vector to be estimated.

Table A.1 presents resulting model fit and estimates. The resulting cost distribution estimates again highlight the extremely high costs for all subsamples: no group of nonparticipants is estimated to have a median entry cost of less than 1M SEK (150K USD). Although cost patterns vary intuitively along various characteristics, in all groups we find that large disincentives to entry are necessary to replicate estimated effects. These patterns directly track the reduced-form estimates.

**Table A.1: Heterogeneous Structural Estimation Results.** Panel A presents the model estimated parameters. Specifically, the first row presents the estimated constant mean and standard deviation. The rows beneath present the estimated shift in the mean for an individual with the specified characteristic. Panel B presents the resulting model fit, with Column 1 presenting the causal estimates and Column 2 presents the model-implied coefficients when using the estimated cost distributions.

**A. Parameter Estimates**

| $\mu_\chi$ | | $\sigma_\chi$ | |
|---|---|---|---|
| 1,283,679 | | 1,295,843 | |
| **Debt** ($\leq 0$) | **Home Owner (Yes)** | **Wealth (High)** | **Equity Returns** ($\leq 0$) |
| -147,498 | 66,566 | 36,073 | 183,931 |
| **Sex (Female)** | **Age** ($> 45$) | **Higher Ed (Yes)** | **Self-Employed (Yes)** |
| 15,434 | 262,141 | -479,789 | 93,758 |

**B. Model Fit**

| **Characteristic** | | **Causal Estimates (1)** | **Model-Implied Estimates (2)** |
|---|---|---|---|
| | **Baseline** | .038 | .044 |
| | **Participants (NP)** | -.001 | .011 |
| | **Nonparticipants (P)** | .121 | .121 |
| | **15K-100K (P)** | -.011 | .002 |
| | **100K-1M (P)** | -.005 | .028 |
| | **1M-2M (P)** | .002 | .015 |
| | **2M+ (P)** | -.027 | .011 |
| | **15K-100K (NP)** | .014 | -.001 |
| | **100K-1M (NP)** | .082 | .060 |
| | **1M-2M (NP)** | .182 | .153 |
| | **2M+ (NP)** | .395 | .387 |
| **Debt** | $\leq 0$ | .212 | .183 |
| | $> 0$ | .094 | .074 |
| **Home Owner** | **Yes** | .105 | .086 |
| | **No** | .144 | .159 |
| **Wealth** | **High** | .066 | .072 |
| | **Low** | .137 | .130 |
| **Prior Equity Returns** | $> 0$ | .140 | .124 |
| | $\leq 0$ | .056 | .071 |
| **Sex** | **Female** | .117 | .123 |
| | **Male** | .147 | .131 |
| **Age** | $> 45$ | .114 | .096 |
| | $\leq 45$ | .140 | .127 |
| **Higher Education** | **Yes** | .224 | .227 |
| | **No** | .099 | .097 |
| **Self-Employed** | **Yes** | .035 | .048 |
| | **No** | .133 | .122 |

# B Online Appendix - Supplemental Tables

**Table B.1: Effect of Wealth (1M SEK) on Participation Probability, Robustness Checks.** The first two rows contain the estimated marginal effect of wealth at $s = 0$ by lottery in the pooled all-year sample and the post-1999 sample stratified by participants (P) and nonparticipants (NP). Restricted: the subsample of households with no self-employment income, debt less than 15K USD, and net wealth less than 1M USD. Capital Insurance: capital insurance ownership is included in participation definition. Individual Analysis: spousal ownership of equities excluded from participation definition. Probit: marginal effects from Probit instead of OLS. For each case, the coefficient from the pooled regression estimated in the all-year sample and the coefficients stratified by pre-lottery participation status estimated in the post-1999 sample are presented.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Lottery and Other Subsamples** | | | | |
| | | **Kombi** | | | | **Triss** | |
| | **Pooled** | **P** | **NP** | | **Pooled** | **P** | **NP** |
| **Effect** | .040 | .005 | .156 | | .035 | -.003 | .103 |
| **SE** | (.018) | (.008) | (.037) | | (.012) | (.007) | (.030) |
| $N$ | 31,664 | 21,168 | 7,896 | | 1,965 | 1,066 | 710 |
| | | **PLS** | | | | **Restricted** | |
| | **Pooled** | **P** | **NP** | | **Pooled** | **P** | **NP** |
| **Effect** | .189 | -.004 | 1.955 | | .066 | .004 | .175 |
| **SE** | (.110) | (.013) | (2.895) | | (.017) | (.006) | (.032) |
| $N$ | 45,225 | 30,641 | 11,307 | | 41,714 | 28,235 | 13,479 |
| | | | **Participation Definitions** | | | | |
| | | **Capital Insurance** | | | | **Individual Analysis** | |
| | **Pooled** | **P** | **NP** | | **Pooled** | **P** | **NP** |
| **Effect** | .051 | .001 | .152 | | .042 | .005 | .100 |
| **SE** | (.010) | (.005) | (.029) | | (.011) | (.004) | (.021) |
| $N$ | 78,854 | 54,456 | 18,332 | 78,854 | 52,875 | 19,913 | |
| | | | **Other Robustness** | | | | |
| | | **Probit** | | | | | |
| | **Pooled** | **P** | **NP** | | | | |
| **Effect** | .117 | .001 | .500 | | | | |
| **SE** | (.036) | (.068) | (.091) | | | | |
| **Marg. Effect** | .037 | <.001 | .090 | | | | |
| $N$ | 78,854 | 50,800 | 19,041 | | | | |

**Table B.2: Demographic and Financial Predictors of Participation in Post-1999 Sample and Sex- and Age-Weighted Swedish Representative Sample.** The regression model is estimated using year-end net wealth in 1999 and is comparable to that used by Calvet et al. (2007). Marginal effects are calculated as the predicted effect of a one-standard deviation change on the probability of participation, holding fixed the value of all other variables at their median value.

| | **Post-1999 Lottery** | | | **Matched Population** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **SE** | **Change** | **Estimate** | **SE** | **Change** |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Financial Assets | .206 | .004 | 39.5% | .176 | .003 | 44.2% |
| Total Real Estate | .025 | .006 | 11.4% | .036 | .005 | 18.4% |
| Total Liabilities | -.009 | .006 | -4.6% | -.023 | .005 | -9.4% |
| Retired | .075 | .029 | 1.5% | .062 | .024 | .8% |
| Self-Employed | .084 | .027 | .9% | .092 | .020 | 1.1% |
| Unemployed | .010 | .041 | .1% | .076 | .027 | .5% |
| Student | .107 | .043 | .8% | .121 | .026 | 1.3% |
| Age | -.012 | .001 | -7.9% | -.009 | .001 | -6.9% |
| Household Size | .002 | .010 | .1% | -.005 | .006 | -.2% |
| High School | .167 | .021 | 1.6% | .180 | .017 | 3.0% |
| Higher Degree | .266 | .022 | 2.5% | .262 | .018 | 4.4% |
| Missing Education | .181 | .083 | .3% | .311 | .072 | .8% |
| Immigrant | -.103 | .044 | -.7% | -.230 | .029 | -2.1% |
| Constant | -4.355 | .117 | | -3.682 | .071 | |
| $N$ | 72,788 | | | 49,959 | | |

**Table B.3: Effect of Wealth (1M SEK) on Participation Probability.** This table presents coefficients, standard errors, sample size, and mean predicted participation probability when lottery wealth is zero ($\hat{y}|L_i = 0$) obtained from estimating Equation 1 in the all-year sample. Columns 5 through 8 show analogous estimates with participation defined more narrowly to only include directly owned stocks.

| **Horizon** | **A. Stock or Mutual Fund** | | | | **B. Stock Only** | | | |
|---|---|---|---|---|---|---|---|---|
| **(s)** | $\beta_s$ **(1)** | **SE (2)** | $N$ **(3)** | $\hat{y}_{\vert L_i=0}$ **(4)** | $\beta_s$ **(5)** | **SE (6)** | $N$ **(7)** | $\hat{y}_{\vert L_i=0}$ **(8)** |
| -1 | .003 | .012 | 72,788 | .726 | .002 | .012 | 72,788 | .425 |
| 0 | .038 | .010 | 78,854 | .727 | .020 | .011 | 78,854 | .431 |
| 1 | .045 | .009 | 95,014 | .729 | .035 | .011 | 95,014 | .434 |
| 2 | .045 | .010 | 116,459 | .747 | .041 | .011 | 116,459 | .461 |
| 3 | .043 | .010 | 143,811 | .760 | .043 | .011 | 143,811 | .478 |
| 4 | .043 | .010 | 151,072 | .769 | .041 | .012 | 151,072 | .494 |
| 5 | .047 | .010 | 154,795 | .772 | .032 | .012 | 154,795 | .501 |
| 6 | .039 | .010 | 169,001 | .778 | .039 | .012 | 169,001 | .511 |
| 7 | .035 | .010 | 182,971 | .787 | .044 | .012 | 182,971 | .523 |
| 8 | .053 | .010 | 197,428 | .793 | .045 | .012 | 197,428 | .533 |
| 9 | .050 | .010 | 216,912 | .794 | .044 | .012 | 216,912 | .538 |
| 10 | .042 | .010 | 214,033 | .798 | .023 | .012 | 214,033 | .546 |

**Table B.4: Effect of Wealth (1M SEK) on Participation Probability by $s = -1$ Participation Status.** This table presents coefficients, standard errors, sample size, and mean predicted participation probability when lottery wealth is zero ($\hat{y}|L_i = 0$) obtained from estimating Equation 1 in the post-1999 sample stratified by participation status. Columns 9 through 16 show analogous estimates with participation defined more narrowly to only include directly owned stocks.

| | **A. Stock or Mutual Fund** | | | | | | | | **B. Stock Only** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Horizon** | **Participants** | | | | **Nonparticipants** | | | | **Participants** | | | | **Nonparticipants** | | | |
| **(s)** | $\beta_s$ | **SE** | $N$ | $\hat{y}_{\lvert L_i=0}$ | $\beta_s$ | **SE** | $N$ | $\hat{y}_{\lvert L_i=0}$ | $\beta_s$ | **SE** | **N** | $\hat{y}_{\lvert L_i=0}$ | $\beta_s$ | **SE** | **N** | $\hat{y}_{\lvert L_i=0}$ |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| -1 | | | 52,875 | | | | 19,913 | | | | 30,942 | | | | 41,846 | |
| 0 | -.001 | .005 | 52,875 | .978 | .121 | .024 | 19,913 | .070 | .008 | .004 | 30,942 | .972 | .018 | .010 | 41,846 | .041 |
| 1 | .002 | .009 | 49,158 | .959 | .113 | .029 | 17,859 | .095 | .001 | .014 | 28,812 | .951 | .019 | .011 | 38,205 | .052 |
| 2 | .012 | .009 | 44,874 | .944 | .090 | .031 | 15,832 | .118 | .007 | .013 | 26,392 | .931 | .025 | .013 | 34,314 | .062 |
| 3 | .022 | .008 | 41,292 | .930 | .067 | .031 | 14,094 | .134 | .011 | .018 | 24,357 | .911 | .029 | .017 | 31,029 | .069 |
| 4 | .019 | .010 | 37,756 | .915 | .078 | .043 | 12,532 | .145 | -.004 | .029 | 22,410 | .892 | .033 | .021 | 27,878 | .076 |

**Table B.5: Effect of Wealth on Participation Probability by Prize Size.** Coefficients are obtained by estimating Equation 1 in the post-1999 sample with the lottery wealth variable replaced by indicators for five mutually exclusive prize categories: 0 to 10K (omitted category), 10K to 100K, 100K to 1M, 1M to 2M, and 2M+ SEK. Marginal effects are calculated by dividing the effect-size estimate by the mean prize in each category. Estimated coefficients are presented when the outcome variable is an indicator of equity market participation, real estate market participation, bond and structured product market participation, and being debt free.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **A. Equity** | | | | | | | |
| | **Participants** | | | | **Nonparticipants** | | | |
| | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ |
| **Estimate** | -.011 | -.005 | .002 | -.027 | .014 | .082 | .182 | .395 |
| **SE** | (.009) | (.016) | (.012) | (.033) | (.029) | (.037) | (.045) | (.095) |
| **ME** | -.367 | -.026 | .002 | -.007 | .379 | .433 | .164 | .126 |
| $N$ | 478 | 801 | 203 | 50 | 256 | 525 | 94 | 28 |
| | **B. Bond and Structured Products** | | | | | | | |
| | **Participants** | | | | **Nonparticipants** | | | |
| | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ |
| **Estimate** | -.018 | -.014 | .025 | -.087 | .031 | .095 | .513 | .411 |
| **SE** | (.020) | (.040) | (.017) | (.073) | (.022) | (.030) | (.036) | (.074) |
| **ME** | -.693 | -.075 | .023 | -.024 | .846 | .494 | .458 | .122 |
| $N$ | 251 | 313 | 112 | 27 | 483 | 1013 | 185 | 51 |
| | **C. Real Estate** | | | | | | | |
| | **Participants** | | | | **Nonparticipants** | | | |
| | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ |
| **Estimate** | -.006 | .017 | -.016 | .000 | .001 | .033 | .100 | .184 |
| **SE** | (.012) | (.017) | (.012) | (.024) | (.011) | (.028) | (.040) | (.108) |
| **ME** | -.177 | .087 | -.015 | <.001 | .037 | .172 | .088 | .056 |
| $N$ | 518 | 885 | 225 | 64 | 285 | 441 | 72 | 14 |
| | **D. Debt-Free** | | | | | | | |
| | **Yes** | | | | **No** | | | |
| | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ | $10K < L_i \leq 100K$ | $100K < L_i \leq 1M$ | $1M < L_i \leq 2M$ | $2M < L_i$ |
| **Estimate** | -.021 | -.068 | .048 | .057 | -.033 | -.036 | .167 | .121 |
| **SE** | (.018) | (.047) | (.027) | (.069) | (.018) | (.025) | (.027) | (.051) |
| **ME** | -.883 | -.350 | .043 | .017 | -.838 | -.187 | .150 | .035 |
| $N$ | 293 | 294 | 77 | 17 | 441 | 1032 | 220 | 61 |

**Table B.6: Heterogeneous Effect of Wealth (1M SEK) on Participation Probability.** Coefficients are obtained by estimating Equation 1 at time $s = 3$ in the post-1999 sample of nonparticipants at time $s = -1$. Hetero $p$ obtained from an $F$-test of the null hypothesis that the two lottery-wealth coefficients are identical. Equity returns are based on the MSCI Sweden Index the calendar year prior to the lottery.

| | **Debt** | | **Home Owner** | | **Net Wealth** | | **Equity Returns** | |
|---|---|---|---|---|---|---|---|---|
| | **$= 0$** | **$> 0$** | **Yes** | **No** | **High** | **Low** | **$\leq 0$** | **$> 0$** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Effect | .182 | .051 | .059 | .073 | .102 | .058 | .051 | .091 |
| SE | (.108) | (.032) | (.044) | (.048) | (.070) | (.033) | (.040) | (.052) |
| $p$ | .091 | .115 | .182 | .125 | .146 | .077 | .199 | .082 |
| Hetero $p$ | .242 | | .819 | | .428 | | .544 | |
| $N$ | 7,150 | 6,944 | 8,363 | 5,731 | 3,450 | 10,644 | 4,922 | 9,172 |
| | **Sex** | | **Age** | | **Higher Education** | | **Self-Employed** | |
| | **Male** | **Female** | **$\leq 45$** | **$> 45$** | **Yes** | **No** | **Yes** | **No** |
| | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| Effect | .146 | .038 | .069 | .055 | .090 | .054 | .133 | .068 |
| SE | (.053) | (.036) | (.056) | (.035) | (.064) | (.034) | (.085) | (.032) |
| $p$ | .006 | .288 | .223 | .118 | .161 | .114 | .117 | .036 |
| Hetero $p$ | .092 | | .829 | | .616 | | .474 | |
| $N$ | 6,097 | 7,997 | 2,284 | 11,810 | 3,652 | 10,442 | 446 | 13,648 |

**Table B.7: Effect of Wealth (1M SEK) on Stock, Bond and Structured Product , and Real Estate Market Participation Probability for Nonparticipants in Equity Markets at $s = -1$.** This table presents coefficients, standard errors, sample size, and mean predicted participation probability when lottery wealth is zero ($\hat{y}|L_i = 0$) obtained from estimating Equation 1 in the post-1999 sample, restricted to households that did not participate in equity markets at $s = -1$. Columns 1-4 show estimates for the effect of wealth on bond market participation, colums 5-8 show the estimates for real estate market participation, while columns 9-12 show the effects on the probability of being debt-free.

| **Horizon** | **A. Bond and Structured Prod.** | | | | **A. Real Estate** | | | | **C. Debt-Free** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(s)** | $\beta_s$ | **SE** | $N$ | $\hat{y}_{\vert L_i=0}$ | $\beta_s$ | **SE** | $N$ | $\hat{y}_{\vert L_i=0}$ | $\beta_s$ | **SE** | $N$ | $\hat{y}_{\vert L_i=0}$ |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** | **(12)** |
| -1 | .000 | .000 | 19,913 | .585 | .021 | .016 | 19,913 | .207 | -.009 | .017 | 19,913 | .490 |
| 0 | .027 | .014 | 19,913 | .579 | .175 | .031 | 19,913 | .228 | .108 | .019 | 19,913 | .496 |
| 1 | .053 | .018 | 17,859 | .574 | .243 | .038 | 17,859 | .248 | .074 | .022 | 17,859 | .506 |
| 2 | .036 | .018 | 15,832 | .575 | .228 | .040 | 15,832 | .272 | .050 | .022 | 15,832 | .514 |
| 3 | .052 | .022 | 14,094 | .580 | .190 | .050 | 14,094 | .287 | .017 | .022 | 14,094 | .517 |
| 4 | .072 | .032 | 12,532 | .580 | .150 | .055 | 12,532 | .301 | -.033 | .024 | 12,532 | .529 |

**Table B.8: Effect of Wealth on Net Wealth, Bonds and Structured Products, Stocks, Bank Account Balances, Real Assets and Debt.** This table presents results from estimating Equation 1 in the all-year and post-1999 (stratified by participants and nonparticipants) samples. We present results for the full sample and subsamples of participants and nonparticipants at horizons $s = 0,\ 2,\ 4$. Financial variables are measured in SEK. Bonds: interest rate funds, premium bonds, interest bonds and structured products. Stocks: directly and indirectly held stocks. Bank: Bank Account Balances. Real Assets: property and land owned. Debt: gross debt. Other: Capital insurance and other financial assets

| | | **Total Wealth** | **Real Assets** | **Financial Assets** | | | | **Debt Debt** |
|---|---|---|---|---|---|---|---|---|
| | | | | **Stocks** | **Bonds** | **Bank** | **Other** | |
| | | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| Pooled | s=0 | .617 | .038 | .139 | .144 | .219 | .045 | -.019 |
| | $N$=78,854 | (.047) | (.047) | (.047) | (.047) | (.047) | (.047) | (.047) |
| | s=2 | .466 | -.008 | .158 | .102 | .089 | .094 | -.012 |
| | $N$=116,459 | (.049) | (.025) | (.034) | (.019) | (.023) | (.017) | (.017) |
| | s=4 | .365 | .019 | .107 | .059 | .068 | .092 | -.001 |
| | $N$=151,072 | (.052) | (.023) | (.030) | (.009) | (.018) | (.016) | (.018) |
| Participants | s=0 | .573 | -.013 | .082 | .185 | .242 | .030 | -.036 |
| | $N$=52,875 | (.046) | (.032) | (.027) | (.039) | (.041) | (.009) | (.019) |
| | s=2 | .468 | -.010 | .148 | .169 | .078 | .056 | -.015 |
| | $N$=44,874 | (.065) | (.061) | (.058) | (.040) | (.026) | (.021) | (.030) |
| | s=4 | .314 | .012 | .030 | .084 | .113 | .055 | -.022 |
| | $N$=37,756 | (.074) | (.056) | (.032) | (.021) | (.048) | (.020) | (.019) |
| Non- | s=0 | .603 | .067 | .144 | .107 | .194 | .063 | -.027 |
| participants | $N$=19,913 | (.062) | (.035) | (.060) | (.023) | (.033) | (.041) | (.019) |
| | s=2 | .329 | .029 | .015 | .098 | .057 | .118 | -.011 |
| | $N$=15,832 | (.053) | (.022) | (.008) | (.021) | (.017) | (.048) | (.020) |
| | s=4 | .282 | .100 | .024 | .077 | .025 | .109 | .053 |
| | $N$=12,532 | (.090) | (.046) | (.011) | (.027) | (.013) | (.062) | (.029) |

**Table B.9: Effect of Wealth (1M SEK) on Participation Probability in Bond and Structured Product, Real Estate, and Debt Markets.** This table presents coefficients, standard errors, sample size, and mean predicted participation probability when lottery wealth is zero ($\hat{y}|L_i = 0$) obtained from estimating Equation 1 in the all-year sample. Columns 1-4 show estimates for the effect of wealth on bond and structured product market participation, columns 5-8 show the estimates for real estate market participation, and columns 9-12 show the estimates for being debt free.

| **Horizon** | **A. Bonds and Struc. Prod.** | | | | **B. Real Estate** | | | | **C. Debt** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(s)** | $\beta_s$ **(1)** | **SE (2)** | $N$ **(3)** | $\hat{y}_{\vert L_i=0}$ **(4)** | $\beta_s$ **(5)** | **SE (6)** | $N$ **(7)** | $\hat{y}_{\vert L_i=0}$ **(8)** | $\beta_s$ **(9)** | **SE (10)** | $N$ **(11)** | $\hat{y}_{\vert L_i=0}$ **(12)** |
| -1 | .015 | .012 | 72,788 | .406 | .017 | .011 | 72,788 | .746 | -.002 | .009 | 72,788 | .421 |
| 0 | .126 | .014 | 78,854 | .429 | .017 | .011 | 78,854 | .744 | .051 | .011 | 78,854 | .427 |
| 1 | .156 | .013 | 95,014 | .444 | .021 | .010 | 95,014 | .743 | .039 | .010 | 95,014 | .442 |
| 2 | .135 | .013 | 116,459 | .450 | .022 | .010 | 116,459 | .742 | .042 | .011 | 116,459 | .457 |
| 3 | .106 | .013 | 143,811 | .455 | .017 | .009 | 143,811 | .742 | .032 | .010 | 143,811 | .461 |
| 4 | .089 | .012 | 151,072 | .467 | .022 | .009 | 151,072 | .743 | .023 | .009 | 151,072 | .463 |
| 5 | .078 | .012 | 154,795 | .472 | .029 | .008 | 154,795 | .746 | .020 | .010 | 154,795 | .464 |
| 6 | .072 | .012 | 169,001 | .471 | .024 | .009 | 169,001 | .749 | .018 | .010 | 169,001 | .466 |
| 7 | .066 | .012 | 182,971 | .468 | .025 | .009 | 182,971 | .753 | .014 | .010 | 182,971 | .465 |
| 8 | .078 | .012 | 197,428 | .470 | .032 | .009 | 197,428 | .759 | .009 | .010 | 197,428 | .462 |
| 9 | .074 | .012 | 216,912 | .484 | .040 | .008 | 216,912 | .763 | .013 | .010 | 216,912 | .459 |
| 10 | .050 | .012 | 214,033 | .490 | .032 | .009 | 214,033 | .766 | .010 | .010 | 214,033 | .459 |

**Table B.10: Effect of Wealth (1M SEK) on Participation Probability in Bond and Structured Product, Real Estate, and Debt Markets by $s = -1$ Participation Status.** This table presents coefficients, standard errors, sample size, and mean predicted participation probability when lottery wealth is zero ($\hat{y}|L_i = 0$) obtained from estimating Equation 1 in the post-1999 sample. Columns 1-8 show estimates for the effect of wealth on bond market and structured product participation, columns 9-16 show the estimates for real estate market participation, while columns 17-24 show the estimates for being debt free.

| Horizon | A. Bond and Structured Product | | | | | | | | B. Real Estate | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Participants | | | | Nonparticipants | | | | Participants | | | | Nonparticipants | | | |
| (s) | $\beta_s$ | SE | $N$ | $\hat{y}_{\mid L_i=0}$ | $\beta_s$ | SE | $N$ | $\hat{y}_{\mid L_i=0}$ | $\beta_s$ | SE | N | $\hat{y}_{\mid L_i=0}$ | $\beta_s$ | SE | N | $\hat{y}_{\mid L_i=0}$ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
| -1 | | | 29,539 | | | | 43,249 | | | | 54,307 | | | | 18,481 | |
| 0 | -.001 | .013 | 29,539 | .940 | .199 | .023 | 43,249 | .085 | -.006 | .006 | 54,307 | .978 | .067 | .024 | 18,481 | .051 |
| 1 | .029 | .010 | 27,004 | .899 | .234 | .025 | 40,013 | .159 | -.002 | .007 | 50,106 | .962 | .113 | .027 | 16,911 | .089 |
| 2 | .035 | .012 | 24,532 | .871 | .217 | .028 | 36,174 | .217 | -.008 | .010 | 45,432 | .949 | .088 | .037 | 15,274 | .122 |
| 3 | .065 | .013 | 22,494 | .852 | .171 | .035 | 32,892 | .268 | .012 | .005 | 41,617 | .942 | .080 | .038 | 13,769 | .148 |
| 4 | .049 | .030 | 20,555 | .840 | .152 | .040 | 29,733 | .313 | .015 | .006 | 37,846 | .934 | .080 | .051 | 12,442 | .172 |

| Horizon | C. Debt-Free | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Yes | | | | No | | | |
| (s) | $\beta_s$ | SE | $N$ | $\hat{y}_{\mid L_i=0}$ | $\beta_s$ | SE | $N$ | $\hat{y}_{\mid L_i=0}$ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| -1 | | | 30,612 | | | | 42,176 | |
| 0 | .034 | .012 | 30,612 | .927 | .067 | .013 | 42,176 | .061 |
| 1 | .037 | .013 | 28,423 | .899 | .059 | .013 | 38,594 | .089 |
| 2 | .053 | .018 | 26,165 | .873 | .059 | .015 | 34,541 | .110 |
| 3 | .005 | .031 | 23,838 | .853 | .040 | .014 | 31,548 | .124 |
| 4 | -.008 | .035 | 21,934 | .833 | .024 | .015 | 28,354 | .141 |

**Table B.11: Heterogeneous Effect of Wealth (1M SEK) on Real Estate Market Participation Probability.** Coefficients are obtained by estimating Equation 1 at time $s = 0$ in the post-1999 sample of real estate market nonparticipants at time at time $s = -1$. Hetero $p$ obtained from an $F$-test of the null hypothesis that the two lottery-wealth coefficients are identical. Equity returns are based on the MSCI Sweden Index the calendar year prior to the lottery.

| | **Debt** | | **Home Owner** | | **Net Wealth** | | **Equity Returns** | |
|---|---|---|---|---|---|---|---|---|
| | $= 0$ | $> 0$ | **Yes** | **No** | **High** | **Low** | $\leq 0$ | $> 0$ |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Effect | .029 | .079 | — | — | -.236 | .079 | .143 | .033 |
| SE | (.028) | (.027) | | | (.134) | (.026) | (.037) | (.021) |
| $p$ | .303 | .003 | | | .079 | .003 | <.001 | .110 |
| Hetero $p$ | .202 | | | | .021 | | .010 | |
| $N$ | 11,913 | 6,568 | 0 | 18,481 | 2,612 | 15,869 | 11,054 | 7,427 |

| | **Sex** | | **Age** | | **Higher Education** | | **Self-Employed** | |
|---|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | $\leq 45$ | $> 45$ | **Yes** | **No** | **Yes** | **No** |
| | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| Effect | .072 | .056 | .050 | .060 | .076 | .065 | -.082 | .068 |
| SE | (.044) | (.025) | (.058) | (.022) | (.061) | (.025) | (.122) | (.024) |
| $p$ | .103 | .022 | .386 | .005 | .212 | .010 | .500 | .005 |
| Hetero $p$ | .755 | | .868 | | .865 | | .227 | |
| $N$ | 8,111 | 10,370 | 3,891 | 14,590 | 5,322 | 13,159 | 351 | 18,130 |

**Table B.12: Heterogeneous Effect of Wealth (1M SEK) on Bond and Structured Product Market Participation Probability.** Coefficients are obtained by estimating Equation 1 at time $s = 0$ in the post-1999 sample of bond and structured product market nonparticipants at time $s = -1$. Hetero $p$ obtained from an $F$-test of the null hypothesis that the two lottery-wealth coefficients are identical. Equity returns are based on the MSCI Sweden Index the calendar year prior to the lottery.

| | **Debt** | | **Home Owner** | | **Net Wealth** | | **Equity Returns** | |
|---|---|---|---|---|---|---|---|---|
| | **$= 0$** | **$> 0$** | **Yes** | **No** | **High** | **Low** | **$\leq 0$** | **$> 0$** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Effect | .208 | .197 | .180 | .257 | .153 | .219 | .318 | .158 |
| SE | (.054) | (.026) | (.025) | (.051) | (.033) | (.031) | (.058) | (.024) |
| $p$ | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| Hetero $p$ | .858 | | .177 | | .150 | | .011 | |
| $N$ | 16,881 | 26,368 | 30,290 | 12,959 | 16,193 | 27,056 | 24,429 | 18,820 |

| | **Sex** | | **Age** | | **Higher Education** | | **Self-Employed** | |
|---|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **$\leq 45$** | **$> 45$** | **Yes** | **No** | **Yes** | **No** |
| | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| Effect | .284 | .140 | .134 | .234 | .171 | .218 | .268 | .195 |
| SE | (.038) | (.027) | (.031) | (.031) | (.033) | (.031) | (.054) | (.024) |
| $p$ | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| Hetero $p$ | .002 | | .022 | | .301 | | .217 | |
| $N$ | 21,510 | 21,739 | 7,203 | 36,046 | 15,374 | 27,875 | 2,255 | 40,994 |

**Table B.13: Heterogeneous Effect of Wealth (1M SEK) on Probability of Being Debt-Free.** Coefficients are obtained by estimating Equation 1 at time $s = 0$ in the post-1999 sample of households with positive debt at time $s = -1$. Hetero $p$ obtained from an $F$-test of the null hypothesis that the two lottery-wealth coefficients are identical. Equity returns are based on the MSCI Sweden Index the calendar year prior to the lottery.

| | **Debt** | | **Home Owner** | | **Net Wealth** | | **Equity Returns** | |
|---|---|---|---|---|---|---|---|---|
| | $= 0$ | $>$ **0** | **Yes** | **No** | **High** | **Low** | $\leq$ **0** | $>$ **0** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Effect | — | — | .049 | .157 | .029 | .103 | .103 | .052 |
| SE | | | (.012) | (.038) | (.013) | (.019) | (.029) | (.013) |
| $p$ | | | <.001 | <.001 | .027 | <.001 | <.001 | <.001 |
| Hetero $p$ | | | .007 | | .001 | | .105 | |
| $N$ | 0 | 42,176 | 35,608 | 6,568 | 20,906 | 21,270 | 22,037 | 20,139 |
| | **Sex** | | **Age** | | **Higher Education** | | **Self-Employed** | |
| | **Male** | **Female** | $\leq$ **45** | $>$ **45** | **Yes** | **No** | **Yes** | **No** |
| | **(9)** | **(10)** | **(11)** | **(12)** | **(13)** | **(14)** | **(15)** | **(16)** |
| Effect | .038 | .083 | .072 | .063 | .044 | .089 | .010 | .078 |
| SE | (.017) | (.018) | (.026) | (.015) | (.015) | (.020) | (.013) | (.014) |
| $p$ | .026 | <.001 | .006 | <.001 | .004 | <.001 | .414 | <.001 |
| Hetero $p$ | .070 | | .747 | | .070 | | <.001 | |
| $N$ | 22,612 | 19,564 | 35,337 | 6,839 | 20,175 | 22,001 | 3,358 | 38,818 |