

# Buy High, Cry Later: Beliefs-driven Cycles of Stock Market Participation \*

Paul Ehling<sup>†</sup>  
BI

Christian Heyerdahl-Larsen<sup>‡</sup>  
BI

Zeshu Xu<sup>§</sup>  
BI

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<sup>†</sup>Department of Finance, BI Norwegian Business School, Nydalsveien 37, 0484 Oslo, paul.ehling@bi.no

<sup>‡</sup>Department of Finance, BI Norwegian Business School, Nydalsveien 37, 0484 Oslo, christian.heyerdahl-larsen@bi.no

<sup>§</sup>Department of Finance, BI Norwegian Business School, Nydalsveien 37, 0484 Oslo, zeshu.xu@bi.no

## **Abstract**

Using survey data, we show that stock market participants are systematically more optimistic than nonparticipants, and that entry and exit coincide with substantial belief revisions. Motivated by these facts, we develop a model in which experience-based beliefs generate endogenous participation cycles. Inexperienced cohorts enter the market with leverage during periods of elevated valuations and exit following downturns, while experienced cohorts typically remain invested because the market-clearing risk premium gravitates toward their beliefs. These interactions generate procyclical participation, endogenous feedback between participation and learning, and welfare losses. When disciplined by realized shocks, the model reproduces fluctuations in participation, entry, and exit.

**Keywords:** Endogenous Stock Market Participation, Entry and Exit, Learning from Experience

**JEL Classification:** E2, G10, G11, G12

# 1 Introduction

One of the fundamental insights of standard portfolio theory is that all investors should participate in the stock market. Yet even in the United States, with its strong investment culture, overall stock market participation remains only slightly above fifty percent.<sup>1</sup> Against this backdrop, we document a central role for beliefs in driving fluctuations in stock market participation. Using data from the Michigan Surveys of Consumers and the RAND American Life Panel, we show that stock market participants are systematically more optimistic about future returns than nonparticipants, and that entry and exit coincide with substantial belief revisions. Participants also update their beliefs more strongly in response to realized stock market returns. Motivated by these findings, we develop a dynamic equilibrium model in which experience-based beliefs generate endogenous cycles in stock market participation, entry, exit, and reentry.

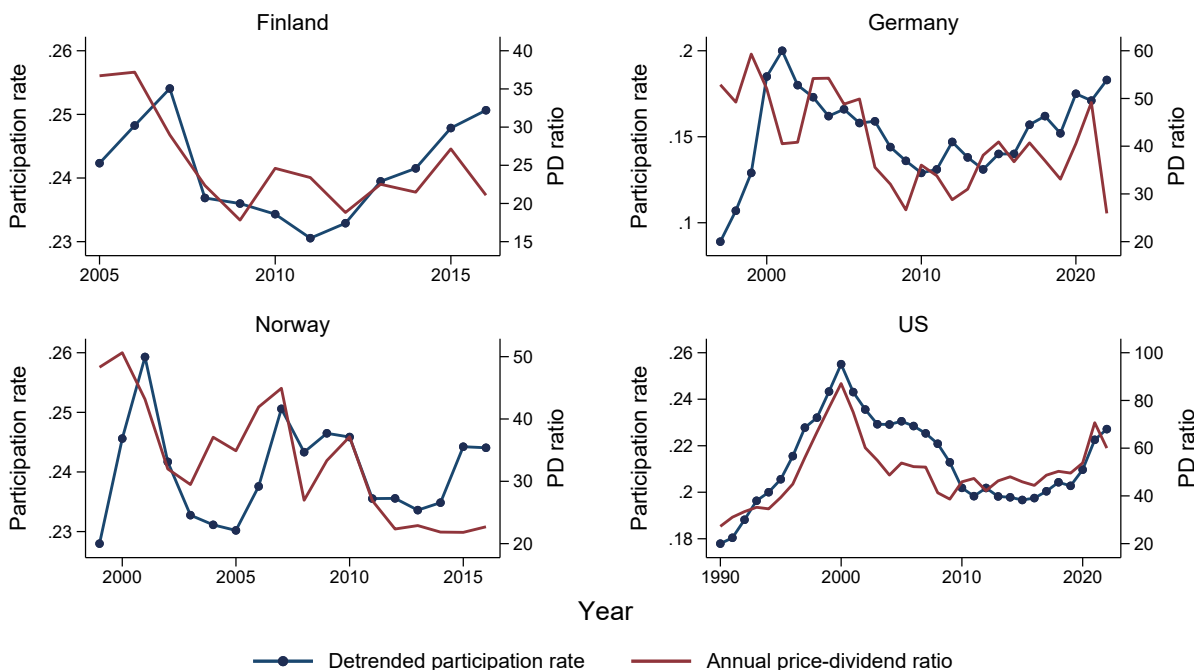
The central mechanism of the model is simple. Inexperienced cohorts become optimistic following periods of strong market performance and enter the stock market with leverage, often during periods of elevated valuations and low expected returns. Following adverse return realizations, many of these cohorts revise their beliefs downward and exit the market. Experienced cohorts, by contrast, typically remain invested even when relatively pessimistic. Because wealth is concentrated among experienced and sophisticated investors, equilibrium asset prices and the market-clearing risk premium gravitate toward their beliefs. As a result, inexperienced investors disproportionately enter when risk premia are low and exit after disappointing returns, generating a procyclical entry-exit pattern that lowers long-run investment performance. Consistent with this mechanism, Figure 1 shows that stock market participation in Finland, Germany, Norway, and the United States tends to rise during periods of elevated valuation ratios.

To study this mechanism, we develop a continuous-time overlapping-generations model

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<sup>1</sup>A compilation of stock market participation rates around the world for 2023–2024 is available at: <https://hellosafe.ca/en/investing/broker/stock-ownership>.

Figure 1: **The Stock Market and Participation.** The figure plots price-dividend ratios together with detrended stock market participation rates (with original means preserved) for Finland, Germany, Norway, and the United States. Price-dividend ratios are computed as  $P_t/D_t = R_t^{price}/(R_t^S - R_t^{price})$ , where  $R_t^{price}$  denotes the price return and  $R_t^S$  the total return including dividends. Data on price-dividend ratios are obtained from Amit Goyal’s website for the United States and from Ken French’s website for the remaining countries. Participation data for Finland are from Breikopf, Knüpfer, and Rantapuska (2021) using data from Statistics Finland, while data for Germany, Norway, and the United States are obtained from the Deutsches Aktieninstitut, Statistics Norway, and the Internal Revenue Service, respectively. A stock market participant is defined as an individual or household with direct or indirect stock holdings in a given year. Additional details are provided in Section F of the Online Appendix.



with three key ingredients: experience-based learning, endogenous stock market participation, and heterogeneous attention to the stock market. Agents learn about expected economic growth from realized outcomes, but participation affects the learning itself. Participants update beliefs more aggressively because they pay closer attention to the stock market, while nonparticipants update more slowly. These interactions generate persistent heterogeneity in expectations across cohorts and over time. In equilibrium, participation decisions shape asset prices, while asset prices feed back into future participation decisions through realized

returns and learning.

The model generates realistic fluctuations in stock market participation, entry, and exit rates. To isolate the beliefs-driven mechanism, we feed the model with shocks extracted from stock market returns. The model-implied participation dynamics closely track those observed in Finland, Germany, Norway, and the United States. In addition, the model reproduces realistic entry and exit flows, even though these flows are not directly targeted. The model further implies that aggregate participation negatively predicts future stock returns, consistent with periods of elevated participation coinciding with low subsequent risk premia.

Our framework also implies sizable welfare costs from cyclical entry and exit. Investors who enter during periods of exuberance tend to lever into the stock market when valuations are high and expected returns are low, while exits occur disproportionately after poor realized returns.

Our paper contributes to the literature on stock market participation in equilibrium, such as Gomes and Michaelides (2008), which explains nonparticipation through fixed participation costs. Closely related is Khorrami (2022), where equilibrium participation dynamics arise from fluctuations in the wealth distribution between participants and nonparticipants. In contrast, our model introduces a beliefs-driven mechanism that jointly generates stock market entry, exit, and reentry through experience-based learning. In this regard, our paper also relates to the literature on experience-based learning, including Malmendier and Nagel (2011), Malmendier and Nagel (2016), Collin-Dufresne, Johannes, and Lochstoer (2017), and Ehling, Graniero, and Heyerdahl-Larsen (2018b). Unlike these papers, participation in our framework is endogenous and feeds back into the learning from experience process itself.<sup>2</sup>

Beyond the literature on stock market participation and experience-based learning, our paper also relates to heterogeneous-beliefs asset pricing models such as Harris and Raviv (1993), Detemple and Murthy (1994), Jouini and Napp (2007), Dumas, Kurshev, and Uppal

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<sup>2</sup>A complementary approach is developed by Pan, Su, Wang, and Yu (2026), who study how entry dynamics driven by past returns and participation growth can generate bubbles, momentum, and value effects. Empirically, they show that aggregate entry predicts future momentum and value strategy returns.

(2009), Xiong and Yan (2010), Cvitanić, Jouini, Malamud, and Napp (2012), Bhamra and Uppal (2014), Ehling, Gallmeyer, Heyerdahl-Larsen, and Illeditsch (2018a), and more recently Gârleanu, Panageas, and Zheng (2026). Broadly speaking, this literature studies how disagreement shapes asset prices and portfolio allocations in equilibrium. In our framework, by contrast, disagreement arises endogenously from lifetime experiences and differs systematically across participants and nonparticipants. Moreover, participation decisions shape the learning process itself, generating endogenous feedback between beliefs, participation, and equilibrium asset prices.

## 2 Motivating Evidence

We use household survey data to motivate the key ingredients of the model and to document systematic links between beliefs and stock market participation. Our evidence points to three main findings. First, stock market participants are consistently more optimistic about future returns than nonparticipants. Second, entry and exit coincide with substantial revisions in beliefs. Third, beliefs and participation decisions are shaped by households' stock market experiences. Together, these patterns suggest that fluctuations in participation are closely linked to belief dynamics.

We primarily use data from the University of Michigan's Surveys of Consumers, complemented by data from the RAND American Life Panel. The Michigan survey interviews approximately 400 households each month and reinterviews roughly half of them six months later, allowing us to track changes in both beliefs and participation over time.<sup>3</sup> We classify respondents as stock market participants if they report direct or indirect stock holdings, and as nonparticipants otherwise. Entry (exit) is defined as a transition from nonparticipation to participation (participation to nonparticipation) between interviews.

A striking feature of the data is the frequency of participation transitions. Over a six-

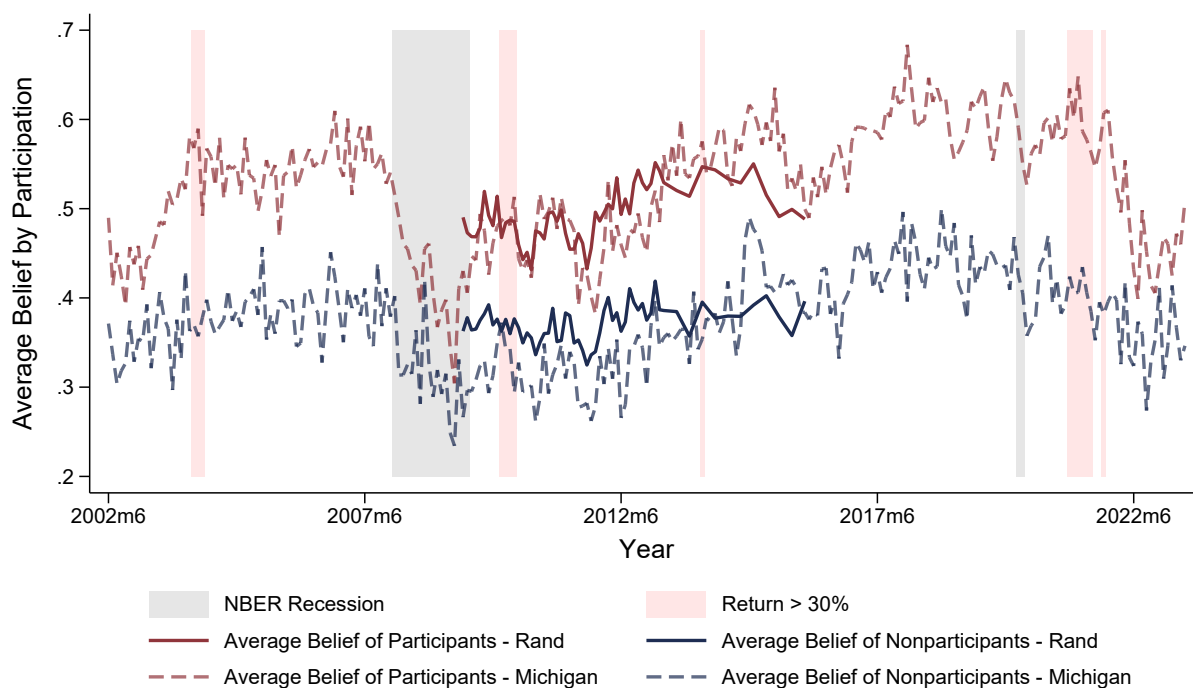
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<sup>3</sup>The households that are reinterviewed in the Michigan survey are broadly similar to those in the full sample (see Section C).

month interval, 6.02% of households enter the stock market, while 5.74% exit it. These large flows suggest that participation is not a fixed household characteristic, but instead varies substantially over time.

## 2.1 Participants are More Optimistic than Nonparticipants

Figure 2: **Beliefs of Participants and Nonparticipants I.** The figure plots monthly average beliefs of stock market participants and nonparticipants in the Michigan and RAND surveys. The t-statistics for the null hypothesis  $Belief(Participant) = Belief(Nonparticipant)$  are 53.78 and 40.75 for the Michigan and RAND surveys, respectively. Additional details on the surveys are provided in Sections C (Michigan) and D (RAND) of the Online Appendix.



Beginning in June 2002, the Michigan survey asks respondents about the probability that a diversified stock mutual fund will increase in value over the following year. We use these responses to construct a measure of subjective stock market beliefs.

Figure 2 shows that participants are systematically more optimistic than nonparticipants in both the Michigan and RAND surveys. In the Michigan survey, average beliefs equal 0.53

for participants and 0.38 for nonparticipants; the corresponding values in the RAND survey are 0.50 and 0.37. These differences are both economically large and highly statistically significant. Moreover, the fact that more optimistic households are more likely to participate is consistent with evidence from Greenwood and Shleifer (2014) showing that investors act on their survey-reported expectations.

To further assess the relation between beliefs and participation, we regress participation on beliefs while controlling for household characteristics and time fixed effects. Column (1) of Table 1 shows that more optimistic households are significantly more likely to participate in the stock market. Moreover, the belief gap between participants and nonparticipants narrows during recessions, consistent with weak market conditions reducing optimism among participants. Column (2) of Table 1 further supports this interpretation, as the interaction between participation and an NBER recession indicator is negative and statistically significant. This pattern is also broadly consistent with Das, Kuhnen, and Nagel (2020), who show that the expectations wedge between different socioeconomic groups tends to be larger in booms than in recessions.

## 2.2 Entry, Exit, and Belief Revisions

We next examine whether changes in beliefs are associated with participation transitions. Both panels of Figure 3 show that households that subsequently enter or exit the stock market hold beliefs close to a participation “cutoff,” lying between the optimism of households that remain participants and the pessimism of households that remain nonparticipants.

Further, column (3) of Table 1 shows that positive belief revisions are associated with increases in stock market participation. To separately study entry and exit decisions, we estimate probit models for each transition. The results in columns (4)-(5) indicate that positive belief revisions are associated with a greater likelihood of entry and a lower likelihood of exit. These results suggest that entry and exit are not random liquidity events, but are

	(1)	(2)	(3)	(4)	(5)
	Parti <sub><i>i,t</i></sub>	Belief <sub><i>i,t</i></sub>	ΔParti <sub><i>i,t,6m</i></sub>	Entry <sub><i>i,t,6m</i></sub>	Exit <sub><i>i,t,6m</i></sub>
Belief <sub><i>i,t</i></sub>	0.708*** (0.019)		0.012* (0.007)	0.422*** (0.055)	-0.781*** (0.048)
Parti <sub><i>i,t</i></sub>		0.106*** (0.003)			
Parti <sub><i>i,t</i></sub> × Recession <sub><i>t</i></sub>		-0.054*** (0.008)			
ΔBelief <sub><i>i,t,6m</i></sub>			0.032*** (0.006)	0.364*** (0.049)	-0.476*** (0.043)
Controls	Y	Y	Y	Y	Y
Dummies	Year-month	Year-month	Year-month	Year-month	Year-month
R-squared	.280	.141	.009	.099	.112
N	74539	74539	44959	13425	31534
Regression	Probit	OLS	OLS	Probit	Probit
Conditional on				Parti <sub><i>i,t</i></sub> =0	Parti <sub><i>i,t</i></sub> =1

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 1: **Participation and Beliefs.** Belief is measured as PSTK/100. Participation is an indicator variable equal to 1 if the household participates in the stock market and 0 otherwise. The change in belief ( $\Delta$ Belief) is defined as the belief reported in the second interview minus that reported in the first interview.  $\Delta$ Participation equals 1 for entry, 0 for no change between interviews, and  $-1$  for exit. Controls include indicators for income quartiles, age groups ( $<40$ ,  $40-60$ ,  $>60$ ), educational attainment, housing status (owner or renter), region of residence (North, South, Northeast, Central North), respondent gender, and political affiliation (Democrat, Republican, non-affiliated). All specifications include year-month (interview-wave) fixed effects. Additional details on the Michigan survey are provided in Section C of the Online Appendix. Corresponding regressions using the RAND survey are reported in Section D.

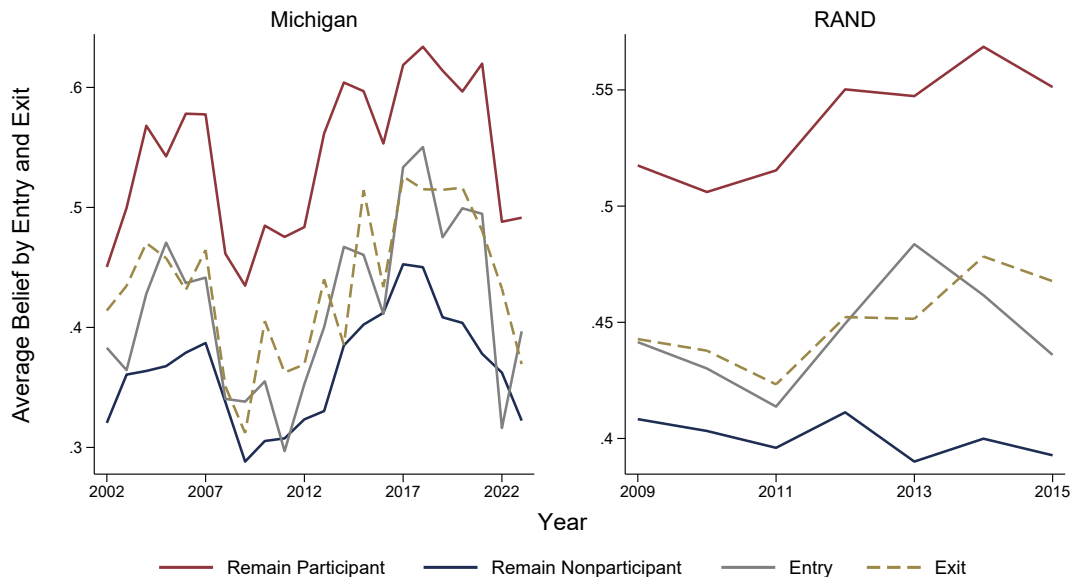
closely linked to changes in expectations about future stock market performance.<sup>4</sup>

## 2.3 Experience-Based Learning

How do households' experiences shape their beliefs? In this regard, Table 2 shows that households become more optimistic following positive stock market returns (column (1)) and that participants revise their beliefs more strongly in response to returns than nonparticipants (column (2)). This pattern is consistent with participants paying greater attention to financial markets and updating more aggressively in response to new information.

<sup>4</sup>We replicate our main analysis on a subsample of respondents who report no changes in income quartile or homeownership status across the two survey waves, see Table 7 in the Online Appendix.

Figure 3: **Participation Transitions.** The panels plot annual average beliefs by participation transition —entry, exit, remain nonparticipant, and remain participant— in the Michigan survey (first interview, left panel) and the RAND survey (right panel). In the Michigan survey, the t-statistics for the null hypotheses  $Belief(Remain\ participant) = Belief(Remain\ nonparticipant)$ ,  $Belief(Remain\ participant) = Belief(Exit)$ , and  $Belief(Entry) = Belief(Remain\ nonparticipant)$  are 24.68, 13.50, and 6.02, respectively. The corresponding t-statistics in the RAND survey are 13.76, 20.46, and 4.66. Additional details on the surveys are provided in Sections C (Michigan) and D (RAND) of the Online Appendix.



Motivated by the experience-based learning literature, we also construct measures of experienced returns based on realized stock market performance over households’ lifetimes.<sup>5</sup> Households with more favorable lifetime stock market experiences are both more likely to participate in the stock market (column (3)) and more optimistic about future returns (column (4)). Using experienced returns as an instrument for beliefs yields a strong positive effect of beliefs on participation (column (5)).<sup>6</sup>

<sup>5</sup>We restrict the regression sample to individuals between ages 25 and 75 and consider starting ages between 15 and 23. The construction is equivalent to Bayesian updating with a diffuse prior beginning at ages 15 to 23 and a pre-entry learning window ranging from 2 to 10 years prior to entry into the economy. A starting age of 20 minimizes the sum of squared errors, although the results are similar across starting ages; see Table 6 in the Online Appendix.

<sup>6</sup>The IV estimate is economically large relative to the reduced-form estimate in column (1) of Table 1. Moving from the 10th to the 90th percentile of the belief distribution increases the probability of participation by approximately 80 percentage points in the IV specification, compared with around 15 percentage points in the reduced-form regression.

	(1)	(2)	(3)	(4)	(5)
	$\Delta\text{Belief}_{i,t,6m}$	$\Delta\text{Belief}_{i,t,6m}$	$\text{Parti}_{i,t}$	$\text{Belief}_{i,t}$	$\text{Parti}_{i,t}$
$\text{Return}_{t,6m}$	0.245*** (0.025)	0.140*** (0.032)			
$\text{Belief}_{i,t}$	-0.638*** (0.005)	-0.648*** (0.005)			3.236*** (0.166)
$\text{Parti}_{i,t}$		0.046*** (0.004)			
$\text{Parti}_{i,t} \times \text{Return}_{t,6m}$		0.145*** (0.029)			
$\text{Experience}_{age_{i,t}}$			1.503*** (0.272)	0.349*** (0.060)	
Controls	Y	Y	Y	Y	Y
Dummies	Year	Year	Year age	Year age	Year age
R-squared	.334	.339	.265	.112	.242
N	45150	45150	73231	63579	63579
Regression	OLS	OLS	Probit	OLS	IV Probit
Cluster at	Year-month	Year-month	Year-month-age	Year-month-age	Year-month-age

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 2: **Beliefs and Experiences.** Return denotes the stock market return between the two interview waves. Belief is measured as PSTK/100. The change in belief ( $\Delta\text{Belief}$ ) is defined as the belief reported in the second interview minus that reported in the first interview. Participation is an indicator variable equal to 1 if the household participates in the stock market and 0 otherwise. We proxy for experienced returns using the average stock market return realized since age 20. Column (5) reports second-stage IV estimates using experienced returns as an instrument for beliefs. Controls include indicators for income quartiles, educational attainment, housing status (owner or renter), region of residence (North, South, Northeast, Central North), respondent gender, and political affiliation (Democrat, Republican, non-affiliated). In columns (1) and (2), the controls additionally include indicators for age groups (<40, 40–60, >60). Monthly stock market returns are obtained from Amit Goyal’s website. Additional details on the Michigan survey are provided in Section C of the Online Appendix. Corresponding regressions using the RAND survey are reported in Section D.

Taken together, the evidence points to a close connection between lifetime experiences, belief formation, and stock market participation. Participants are systematically more optimistic than nonparticipants, and entry and exit coincide with substantial revisions in beliefs. These findings motivate our model of endogenous participation cycles driven by experience-based learning and complement the evidence in Giglio, Maggiori, Stroebel, and Utkus (2021) that investors with more optimistic return expectations hold larger equity positions.

### 3 The Model

In our continuous-time overlapping-generations (OLG) exchange economy, agents die at rate  $\nu > 0$  and are replaced by newborns at the same rate. The total population size therefore remains constant and can be normalized to one, with the time- $t$  size of the cohort born at time  $s < t$  given by  $\nu e^{-\nu(t-s)}$ .<sup>7</sup>

Output  $Y_t$  evolves according to

$$dY_t/Y_t = \mu_Y dt + \sigma_Y dz_t, \quad (1)$$

where  $z_t$  is a standard Brownian motion.

To generate experience-based learning, agents observe output realizations but do not know the expected growth rate  $\mu_Y$ . At birth (time  $s$ ), each newborn cohort starts with a prior belief  $\hat{\mu}_{s,s}$  that depends on the time of birth and a common prior variance  $\hat{V} > 0$ . Given their perceived growth rate  $\hat{\mu}_{s,t}$ , agents observe output dynamics as

$$dY_t/Y_t = \hat{\mu}_{s,t} dt + \sigma_Y dz_{s,t}, \quad (2)$$

where  $z_{s,t}$  is a Brownian motion under the beliefs of a cohort born at time  $s$ .

To capture differences in attention to financial markets, belief updating depends on participation status. Participants ( $P$ ) update beliefs according to standard Bayesian updating, whereas nonparticipants ( $N$ ) under-react.<sup>8</sup> Formally, at time  $t$  a cohort born at  $s$  perceives

$$d\hat{\mu}_{s,t} = \begin{cases} \frac{\varphi}{\sigma_Y} \hat{V}_{s,t} dz_{s,t}^Y, & \text{if } N, \text{ or} \\ \frac{1}{\sigma_Y} \hat{V}_{s,t} dz_{s,t}^Y, & \text{if } P, \end{cases} \quad \text{where} \quad \frac{1}{\hat{V}_{s,t}} = \begin{cases} \frac{1}{\hat{V}'_s} + \frac{\varphi}{\sigma_Y^2} (t - t'_s), & \text{if } N, \text{ or} \\ \frac{1}{\hat{V}'_s} + \frac{1}{\sigma_Y^2} (t - t'_s), & \text{if } P, \end{cases} \quad (3)$$

where  $\varphi \in [0, 1]$  governs the attention of nonparticipants,  $t'_s$  is the last switching time between

<sup>7</sup>See Blanchard (1985) and Gârleanu and Panageas (2015) for the origins of this framework.

<sup>8</sup>See Berrada (2009) for a related deviation from Bayesian updating.

participation and nonparticipation (or  $t'_s = s$  if none has occurred), and  $\widehat{V}'_s$  is the variance at that switching time. This formulation nests Bayesian updating when  $\varphi = 1$  and dogmatic beliefs when  $\varphi = 0$ ; the participation decision itself is endogenous.

Since agents know  $\sigma_Y$ , the perceived and true shocks are linked by

$$dz_{s,t}^Y = dz_t - \Delta_{s,t} dt, \quad (4)$$

where  $\Delta_{s,t} \equiv (\widehat{\mu}_{s,t} - \mu_Y) / \sigma_Y$  is the standardized estimation error. Under the true probability measure, the dynamics of expected growth become

$$d\widehat{\mu}_{s,t} = \begin{cases} -\frac{\varphi}{\sigma_Y} \widehat{V}_{s,t} \Delta_{s,t} dt + \frac{\varphi}{\sigma_Y} \widehat{V}_{s,t} dz_t, & \text{if } N, \text{ or} \\ -\frac{1}{\sigma_Y} \widehat{V}_{s,t} \Delta_{s,t} dt + \frac{1}{\sigma_Y} \widehat{V}_{s,t} dz_t, & \text{if } P. \end{cases} \quad (5)$$

Solving these stochastic differential equations yields the following characterization of belief errors.

**Proposition 1.** *The estimation error at time  $t$  of the cohort born at time  $s$  is*

$$\Delta_{s,t} = \begin{cases} \frac{\sigma_Y^2}{\sigma_Y^2 + \varphi \widehat{V}'_s(t-t'_s)} \Delta_{s,t'_s} + \frac{\varphi \widehat{V}'_s}{\sigma_Y^2 + \varphi \widehat{V}'_s(t-t'_s)} (z_t - z_{t'_s}), & \text{if } N, \text{ or} \\ \frac{\sigma_Y^2}{\sigma_Y^2 + \widehat{V}'_s(t-t'_s)} \Delta_{s,t'_s} + \frac{\widehat{V}'_s}{\sigma_Y^2 + \widehat{V}'_s(t-t'_s)} (z_t - z_{t'_s}), & \text{if } P, \end{cases} \quad (6)$$

where  $t'_s > s$  denotes switching from participant to nonparticipant, or vice versa, and where  $\Delta_{s,t'_s} = \frac{\widehat{\mu}_{s,t'_s} - \mu_Y}{\sigma_Y}$ ,  $\lim_{t-t'_s \rightarrow \infty} \Delta_{s,t} = 0$  a.s.

Proposition 1 characterizes the evolution of the estimation error  $\Delta_{s,t}$  for a cohort born at time  $s$ . The process is piecewise continuous, with dynamics that depend on whether the cohort participates in the stock market or not, and are therefore partitioned by the endogenous switching times  $t'_s$ . Economically, a positive estimation error corresponds to optimism about future economic growth relative to the truth.

### 3.1 Security Markets and Prices

Cohorts trade an instantaneously risk-free bond (in zero net supply), shares of the stock market, and annuities. The bond evolves according to

$$dB_t/B_t = r_t dt, \quad (7)$$

where  $r_t$  is the equilibrium real short rate.

Shares in the stock market are normalized to one and trade at price  $S_t$ . All output is distributed as dividend, so stock returns satisfy

$$dR_t = (dS_t + D_t dt) / S_t = (dS_t + Y_t dt) / S_t = \mu_t^S dt + \sigma_t^S dz_t = \mu_{s,t}^S dt + \sigma_t^S dz_{s,t}, \quad (8)$$

where  $\mu_t^S$ ,  $\mu_{s,t}^S$ , and  $\sigma_t^S$  are determined in equilibrium. Cohorts agree on current prices but disagree about the probabilities of future events. Using the relation between perceived and actual shocks in (4), we obtain  $\mu_{s,t}^S = \mu_t^S + \sigma_t^S \Delta_{s,t}$ .

To insure against mortality risk, a competitive insurance sector offers actuarially fair annuity contracts at rate  $\nu$  (Yaari (1965)). Since agents place no value on leaving financial wealth behind, they fully annuitize their wealth, implying that the financial wealth of deceased agents is redistributed to surviving agents through annuity payments of rate  $\nu$ .

### 3.2 The Disagreement Process

In our framework, nonparticipants are agents whose beliefs have become sufficiently pessimistic following adverse realized returns. Since the stock market is the only source of aggregate consumption risk, agents exit only when their perceived instantaneous price of risk  $\theta_{s,t}$  falls below a lower threshold  $\vartheta^l$ . Nonparticipants reenter once their perceived market price of risk  $\theta_{s,t}$  rises above the upper threshold  $\vartheta^h$ , where  $\vartheta^h \geq \vartheta^l$ . A positive gap captures the idea that an agent who has left the market requires a larger upward movement

in the perceived price of risk to reenter than the downward movement that prompted exit. The case  $\vartheta^h = \vartheta^l$  is nested and imposes no such inertia.

To solve the model we embed the incomplete-markets problem with endogenous participation into a complete-markets economy with fictitious state prices, following He and Pearson (1991) and Karatzas, Lehoczky, Shreve, and Xu (1991). In this fictitious economy the stochastic discount factor perceived by a cohort born at time  $s$  evolves as

$$d\xi_{s,t}/\xi_{s,t} = -r_t dt - \underline{\theta}_{s,t} dz_{s,t}, \quad \text{where } \underline{\theta}_{s,t} = \begin{cases} 0, & \text{if } N, \text{ or} \\ \theta_{s,t}, & \text{if } P. \end{cases} \quad (9)$$

On the true probability measure the stochastic discount factor satisfies

$$d\xi_t/\xi_t = -r_t dt - \theta_t dz_t. \quad (10)$$

From (8) we have  $\theta_{s,t} = \theta_t + \Delta_{s,t}$ , so exit occurs when  $\Delta_{s,t} < \vartheta^l - \theta_t$  and (conditional on nonparticipation) entry occurs when  $\Delta_{s,t} > \vartheta^h - \theta_t$ .

The disagreement process  $\eta_{s,t}$  that relates objective and perceived stochastic discount factors ( $\xi_t = \eta_{s,t} \xi_{s,t}$ ) follows

$$d\eta_{s,t}/\eta_{s,t} = (\underline{\theta}_{s,t} - \theta_t) dz_t. \quad (11)$$

### 3.3 Preferences and Individual Optimization

To generate variation in valuation ratios, we introduce heterogeneity in time preferences within each cohort while keeping the cross-sectional distribution of types time-invariant. Let  $\rho_i$  denote the time-preference rate of type- $i$  agents and  $\alpha_i$  their density, with  $\int_i \alpha_i di = 1$ . Because all agents within a cohort share the same learning history, their subjective stochastic discount factors are identical across types.<sup>9</sup>

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<sup>9</sup>Accordingly, whenever unambiguous, we suppress the type index  $i$  in  $dz_{s,t}$ ,  $\xi_{s,t}$ ,  $\theta_{s,t}$ , and  $\eta_{s,t}$ .

Newborns are endowed via a lump-sum tax  $\tau$  on the consumption of all living agents.<sup>10</sup> A cohort born at time  $s$  of size  $\nu$  receives total tax revenue  $\tau C_s$ , so each newborn starts with initial wealth  $W_{i,s,s} = W_{s,s} = \tau C_s / \nu$ .

Agents face constant mortality risk independent of output. Integrating over the stochastic lifetime implied by the death intensity  $\nu$ , expected lifetime utility for type- $i$  agents in cohort  $s$  is given by

$$\mathbb{E}_{s,s} \left[ \int_s^\infty e^{-(\rho_i + \nu)(t-s)} \log(c_{i,s,t}) dt \right]. \quad (12)$$

Wealth dynamics are

$$dW_{i,s,t} = \begin{cases} (r_t W_{i,s,t} + \nu W_{i,s,t} - \tau c_{i,s,t} - c_{i,s,t}) dt, & \text{if } N, \text{ or} \\ [r_t W_{i,s,t} + \pi_{i,s,t} (\mu_{s,t}^S - r_t) + \nu W_{i,s,t} - \tau c_{i,s,t} - c_{i,s,t}] dt + \pi_{i,s,t} \sigma_t^S dz_{s,t}, & \text{if } P, \end{cases} \quad (13)$$

where  $\pi_{i,s,t}$  is the dollar investment in the stock market.

### 3.4 Equilibrium

The fictitious unconstrained consumption-portfolio choice problem, corresponding to the static problem of Cox and Huang (1989), is

$$\max_{c_{i,s}} \mathbb{E}_{s,s} \left[ \int_s^\infty e^{-(\rho_i + \nu)(t-s)} \log(c_{i,s,t}) dt \right]$$

s.t.

$$\mathbb{E}_{s,s} \left[ \int_s^\infty e^{-\nu(t-s)} \frac{\xi_{s,t}}{\xi_{s,s}} (c_{i,s,t} + \tau c_{i,s,t}) dt \right] = W_{i,s,s}. \quad (14)$$

From the first-order conditions (FOCs), we obtain

$$\frac{e^{-(\rho_i + \nu)(t-u)}}{c_{i,s,t}} = \kappa_{i,s} (1 + \tau) e^{-\nu(t-u)} \frac{\xi_{s,t}}{\xi_{s,s}}, \quad (15)$$

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<sup>10</sup>An alternative equilibrium with a wealth tax, which has a similar structure, is summarized in Section E of the Online Appendix.

where  $\kappa_{i,s}$  is the Lagrange multiplier associated with the static budget constraint.

**Proposition 2.** *At date  $t$ , the optimal consumption of a living type- $i$  agent of cohort  $s$  is*

$$c_{i,s,t} = c_{i,s,s} e^{-\rho_i(t-s)} \frac{\eta_{s,t} \xi_s}{\eta_{s,s} \xi_t}. \quad (16)$$

We conjecture and verify that the consumption-to-wealth ratio is constant:  $c_{i,s,t}/W_{i,s,t} = \beta_i = (\rho_i + \nu)/(1 + \tau)$ . We define the wealth share of type- $i$  agents born at  $s$  as  $f_{i,s,t}^W = \alpha_i \nu e^{-\nu(t-s)} W_{i,s,t}/W_t$  and the corresponding consumption share as  $f_{i,s,t}^c = \alpha_i \nu e^{-\nu(t-s)} c_{i,s,t}/Y_t$ .

**Proposition 3.** *In equilibrium, the real short rate is*

$$r_t = \underbrace{\nu - \tau\beta}_{\text{OLG}} + \underbrace{\bar{\rho}_t + \mu_Y - \sigma_Y(\sigma_Y + \sigma_Y \left(\frac{1}{\bar{\Phi}_t} - 1\right) - \bar{\Delta}_t)}_{\text{Beliefs-driven participation}} = \nu - \tau\beta + \bar{\rho}_t - \sigma_Y^2 \frac{1}{\bar{\Phi}_t} + \bar{\mu}_t, \quad (17)$$

and the market price of risk is

$$\theta_t = \underbrace{\sigma_Y}_{\text{Log utility}} + \underbrace{\sigma_Y \left(\frac{1}{\bar{\Phi}_t} - 1\right) - \bar{\Delta}_t}_{\text{Beliefs-driven participation}} = \sigma_Y \frac{1}{\bar{\Phi}_t} - \frac{\bar{\mu}_t - \mu_Y}{\sigma_Y}, \quad (18)$$

where  $\beta = \int_i \alpha_i \beta_i di$  denotes the constant consumption-to-wealth ratio of the newborn cohort,  $\bar{\rho}_t = \int_i \rho_i \int_{-\infty}^t f_{i,s,t}^c ds di$  is the consumption-weighted average time preference,  $\bar{\Phi}_t = \int_i \int_{-\infty}^t f_{i,s,t}^c \mathbb{1}_{s,t} ds di$  is the aggregate consumption share of stock-market participants ( $\mathbb{1}_{s,t} = 1$  if cohort  $s$  participates),  $\bar{\Delta}_t$  is the consumption-weighted average standardized estimation error conditional on participation, and  $\bar{\mu}_t$  is the consumption-weighted average expected growth rate conditional on participation (which we label the market view of the participants).

The real short rate therefore consists of three components: an OLG term, a standard log-utility term, and a *beliefs-driven participation effect*. Similarly, the market price of risk reflects both the usual log-utility component and the beliefs-driven participation effect. Crucially, equilibrium asset prices depend only on the beliefs of agents who participate in the

stock market.

**Proposition 4.** *The expected excess return on the stock market is given by*

$$\mu_t^S - r_t = \sigma_t^S \theta_t, \quad (19)$$

and the stock market volatility is

$$\sigma_t^S = \tilde{\Phi}_t \left( \theta_t + \tilde{\Delta}_t \right), \quad (20)$$

where  $\tilde{\Phi}_t = \int_i \int_{-\infty}^t f_{i,s,t}^W \mathbb{1}_{s,t} ds di$  is the aggregate wealth share of participants and  $\tilde{\Delta}_t$  is the corresponding wealth-weighted average belief conditional on participation.

Unlike in standard log-utility economies, consumption- and wealth-weighted quantities differ in our model because agents differ in time preferences. Since stock-market clearing depends on wealth shares, equilibrium volatility is driven by wealth-weighted beliefs.

**Proposition 5.** *For participants, the optimal dollar investment in the stock market is*

$$\pi_{i,s,t} = \frac{\Delta_{s,t} + \theta_t}{\sigma_t^S} W_{i,s,t}. \quad (21)$$

The portfolio policy consists of two components. The first term,  $(\Delta_{s,t} - \bar{\Delta}_t)/\sigma_t^S = (\hat{\mu}_{s,t} - \bar{\mu}_t)/(\sigma_Y \sigma_t^S)$ , captures speculative demand based on relative optimism. The second term,  $(\theta_t + \bar{\Delta}_t)/\sigma_t^S = (\sigma_Y/\sigma_t^S)(1/\bar{\Phi}_t)$ , depends on the ratio of exogenous to endogenous volatility and the inverse of the consumption share of participants. In contrast to the complete-markets benchmark with log utility, variations in portfolio composition arise only through the belief component. Because of log preferences, an agent's leverage (and therefore the participation decision itself) is independent of differences in time preferences.

A key step in characterizing equilibrium is to jointly determine  $\theta_t$  and stock-market participation. In equilibrium, a previously participating cohort with cutoff estimation error

$\Delta_{s,t}^l = \vartheta^l - \theta_t$  demands  $\pi_{i,s,t}^l = \vartheta^l W_{i,s,t} / \sigma_t^S$  shares of the stock, while a previously nonparticipating cohort with cutoff  $\Delta_{s,t}^h = \vartheta^h - \theta_t$  demands  $\pi_{i,s,t}^h = \vartheta^h W_{i,s,t} / \sigma_t^S$ . Demand is therefore discontinuous in beliefs: sufficiently optimistic agents participate, sufficiently pessimistic agents do not, and agents with intermediate beliefs participate only if they were already in the market.

Section A of the Appendix provides two additional propositions describing the dynamics of equilibrium consumption of participants and nonparticipants as well as the dynamics of consumption and wealth shares across agent types. All proofs are collected in Section B.

## 4 Properties of the Model

We now examine the quantitative properties and time-series dynamics implied by the model in Section 3.

### 4.1 Parameters

The model is governed by eleven parameters:  $\nu$ ,  $\mu_Y$ ,  $\sigma_Y$ ,  $\widehat{\mu}_{s,s}$ ,  $\widehat{V}$ ,  $\rho_a$ ,  $\rho_b$ ,  $\tau$ ,  $\varphi$ ,  $\vartheta^l$  and  $\vartheta^h$ . We set the birth and death rate  $\nu$  to 2% and the drift and volatility of aggregate output to  $\mu_Y = 2\%$  and  $\sigma_Y = 3.3\%$ , respectively. Following Ehling, Graniero, and Heyerdahl-Larsen (2018b), the prior belief  $\widehat{\mu}_{s,s}$  and prior variance  $\widehat{V}$  are formed over a pre-entry learning window of  $n$  years during which agents accumulate formative experiences with stock returns before entering the economy:  $\widehat{\mu}_{s,s} = \mu_Y + \sigma_Y \frac{z_s^Y - z_{s-n}^Y}{n}$ , and  $\widehat{V} = \frac{\sigma_Y^2}{n}$ . Motivated by the empirical evidence in Table 6 in the Online Appendix, we set  $n = 5$  and interpret agents as entering the economy at age 25.<sup>11</sup> Regarding time preferences, we assume that half of the agents in each cohort have a low discount rate  $\rho_a = 0.1\%$  and the other half have a higher discount rate  $\rho_b = 0.5\%$ . Together with the consumption tax  $\tau = 0.35$ , this specification implies that newly born type-*a* and type-*b* agents consume 27.2% and 32.4% of aggregate per-capita consumption, respectively.<sup>12</sup>

<sup>11</sup>For Norway, we determine  $n = 8$  in the numerical exercise below.

<sup>12</sup>The consumption share of a newborn agent of type  $i$  is given by  $\frac{c_{i,t,t}}{C_t} = \frac{\tau}{\nu} \beta_i = \frac{\tau}{\nu} \frac{\nu + \rho_i}{1 + \tau} = \frac{\tau}{1 + \tau} (1 + \frac{\rho_i}{\nu})$ .

On average, therefore, a newborn agent consumes 29.8% of average per-capita consumption in the economy. For the relative attention of nonparticipants we set  $\varphi = 0.5$ , consistent with the magnitude of relative updating sensitivity documented in the Michigan survey (see Table 2). Lastly, we set the lower participation threshold,  $\vartheta^l$ , at 0.01 and determine the upper threshold  $\vartheta^h$  in the numerical exercises below.

To capture persistent heterogeneity in participation observed in the data, we additionally assume that 25% of agents know the true parameter and therefore always participate in the stock market (designated participants), while 50% are designated nonparticipants who never participate. The remaining 25% are of the reentry type described in Section 3. Importantly, this assumption does not materially affect the participation dynamics that are the primary focus of the paper.

## 4.2 Average Participation, Entry and Exit

Our focus is on stock market participation, entry, and exit. More standard asset pricing moments are delegated to Table 11 in the Online Appendix.

Table 3 reports standard statistics for participation, entry, and exit rates in the model and the data, together with two model-implied correlations. Importantly, the observable participation rate is positively correlated with the endogenous state variables  $\bar{\Phi}$  and  $\tilde{\Phi}$ , the aggregate consumption and wealth shares of participants. This is relevant because, in the empirical analysis below, we use the participation rate as a proxy for the mechanism underlying the model.

Participation rates vary substantially across countries and even across datasets within a country. Although we do not directly target participation levels, the model broadly spans the range observed in the data across parameterizations. Entry and exit rates are also quantitatively meaningful, indicating ongoing turnover in stock market participation despite substantial persistence in participation status. Since participation evolves through entry and exit, the similar magnitude of the two flows implies a stationary participation rate in the

model.

	Mean	Std dev	10 <sup>th</sup>	50 <sup>th</sup>	90 <sup>th</sup>		Mean
<b>Participation rate</b>	0.3606	0.0537	0.2934	0.3543	0.4387	<b>Corr(<math>\bar{\Phi}</math>, Participation)</b>	0.8548
<b>Entry rate</b>	0.0198	0.0145	0.0056	0.0154	0.0380	<b>Corr(<math>\tilde{\Phi}</math>, Participation)</b>	0.8507
<b>Exit rate</b>	0.0204	0.0132	0.0072	0.0178	0.0361		

Table 3: **Summary Statistics of Participation, Entry, and Exit.** The table reports average participation, entry, and exit rates, together with their standard deviations and 10th, 50th, and 90th percentiles, as well as average correlations between participation and  $\bar{\Phi}$  and  $\tilde{\Phi}$ . Model averages are computed from a forward simulation initialized at the final state of a burn-in simulation. Time is monthly, and one cohort is born each period. After 6,000 burn-in periods, the economy contains 6,000 cohorts, after which the number of cohorts is held constant. For computational convenience, during the first 240 burn-in periods we set  $\hat{\mu}_{s,s} = \mu_Y$  and  $\hat{V} = \frac{\sigma_Y^2}{n}$ . The forward simulation consists of 10,000 paths, each 6,000 periods (500 years) long. Parameter values are reported in Subsection 4.1; data sources are described in Section F of the Online Appendix. Here, we set  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ .

Because the model exhibits substantial path dependence —stemming from experience-based learning and reduced attention— the analysis focuses primarily on time-series dynamics of participation, entry, and exit. We generate these dynamics by feeding the model shocks extracted from stock market returns, to which we now turn.

### 4.3 Shocks to the Stock Market

For Finland, Germany, and Norway, we use monthly international country portfolio returns from Kenneth French’s website, starting in 1975. We focus on value-weighted total returns in local currency. For Finland prior to 1975, we rely on the market returns constructed by Nyberg and Vaihekoski (2014), which are available from 1912 onward. For the United States, we use CRSP value-weighted total returns from 1926 onward and index returns from 1871 to 1926 obtained from Amit Goyal’s data library.

Using these historical stock returns, we construct the process  $dz_t$ . Specifically, we standardize monthly stock returns (to mean zero and standard deviation  $\sqrt{dt}$ ) to obtain the shocks.<sup>13</sup>

<sup>13</sup>See Figure 11 in the Online Appendix for the time-series of implied shocks.

## 4.4 Cohort Estimation Error

We begin by examining how different cohorts update their beliefs in response to stock-market shocks. The top panel of Figure 4 shows the standardized estimation error  $\Delta_{s,t}$  for three representative cohorts entering the economy in 1950, 1970, and 1990. Solid segments of the lines indicate periods of stock-market participation, while dotted segments indicate nonparticipation. Red markers denote transitions from nonparticipation to participation, and orange markers denote exits. These paths are generated using the implied U.S. shocks.

Two key patterns stand out. First, agents update most aggressively when inexperienced: early-life shocks generate large swings in  $\Delta_{s,t}$ . As cohorts accumulate experience, the precision of their beliefs increases and belief revisions become progressively smaller. Second, substantial differences in estimation errors persist across cohorts even after long histories of observed data. These persistent differences in beliefs translate into heterogeneous participation behavior. Some cohorts switch repeatedly between participation and nonparticipation, some remain predominantly in the market, and others predominantly out of the market, while still others —such as the cohort born in 1980 (not shown)— remain invested throughout.

## 4.5 Endogenous Learning

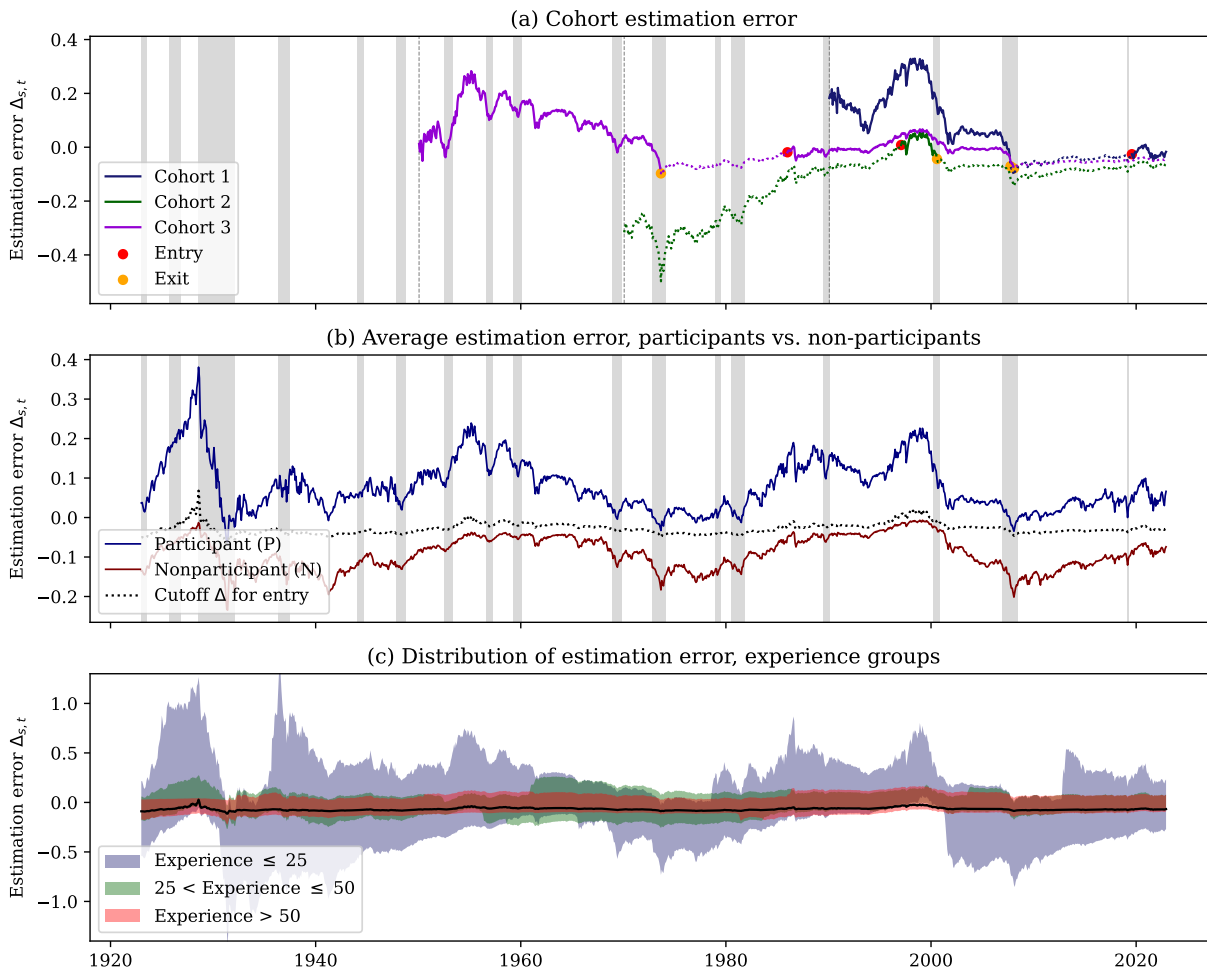
We now turn to the interaction between beliefs and equilibrium. The middle panel of Figure 4 displays the endogenous mean estimation errors of participants and nonparticipants over time, based on the implied U.S. shocks. The blue solid line corresponds to participants and the maroon line to nonparticipants. Overall, the belief wedge between participants and nonparticipants varies substantially over time. Due to reduced attention, this wedge narrows following periods of low returns and widens following periods of high returns,<sup>14</sup> implying greater variance and less precise beliefs among agents who subsequently reenter the market.

The bottom panel of Figure 4 shows that this dispersion is driven primarily by in experi-

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<sup>14</sup>This is consistent with Column (2) of Table 1.

Figure 4: **Estimation Errors.** The top panel displays the standardized estimation error,  $\Delta_{s,t}$ , for cohorts entering the economy in 1950, 1970, and 1990, indicated by the dotted vertical lines. Solid segments denote periods of stock market participation, while dotted segments denote nonparticipation. Red markers indicate transitions from nonparticipation to participation, and orange markers indicate exits from the stock market. The middle panel plots the average estimation error over time for participants (blue solid line) and nonparticipants (maroon solid line). The black dotted line denotes the cutoff estimation error for entry,  $\vartheta^h - \theta_t$ . The bottom panel shows the distribution of estimation errors across groups with different levels of experience. Gray bars indicate NBER recession periods. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3.



enced agents. Their beliefs react strongly to shocks, whereas the beliefs of more experienced agents are more stable and remain closer to the true mean growth rate. Following sequences of positive (negative) shocks, the most recent cohorts become the most optimistic (pessimistic) agents in the economy. Nevertheless, experienced investors typically remain in the market even when relatively pessimistic. The reason is that the endogenous market-clearing cutoff depends not only on the distribution of beliefs but also on the distribution of wealth, which is concentrated among experienced cohorts. Wealthy, sophisticated, and experienced investors therefore pull the cutoff toward their own beliefs.

Together, these two panels illustrate the central mechanism of the model: participation depends on the joint distribution of wealth and beliefs, learning differs across participants and nonparticipants, and asset prices are determined by participants. Moreover, because only participants update optimally, nonparticipation slows down aggregate learning and amplifies belief heterogeneity in the economy.<sup>15</sup>

## 5 Stylized Patterns

To provide evidence for the proposed mechanism, we document two stylized facts about stock market participation that are consistent with a learning-from-experience framework.

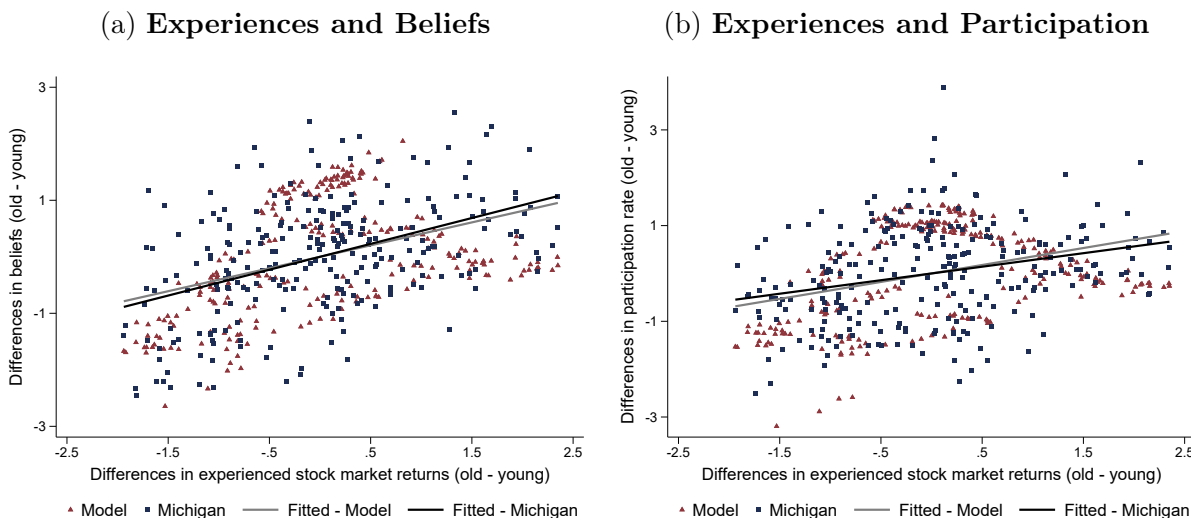
### 5.1 Lifetime Experience and Participation

Motivated by evidence in Malmendier and Nagel (2011) and Knüpfer, Rantapuska, and Sarvimäki (2017), we examine differences in participation rates through the lens of lifetime experiences. Unlike existing experience-based learning models, where agents always participate in the stock market, our framework allows experiences to affect endogenous participation

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<sup>15</sup>As noted above, reentering nonparticipants have beliefs with a higher posterior variance ( $\widehat{V}$ ) than participants from nearby cohorts, which increases the weight placed on new information. Overall, with relative attention of nonparticipants  $\varphi = 0.5$ , the unconditional sensitivity of nonparticipants' beliefs is about 70% of that of participants. The smaller average belief revisions are consistent with the evidence in column (2) of Table 2.

Figure 5: **Experiences, Beliefs, and Participation: Data versus Model.** Panel (a) shows differences in beliefs between old and young agents implied by the model (red) and measured in the Michigan Survey of Consumers (blue), based on differences in experienced returns. Panel (b) shows the corresponding differences in stock market participation rates. We proxy for differences in experienced stock market returns by subtracting the average stock market return over the previous 20 years from the average return over the previous 50 years. In the Michigan survey, old refers to households older than 60 and young to households younger than 40. In the simulation, we consider agents with under 25 years of experience as young, and with over 50 years of experience as old. All differences are standardized. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The model simulations use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ .



decisions. This distinction is important because, without endogenous participation, differences in participation are difficult to attribute directly to beliefs since experiences may also affect preferences.

To address this issue, we compute both model-implied and empirical differences in beliefs based on differences in experienced U.S. stock market returns. Specifically, we compare agents aged 40 or younger (agents in the model begin trading at age 20) with agents older than 60. Figure 5a plots the resulting differences in beliefs using data from the Michigan Survey of Consumers.<sup>16</sup> The figure shows that larger differences in experienced returns between old and young agents are associated with larger differences in beliefs.

<sup>16</sup>See also Figure 16, which uses data from the SCF (Survey of Consumer Finances).

We next compute model-implied differences in participation rates between old and young agents (red arrows) and compare them with the corresponding differences measured in the Michigan survey (blue squares). Therefore, the results suggest that differences in experienced returns are positively related to differences in stock market participation both in the model and in the data.

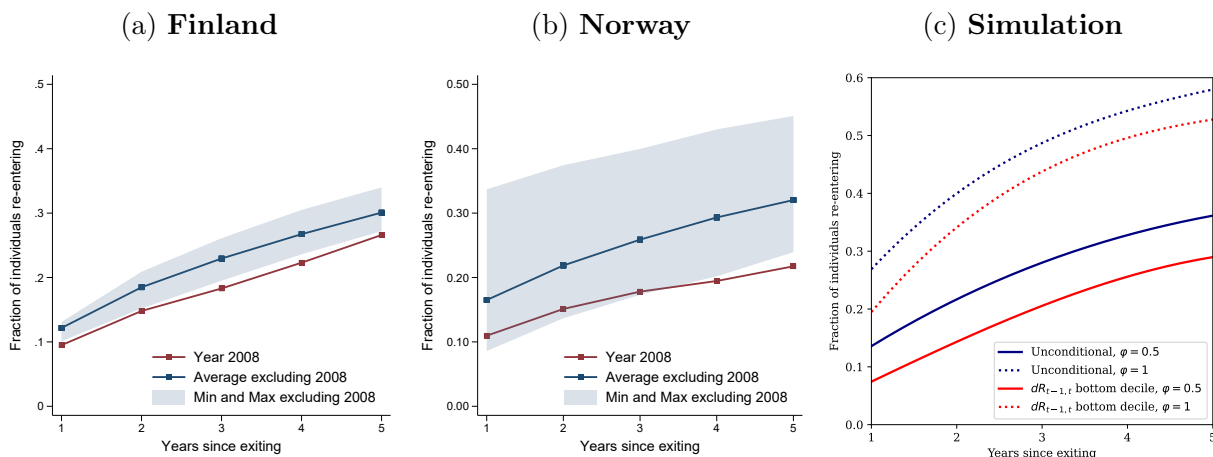
Each plot additionally reports fitted relations (dashed lines), which suggest that the beliefs-driven model with constrained experience-based learning reproduces the differences in beliefs and participation rates observed in the survey data reasonably well. In particular, the correlation between the belief gap in the model and in the Michigan data is 0.2541 (t-statistic = 2.78, using Newey-West standard errors with 12 lags), while the corresponding correlation for the participation gap is 0.2601 (t-statistic = 2.51).

## 5.2 Reentry frequencies

Next, we study reentry frequencies conditional on experienced returns. Figure 6a plots the fraction of investors in Finland who subsequently reenter the stock market after exiting between 2005 and 2011. According to the data, roughly 30% of investors who exit the stock market reenter within five years. Strikingly, the fraction of reentering investors among those who exited in 2008 —when the total stock return in Finland was -51%— is the lowest in the sample. This pattern is consistent with the mechanism of experience-based learning: investors who exit following large negative return realizations become persistently pessimistic and are therefore less likely to reenter the market. A similar pattern emerges for Norway, as shown in Figure 6b.

Our model replicates this pattern. In the simulation, we track exiting cohorts over a ten-year horizon and compute the fraction of agents who reenter the stock market for the first time after a given number of years. Figure 6c compares these model-implied reentry frequencies with the data. The blue solid lines show the unconditional average reentry rate by years since exit, while the red solid lines show the corresponding reentry rate conditional

Figure 6: **Fraction of Investors Re-entering the Stock Market within  $n$  Years After Exit: Data versus Model.** The left and middle panels show the fraction of investors reentering the stock market within a given number of years after exit using data from Finland and Norway, respectively. The red line denotes the fraction of reentering investors among those who exited in 2008, at the height of the global financial crisis, while the blue line denotes the average fraction among investors who exited between 2005 and 2011 for Finland (2003 and 2011 for Norway), excluding 2008. The right panel shows the fraction of investors returning to the stock market after exit, for the economy with reduced attention ( $\varphi = 0.5$ , solid lines), and a benchmark economy with full attention ( $\varphi = 1.0$ , dotted lines). The blue lines denote unconditional averages, while the red lines denote averages conditional on one-year stock returns being in the bottom decile at the time of exit. We use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$  in simulation. Other parameter values are reported in Subsection 4.1. Details of the forward simulation are provided in the caption of Table 3.



on the one-year stock return at the time of exit falling below the 10th percentile of the time series. Consistent with the data, investors who exit following particularly negative return realizations are substantially less likely to reenter the stock market.

Reduced attention among nonparticipants is important for matching the magnitude and persistence of this effect. When agents stop participating, they pay less attention to stock market outcomes and therefore update their beliefs more slowly. As a result, pessimistic beliefs formed after large negative return realizations persist for longer, delaying reentry into the market. Compared to an economy with full attention ( $\varphi = 1$ ), this mechanism generates substantially lower reentry frequencies and brings the model much closer to the patterns observed in the Finnish and Norwegian data.

## 6 Stock Market Participation, Entry and Exit Dynamics

We now confront the model with realized historical shocks to study fluctuations in participation, entry, and exit rates.

### 6.1 Dynamics

#### 6.1.1 Stock Market Participation

Figure 7 compares changes in stock market participation rates in Finland, Germany, Norway, and the United States with the corresponding dynamics implied by the model.<sup>17</sup> Overall, the model-generated dynamics closely resemble those observed in the data, and all four correlations are statistically significant.

Importantly, the model captures several major turning points associated with large market fluctuations. In particular, the model reproduces the broad increase in participation during the late 1990s and the subsequent decline following the collapse of the dot-com boom around 2001. A similar pattern emerges around the global financial crisis. Across countries, the model generates pronounced declines in participation following the large negative return realizations of 2008, together with the gradual recovery in participation during the subsequent stock market rebound.

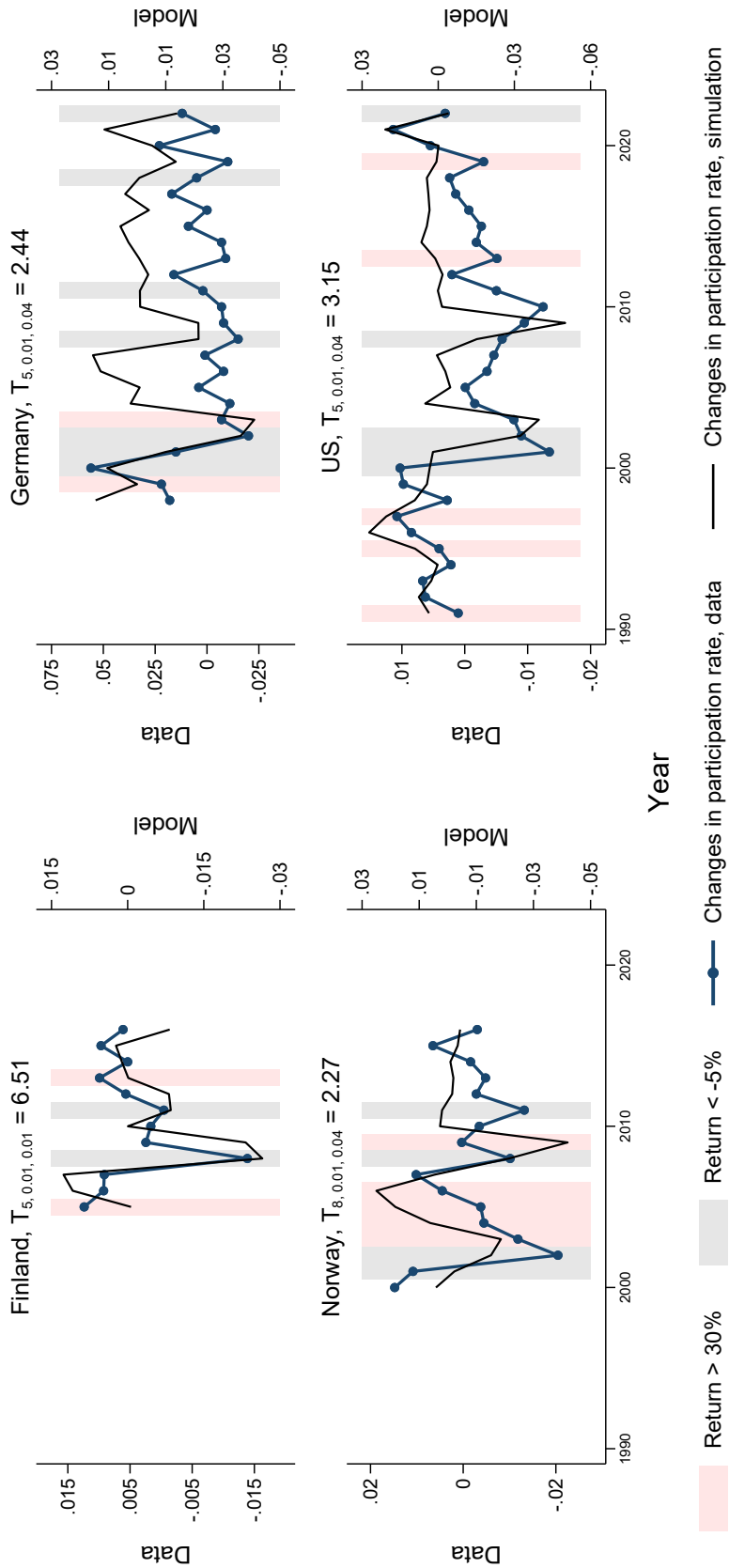
The model also captures cross-country heterogeneity in participation dynamics. This reflects the fact that the realized sequence of stock-market shocks differs across countries, implying different belief dynamics and therefore different participation cycles. Despite its parsimonious structure, the model is able to account for a sizable fraction of these fluctuations.<sup>18</sup>

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<sup>17</sup>For the United States, we focus on IRS data because they provide the most comprehensive measure of participation. The Online Appendix additionally reports the time-series dynamics of participation in the Michigan, RAND, and SCF surveys alongside the model-implied series.

<sup>18</sup>We view the correlation between the data and the model counterpart as a relevant measure of fit because the literature has proposed other important explanations for nonparticipation, entry, and exit, including participation costs (see Gomes and Michaelides (2008)) and labor income uncertainty (Bonaparte, Korniotis, Kumar, Michaelides, and Zhang (2025)). Since the model is designed to isolate the *beliefs-driven participation effect*, it is not intended to account for all other contributing factors. Accordingly, we do not test the

Figure 7: **Participation Rate Dynamics: Data versus Model.** The figure plots changes in participation rates in Finland, Germany, Norway, and the United States (blue solid lines with dots) together with the corresponding simulated changes in participation rates implied by the model (solid lines).  $T_{n,\phi^t,\phi^h}$  denotes the t-statistic on the coefficient obtained from regressing changes in actual participation rates on a constant and changes in model-implied participation rates. Model-implied participation rates are annual averages to match the data frequency. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively.



The results are conservative and robust along several dimensions. First, parameters are pre-specified, and the numerical exercises determine only the upper participation threshold,  $\vartheta^h$ . Second, alternative measures of participation strengthen the model’s performance. Using participation rates from the triennial Survey of Consumer Finances yields a  $t$ -statistic of 6.23 (Figure 13 in the Online Appendix), compared with 3.15 in Figure 7. Likewise, defining annual participation as the fraction of agents who participate at any point during the previous 12 months —rather than using annual averages— raises the corresponding  $t$ -statistic to 6.25 (Figure 14 in the Online Appendix). This latter definition is closely aligned with the IRS-based participation measure used for the United States.

### 6.1.2 Entry and Exit

We now compare the time-series dynamics of entry and exit in the data with those implied by the model using registry data from Finland and Norway. The top panels of Figure 8a display entry rates for Finland (left) and Norway (right). Overall, the model tracks both the timing and magnitude of entry observed in the data. In particular, the model reproduces the pronounced slowdown in entry following major stock market downturns, for instance around the collapse of the technology bubble in the early 2000s and during the global financial crisis of 2008–2009. Conversely, sustained increases in stock prices are followed by strong recoveries in entry rates both in the data and in the model, consistent with optimistic belief revisions among nonparticipants.

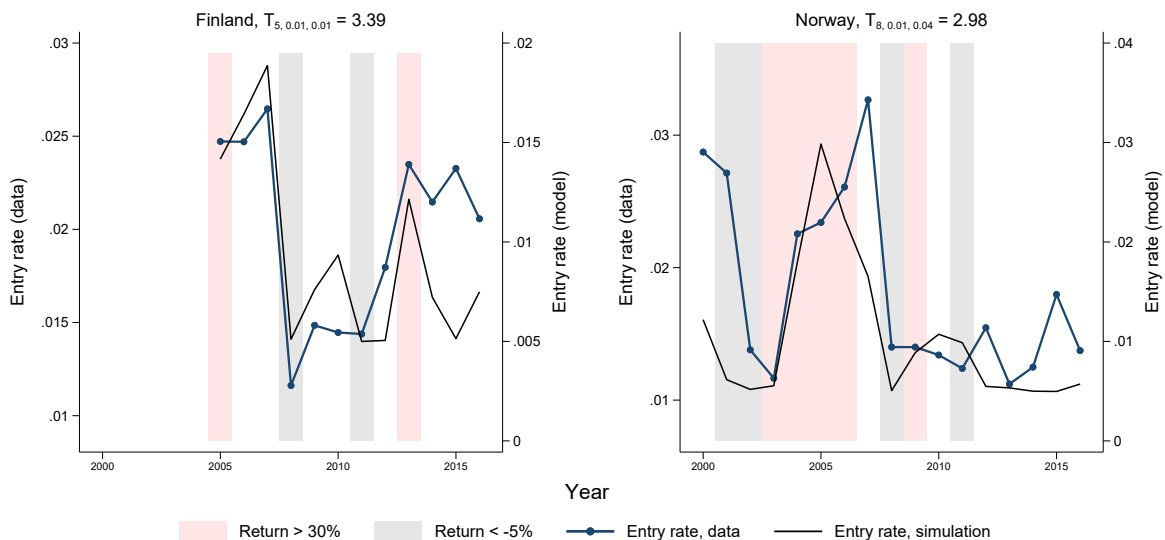
A similar pattern emerges for exit rates, shown in the bottom panels of Figure 8b. Exit rates rise sharply following large negative return realizations and subsequently decline during periods of market recovery. Again the model captures these dynamics particularly well during the financial crisis, when pessimistic belief revisions generate a substantial increase in stock market exits. The mechanism is especially visible in Finland, where the collapse in stock prices during 2008 coincides with a pronounced spike in exits both in the data and in the

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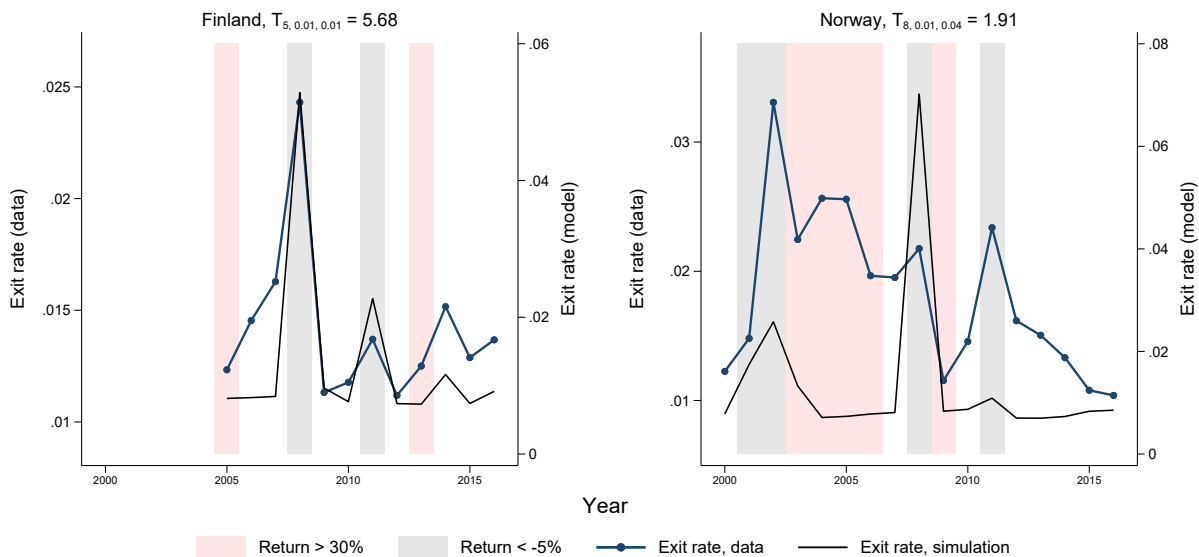
hypothesis of a perfect fit.

Figure 8: **Entry and Exit: Data versus Model.** The figure plots time-series of entry into and exit from the stock market in Finland and Norway (blue lines with dots), together with the corresponding simulated entry and exit rates implied by the model.  $T_{n,\vartheta^l,\vartheta^h}$  denotes the t-statistic on the coefficient obtained from regressing actual entry (exit) rates on a constant and model-implied entry (exit) rates. The number of individuals entering and exiting the stock market in Finland is obtained from Breitung, Knüpfer, and Rantapuska (2021), while population data are from Statistics Finland. Data on the percentage of individuals entering and exiting the stock market in Norway are from Statistics Norway. Model-implied entry and exit rates are measured at one-year horizon (December to December). Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively.

(a) **Entry into the Stock Market – Finland and Norway**



(b) **Exit from the Stock Market – Finland and Norway**



simulated series. More broadly, the model reproduces the cyclical nature of exit behavior: households are more likely to leave the stock market after periods of poor realized returns and less likely to exit following extended market recoveries.

Taken together, these results suggest that the model captures not only average participation dynamics, but also the underlying turnover in stock market participation. Entry and exit are not random fluctuations; rather, they respond systematically to realized returns through their effects on household beliefs. As with changes in participation rates, the correlations between the model and the data are statistically significant.

## 6.2 Predictability

In the model, the participation rate negatively predicts future stock market returns because it is positively correlated with the consumption and wealth shares of participants, which are state variables for the real short rate and the market price of risk. Intuitively, elevated participation rates correspond to periods of heightened optimism, particularly among inexperienced investors. As beliefs subsequently revert following more typical return realizations, future realized stock market returns tend to be lower. Panel A of Table 4 confirms this intuition for both total and excess model-implied returns at 12-, 24-, and 36-month horizons.

Panel B provides empirical support for the predictive content of the participation rate and constitutes another footprint of the mechanism emphasized in this paper. Using detrended participation rates from Finland, Germany, Norway, and the United States, we estimate predictive panel regressions for future stock market returns. Consistent with the model, all coefficients on the participation rate are negative. Moreover, the coefficients are statistically significant at the 1% level for both total and excess returns at the 12-, 24-, and 36-month horizons. Further, the regressions include country fixed effects and Driscoll-Kraay corrected standard errors to account for cross-sectional and serial correlation. In addition, controlling for the price-dividend ratio leaves the predictive content of participation qualitatively intact; see Table 13 in the Online Appendix.

<b>Panel A: Simulation results</b>						
	<b>Total returns</b>			<b>Excess returns</b>		
	(1) 12m	(2) 24m	(3) 36m	(4) 12m	(5) 24m	(6) 36m
<b>Participation rate</b>	-0.0408	-0.0583	-0.0717	-0.0664	-0.0943	-0.1155
<b>Panel B: International evidence</b>						
	<b>Total returns</b>			<b>Excess returns</b>		
	(1) 12m	(2) 24m	(3) 36m	(4) 12m	(5) 24m	(6) 36m
<b>Participation rate</b>	-0.327*** (0.110)	-0.319*** (0.074)	-0.219*** (0.052)	-0.380*** (0.132)	-0.361*** (0.082)	-0.250*** (0.071)
N	89	89	89	89	89	89

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 4: **Participation Rate and Future Returns: Data versus Model.** Panel A reports predictive regressions at 12-, 24-, and 36-month horizons using the model-implied participation rate as the explanatory variable. Columns (1)-(3) use total returns as the dependent variable, while columns (4)-(6) use excess returns. All variables are standardized. Coefficient estimates are averaged across regressions estimated from 10,000 simulated paths with non-overlapping annual observations, where each path contains 200 data points. Parameter values are reported in Subsection 4.1. Further details of the forward simulation are provided in the caption of Table 3. Panel B reports predictive panel regressions at 12-, 24-, and 36-month horizons using detrended participation rates from Finland, Germany, Norway, and the United States as explanatory variables. Columns (1)-(3) use total returns, while columns (4)-(6) use excess returns. Participation rates are measured at annual frequency. Interest rates are given by 12-month Treasury bill rates from Bloomberg (Finland), the Bundesbank (Germany), Statistics Norway (Norway), and Amit Goyal’s website (United States). All variables are standardized. The panel regressions include country fixed effects and use Driscoll-Kraay standard errors with 2, 4, and 6 lags, respectively.

These estimates should be interpreted with some caution. The international panel is short, and predictive regressions of this kind raise two well-known concerns. First, the overlapping return horizons induce serial correlation in the residuals, and developed-market returns are correlated across countries; we address both by using Driscoll-Kraay standard errors, which are robust to serial and cross-sectional dependence. Second, the detrended participation rate is persistent, so the regressions are subject to the small-sample bias that affects predictive regressions with persistent regressors. We do not include time fixed effects,

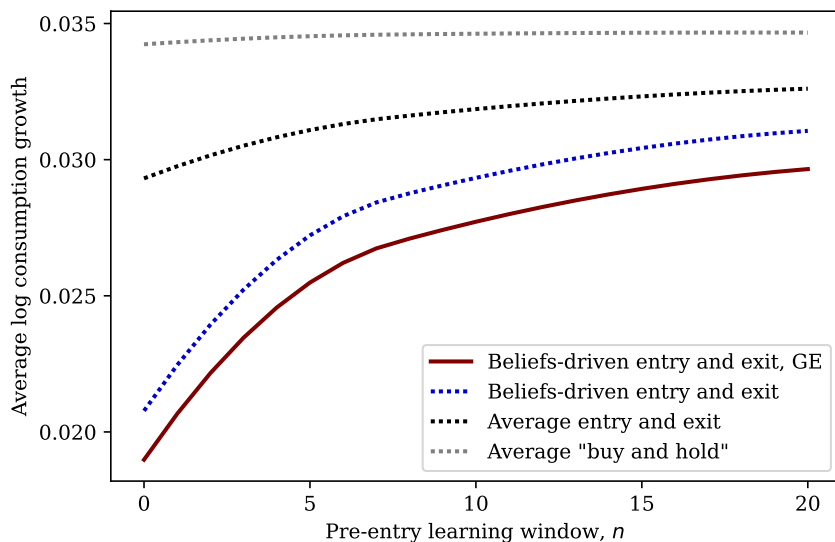
since with only four countries they would absorb the common global component of returns and identify the coefficient purely from cross-country differences in the timing of participation, discarding precisely the comovement that the mechanism predicts. For these reasons, we view Panel B not as a standalone predictability result but as corroborating evidence, consistent with the model's implication that elevated participation precedes lower returns.

### 6.3 The Cost of Beliefs-Driven Entry and Exit

The preceding analysis suggests that beliefs-driven entry and exit can be costly because agents tend to enter the stock market when expected returns are low and exit when expected returns are high.

To quantify the welfare cost of beliefs-driven entry and exit, we compute the average log consumption growth of the agent in our economy conditional on the pre-entry learning window and compare it to the log consumption growth of three marginal benchmark investors with identical pre-entry learning. These average log consumption growth rates are shown in Figure 9. We see that the log consumption growth (solid maroon line) in our economy ranges from slightly below 2 percent without pre-entry learning to slightly below 3 percent with 20 years pre-entry learning. Essentially, the average log consumption growth of the marginal agents captures the costs coming from returns due to market timing, from entry and exit due to market timing, and both. Specifically, the dotted blue line shows the average log consumption growth of a hypothetical marginal agent entering and exiting at the same time as our agents earning the average return in the model, which because of independence is simply the average return. The dotted black line instead shows the average log consumption growth with randomized entry and exit (reflecting the actual odds of entry and exit in the model) earning the actual return in the model. The gray dotted line corresponds to a marginal investor holding the average portfolio of participants (a strategy that buy and holds the average portfolio) earning the average return, which is almost free of a dependency on the pre-entry learning period.

Figure 9: **Pre-Entry Learning and the Average log consumption growth rate.** The figure shows the average log consumption growth rate conditional on the pre-entry learning window, for reentry agents with time preference  $\rho = 0.1\%$ . The solid maroon line denotes our economy with beliefs-driven entry and exit and endogenous asset prices. The three dotted lines denote the average log consumption growth rate for three benchmark marginal investors. The blue line represents the log consumption growth with actual beliefs-driven entry and exit using average returns (instead of market timing driven realized returns) given the pre-entry learning window. The black line corresponds to the log consumption growth using average probability of participating (free of market timing driven participation choice), assuming that a marginal participant holds the average portfolio of actual model participants. The gray line corresponds to a marginal investor holding the unconditional average portfolio. Equilibrium parameter values are reported in Subsection 4.1. Further details of the forward simulation are provided in the caption of Table 3.



Overall, the welfare costs of beliefs-driven participation dynamics are economically large. For pre-entry learning horizons ranging from 0 to 20 years, poorly timed stock market exposure reduces average log consumption growth by approximately 0.1 to 0.2 percentage points (dotted blue line versus solid maroon line). The welfare costs associated with entry, exit, and reentry are even larger, ranging from roughly 0.2 to nearly 1 percentage point (dotted black line versus dotted blue line). Because participation negatively predicts subsequent returns, eliminating both sources of inefficiency raises average log consumption growth by between 0.2 and 0.5 percentage points.

Nevertheless, log consumption growth based on the average portfolio of participants

earning the average return remains below that in an idealized economy with universal stock market participation. In such an economy, the average investor always holds the market portfolio and earns the market return.

## 6.4 Discussion

The account of participation dynamics offered by our model is robust along several dimensions. The clearest summary is Table 12, which reports the fit of the model—the  $t$ -statistic from regressing actual on model-implied participation, entry, and exit rates—as we perturb each parameter in turn. The result is uniform: across the four countries and all three flows, every specification remains statistically significant, and the large majority remain significant at the one percent level. The fit does not hinge on any single parameter choice.

This holds, first, for the length of the pre-entry learning window  $n$  (Panel A): the  $t$ -statistics are essentially unchanged as we shorten and lengthen the window, and in several cases the fit even improves. The same stability appears in Table 6 of the Online Appendix, where the positive relation between experienced returns, beliefs, and participation holds across the full range of starting ages. The mechanism does not rely on a finely tuned learning horizon.

It holds, second, for the participation thresholds  $\vartheta^l$  and  $\vartheta^h$ . A single lower threshold, together with a common upper threshold for Germany, Norway, and the United States, reproduces the participation cycles in these economies, and the fit remains significant as the thresholds are perturbed (Panels C and D). This is notable because the four series differ substantially in coverage, frequency, and quality—tax-registry data for Finland and Norway, survey aggregates for Germany, and dividend-based records for the United States. That essentially the same behavioral thresholds organize participation dynamics across such heterogeneous data supports the view that we are capturing a common, beliefs-driven mechanism rather than features specific to any one dataset. The fit is likewise insensitive to the composition of agent types (Panel B) and to the attention parameter  $\varphi$  (Panel E).

The empirical findings themselves reproduce across surveys. Our motivating evidence is drawn primarily from the Michigan survey, but the RAND American Life Panel—a longer panel with a different design and sampling frame—independently confirms all three patterns (Section D). The RAND survey also contains a direct measure of attention to the stock market, and respondents who follow the market more closely update their beliefs more aggressively, consistent with the heterogeneous-attention channel at the heart of the model.

As pointed out above, our conclusions are not sensitive to the precise definition of participation or to the fiscal structure of the model. The results hold when participation is measured as an annual average or based on dividends, and speak to untargeted results obtained with the survey-based U.S. measure from the Survey of Consumer Finances (Figures 13–15). Most of the predictive content of participation survives controlling for the price-dividend ratio (Table 13), and financing newborn cohorts through a wealth tax rather than a consumption tax leaves the core implications of the model unchanged (Section E).

Overall, these patterns indicate that the model’s account of participation dynamics reflects a common learning-from-experience mechanism rather than an artifact of a particular dataset, parameterization, or modeling choice.

## 7 Conclusion

Using survey data, we document systematic links between beliefs and stock market participation. Participants are substantially more optimistic than nonparticipants, while entry into and exit from the stock market coincide with large revisions in beliefs. Moreover, beliefs respond strongly to lifetime experiences, and differences in experienced returns help explain variation in participation decisions across households and over time.

Motivated by these findings, we develop a dynamic equilibrium model with overlapping generations, experience-based learning, and endogenous stock market participation. In the model, agents learn from realized outcomes, but participation itself shapes the learning

process because participants pay closer attention to financial markets than nonparticipants. Participation, beliefs, and asset prices therefore interact dynamically in equilibrium.

The central implication is that inexperienced agents become optimistic following periods of strong market performance and enter during episodes of elevated valuations and low expected returns. After adverse return realizations, many revise their beliefs downward and exit, whereas experienced and wealthier cohorts typically remain invested. Because equilibrium prices are shaped disproportionately by experienced participants, the model generates endogenous cycles in participation, entry, exit, and reentry. When disciplined by realized shocks, it reproduces these dynamics across Finland, Germany, Norway, and the United States, matches observed reentry patterns following large negative returns, and implies that elevated participation predicts lower subsequent stock market returns.

The model further implies substantial welfare costs. Investors tend to enter during periods of exuberance, when expected returns are low, and exit following poor realized returns, when expected returns are high. Relative to a complete-information benchmark economy with continuous participation, these participation cycles generate sizable welfare losses.

Overall, our findings suggest that stock market participation is not merely a passive outcome of household characteristics or participation costs, but an endogenous equilibrium outcome shaped by belief dynamics, learning, and lifetime experiences.

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## A Equilibrium Consumption Dynamics

In equilibrium, the (log) consumption dynamics of participants and nonparticipants differ:

**Proposition 6.** *The log consumption at time  $t$  for an agent of type  $i$  born at time  $s$  has the dynamics*

$$d\log(c_{i,s,t}) = \begin{cases} (-\rho_i + r_t) dt, & \text{if } N, \text{ or} \\ (-\rho_i + r_t + \frac{1}{2}\theta_t^2 - \frac{1}{2}\Delta_{s,t}^2) dt + (\theta_t + \Delta_{s,t}) dz_t, & \text{if } P. \end{cases} \quad (22)$$

Proposition 6 characterizes the determinants of expected log consumption growth. Non-participants forgo the equity risk premium altogether, while participants incur welfare losses whenever the expected squared estimation error exceeds the squared market price of risk.

The next proposition characterizes the dynamics of cohort consumption and wealth shares:

**Proposition 7.** *The consumption share at time  $t$  of type  $i$  agents born at  $s$  follows the process*

$$\begin{aligned} df_{i,s,t}^c / f_{i,s,t}^c &= (-\tau\beta + \bar{\rho}_t - \rho_i) dt + (\theta_t - \sigma_Y) (\theta_{s,t} - \sigma_Y) dt + (\theta_{s,t} - \sigma_Y) dz_t \\ &= \begin{cases} [-\tau\beta + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y)] dt - \sigma_Y dz_t, & \text{if } N, \text{ or} \\ [-\tau\beta + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_Y)] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_Y) dz_t, & \text{if } P, \end{cases} \end{aligned} \quad (23)$$

and the wealth share at time  $t$  of type  $i$  agents born at  $s$  follows the process

$$df_{i,s,t}^W / f_{i,s,t}^W = \begin{cases} [-\nu + \tilde{\beta}_t - \rho_i - \sigma_t^S (\theta_t - \sigma_t^S)] dt - \sigma_t^S dz_t, & \text{if } N, \text{ or} \\ [-\nu + \tilde{\beta}_t - \rho_i - \sigma_t^S (\theta_t - \sigma_t^S) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_t^S)] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_t^S) dz_t, & \text{if } P. \end{cases}, \quad (24)$$

where  $\tilde{\beta}_t \equiv \frac{C_t}{W_t}$  is the aggregate consumption-to-wealth ratio.

Proposition 7 highlights that, despite the presence of a single Brownian shock and closed-form solution throughout, simulating the equilibrium still requires tracking the entire cross-sectional distribution of consumption and wealth shares.

## B Proofs of Propositions

### B.1 Proof of Proposition 1

Following standard filtering theory in Liptser and Shirayayev (2013), we have that the dynamics of the expected output growth rate and the posterior variance of the estimates perceived by an agent born at  $s$  being a participant ( $P$ ) are given by Equation (3), which is consistent with Bayesian updating. For a nonparticipant ( $N$ ) with reduced attention, a lower weight is attached to the perceived innovations relative to Bayesian updating, and the posterior variance decays slower.

Using the definition of  $\Delta_{s,t}$  together with Ito's lemma yields

$$d\Delta_{s,t} = \frac{d\hat{\mu}_{s,t}}{\sigma_Y} = \begin{cases} \frac{\varphi\hat{V}'_s}{\sigma_Y^2 + \varphi\hat{V}'_s(t-t'_s)} dz_{s,t}, & \text{if } N, \text{ or} \\ \frac{\hat{V}'_s}{\sigma_Y^2 + \hat{V}'_s(t-t'_s)} dz_{s,t}, & \text{if } P. \end{cases}$$

Solving these stochastic differential equations yields

$$\Delta_{s,t} = \begin{cases} \frac{\sigma_Y^2}{\sigma_Y^2 + \varphi\hat{V}'_s(t-t'_s)} \Delta_{s,t'_s} + \frac{\varphi\hat{V}'_s}{\sigma_Y^2 + \varphi\hat{V}'_s(t-t'_s)} (z_t - z_{t'_s}), & \text{if } N, \text{ or} \\ \frac{\sigma_Y^2}{\sigma_Y^2 + \hat{V}'_s(t-t'_s)} \Delta_{s,t'_s} + \frac{\hat{V}'_s}{\sigma_Y^2 + \hat{V}'_s(t-t'_s)} (z_t - z_{t'_s}), & \text{if } P, \end{cases}$$

### B.2 Proof of Proposition 2

The proof follows directly from Equation (15), when  $t = s$ , and  $c_{i,s,s} = \frac{1}{\kappa_{i,s}(1+\tau)\xi_{s,s}}$ . We next show from the initial budget constraint that  $\beta_i$  is constant over time.

$$\begin{aligned} W_{i,s,s} &= E_{s,s} \left[ \int_s^\infty e^{-\nu(t-s)} \frac{\xi_{s,t}}{\xi_{s,s}} (c_{i,s,t} + \tau c_{i,s,t}) dt \right] \\ &= (1 + \tau) E_{s,s} \left[ \int_s^\infty e^{-\nu(t-s)} \frac{\xi_{s,t}}{\xi_{s,s}} c_{i,s,s} e^{-\rho_i(t-s)} \frac{\xi_{s,s}}{\xi_{s,t}} dt \right] \\ &= (1 + \tau) \frac{1}{\rho_i + \nu} c_{i,s,s} \\ &= \frac{c_{i,s,s}}{\beta_i}. \end{aligned}$$

We thus have  $\beta_i = \frac{\rho_i + \nu}{1 + \tau}$ , which is a constant.

### B.3 Proof of Proposition 3

Using market clearing in the consumption goods market,

$$\begin{aligned}
Y_t &= \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} ds di, \quad \text{a.s., and therefore,} \\
dY_t &= \left( \int_i \alpha_i \nu c_{i,t,t} di - \nu C_t \right) dt + \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} [(-\rho_i + r_t + \underline{\theta}_{s,t} \theta_t) dt + \underline{\theta}_{s,t} dz_t] ds di \\
&= \left( \int_i \alpha_i \nu \beta_i W_{i,t,t} di - \nu C_t \right) dt + r_t C_t dt - \left( \int_i \alpha_i \rho_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} ds di \right) dt \\
&\quad + \theta_t \left[ \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} (\Delta_{s,t} + \theta_t) \mathbb{1}_{s,t} ds di \right] dt + \left[ \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} (\Delta_{s,t} + \theta_t) \mathbb{1}_{s,t} ds di \right] dz_t \\
&= C_t \left\{ (\tau \beta - \nu + r_t - \bar{\rho}_t + \theta_t^2 \bar{\Phi}_t + \theta_t \bar{\Phi}_t \bar{\Delta}_t) dt + \bar{\Phi}_t (\theta_t + \bar{\Delta}_t) \right\} \\
&= Y_t (\mu_Y dt + \sigma_Y dz_t),
\end{aligned}$$

using the definitions of  $\beta$ ,  $\bar{\Delta}_t$  and  $\bar{\Phi}_t$ . Matching drift and diffusion terms yields the expressions for the interest rate  $r_t$  and the market price of risk  $\theta_t$ .

### B.4 Proof of Proposition 4

As the bond has zero net supply, we have,

$$S_t = W_t = \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} W_{i,s,t} ds di.$$

With log utility,  $\frac{dW_{i,s,t}}{W_{i,s,t}} = \frac{dc_{i,s,t}}{c_{i,s,t}}$  holds for each type  $i$ . Using Proposition 2 and  $\int_i \alpha_i \nu W_{i,t,t} di = \tau C_t$  from consumption tax, we have

$$\begin{aligned}
dW_t &= d \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} W_{i,s,t} ds di \\
&= \int_i \alpha_i \nu W_{i,t,t} di dt - \nu W_t dt + \int_i \alpha_i \int_{-\infty}^t \nu e^{-\nu(t-s)} W_{i,s,t} [(-\rho_i + r_t + \underline{\theta}_{s,t} \theta_t) dt + \underline{\theta}_{s,t} dz_t] ds di \\
&= W_t \left\{ \tau \tilde{\beta}_t - \nu - \tilde{\rho}_t + r_t + \theta_t \int_i \alpha_i \int_{-\infty}^t f_{i,s,t}^W (\Delta_{s,t} + \theta_t) \mathbb{1}_{s,t} ds di \right\} dt \\
&\quad + W_t \left\{ \int_i \alpha_i \int_{-\infty}^t f_{i,s,t}^W (\Delta_{s,t} + \theta_t) \mathbb{1}_{s,t} ds di \right\} dz_t \\
&= W_t \left\{ \tau \tilde{\beta}_t - \nu - \tilde{\rho}_t + r_t + \theta_t \tilde{\Phi}_t (\tilde{\Delta}_t + \theta_t) \right\} dt + W_t \tilde{\Phi}_t (\tilde{\Delta}_t + \theta_t) dz_t \\
&= dS_t = S_t (\mu_t^S dt + \sigma_t^S dz_t) - Y_t dt,
\end{aligned}$$

where  $\tilde{\rho}_t = \int_i \rho_i \int_{-\infty}^t f_{i,s,t}^W ds di$  is the wealth weighted average time preference, and  $\tilde{\beta}_t \equiv \frac{C_t}{W_t}$  is the aggregate consumption-to-wealth ratio:

$$\begin{aligned}\tilde{\beta}_t &= \frac{C_t}{W_t} = \frac{\int_i \int_{-\infty}^t \nu e^{-\nu(t-s)} c_{i,s,t} ds di}{W_t} = \int_i \int_{-\infty}^t \frac{c_{i,s,t}}{W_{i,s,t}} \frac{W_{i,s,t}}{W_t} ds di \\ &= \int_i \beta_i \int_{-\infty}^t f_{i,s,t}^W ds di = \int_i \frac{\rho_i + \nu}{1 + \tau} \int_{-\infty}^t f_{i,s,t}^W ds di \\ &= \frac{\tilde{\rho}_t + \nu}{1 + \tau}.\end{aligned}$$

Matching drift and diffusion terms yields the equilibrium stock return drift  $\mu_t^S$  and volatility  $\sigma_t^S$ . Therefore,

$$\begin{aligned}\mu_t^S - r_t &= \tau \tilde{\beta}_t - \nu - \tilde{\rho}_t + \theta_t \tilde{\Phi}_t \left( \tilde{\Delta}_t + \theta_t \right) + \frac{Y_t}{S_t} = \tau \tilde{\beta}_t - \nu - \tilde{\rho}_t + \theta_t \tilde{\Phi}_t \left( \tilde{\Delta}_t + \theta_t \right) + \tilde{\beta}_t \\ &= (\tau + 1) \tilde{\beta}_t - \nu - \tilde{\rho}_t + \theta_t \tilde{\Phi}_t \left( \tilde{\Delta}_t + \theta_t \right) = \theta_t \tilde{\Phi}_t \left( \tilde{\Delta}_t + \theta_t \right).\end{aligned}$$

## B.5 Proof of Proposition 5

The proof follows from the diffusion terms of the wealth process in Equation (13) together with the relation between wealth and consumption. Further, for participants, we have  $\underline{\theta}_{s,t} = \theta_t + \Delta_{s,t}$ , thus

$$\begin{aligned}W_{i,s,t} &= \frac{c_{i,s,t}}{\beta_i} = \frac{c_{i,s,t} e^{-\rho_i(t-s)}}{\beta_i} \frac{\eta_{i,s,t} \xi_s}{\eta_{i,s,t} \xi_t}, \\ \therefore dW_{i,s,t}/W_{i,s,t} &= \left[ -\rho_i + r_t + \theta_t^2 - (\underline{\theta}_{s,t} - \theta_t) \theta_t \right] dt + (\theta_t + \underline{\theta}_{s,t} - \theta_t) dz_t \\ &= \left( -\rho_i + r_t + \theta_t^2 - \Delta_{s,t} \theta_t \right) dt + (\theta_t + \Delta_{s,t}) dz_t,\end{aligned}$$

and thus,  $\pi_{i,s,t} = \frac{\Delta_{s,t} + \theta_t}{\sigma_t^S} W_{i,s,t}$  for stock market participants.

## B.6 Proof of Proposition 6

Applying Ito's lemma to the optimal consumption process in Proposition 2 yields

$$dc_{i,s,t}/c_{i,s,t} = (-\rho_i + r_t + \underline{\theta}_{s,t} \theta_t) dt + \underline{\theta}_{s,t} dz_t,$$

which implies that

$$\begin{aligned} d\log(c_{i,s,t}) &= \left( -\rho_i + r_t + \underline{\theta}_{s,t}\theta_t - \frac{1}{2}(\underline{\theta}_{s,t})^2 \right) dt + \underline{\theta}_{s,t}dz_t \\ &= \begin{cases} (-\rho_i + r_t)dt, & \text{if } N, \text{ or} \\ (-\rho_i + r_t + \frac{1}{2}\theta_t^2 - \frac{1}{2}\Delta_{s,t}^2)dt + (\theta_t + \Delta_{s,t})dz_t, & \text{if } P. \end{cases} \end{aligned}$$

## B.7 Proof of Proposition 7

From the definition of  $f_{i,s,t} = \frac{\alpha_i \nu e^{-\nu(t-s)} c_{i,s,t}}{C_t}$ , we have

$$\begin{aligned} df_{i,s,t}^c / f_{i,s,t}^c &= -\nu dt + \frac{dc_{i,s,t}}{c_{i,s,t}} - \frac{dC_t}{C_t} + \frac{dC_t^2}{C_t^2} - \frac{dc_{i,s,t}dC_t}{c_{i,s,t}C_t} \\ &= \left\{ -\nu - \rho_i + r_t + \underline{\theta}_{s,t}\theta_t - \mu_Y + \sigma_Y^2 - \underline{\theta}_{s,t}\sigma_Y \right\} dt + (\underline{\theta}_{s,t} - \sigma_Y) dz_t \\ &= -\tau\beta dt + (\theta_t - \sigma_Y)(\underline{\theta}_{s,t} - \sigma_Y)dt + (\underline{\theta}_{s,t} - \sigma_Y)dz_t. \end{aligned}$$

Since  $\underline{\theta}_{s,t} = 0$  for nonparticipants and  $\underline{\theta}_{s,t} = \theta_t + \Delta_{s,t}$  for participants, the consumption-share dynamics simplify to

$$\begin{aligned} df_{i,s,t}^c / f_{i,s,t}^c &= (-\tau\beta + \bar{\rho}_t - \rho_i) dt + (\theta_t - \sigma_Y) (\underline{\theta}_{s,t} - \sigma_Y) dt + (\underline{\theta}_{s,t} - \sigma_Y) dz_t \\ &= \begin{cases} [-\tau\beta + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y)] dt - \sigma_Y dz_t, & \text{if } N, \text{ or} \\ [-\tau\beta + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_Y)] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_Y) dz_t, & \text{if } P. \end{cases} \end{aligned}$$

Using the definition  $f_{i,s,t}^W = \frac{\alpha_i \nu e^{-\nu(t-s)} W_{i,s,t}}{W_t}$ , we finally have

$$\begin{aligned} df_{i,s,t}^W / f_{i,s,t}^W &= -\nu dt + \frac{dW_{i,s,t}}{W_{i,s,t}} - \frac{dW_t}{W_t} + \frac{dW_t^2}{W_t^2} - \frac{dW_{i,s,t}dW_t}{W_{i,s,t}W_t} = -\nu dt + \frac{dc_{i,s,t}}{c_{i,s,t}} - \frac{dW_t}{W_t} + \frac{dW_t^2}{W_t^2} - \frac{dc_{i,s,t}dW_t}{c_{i,s,t}W_t} \\ &= \left\{ -\nu - \rho_i + r_t + \underline{\theta}_{s,t}\theta_t - \mu_t^S + \frac{Y_t}{W_t} + (\sigma_t^S)^2 - \underline{\theta}_{s,t}\sigma_t^S \right\} dt + (\underline{\theta}_{s,t} - \sigma_t^S) dz_t \\ &= \left\{ -\nu - \rho_i + \frac{Y_t}{W_t} + \underline{\theta}_{s,t}\theta_t - \sigma_t^S\theta_t + (\sigma_t^S)^2 - \underline{\theta}_{s,t}\sigma_t^S \right\} dt + (\underline{\theta}_{s,t} - \sigma_t^S) dz_t \\ &= \begin{cases} \left[ -\nu - \rho_i + \tilde{\beta}_t - \sigma_t^S (\theta_t - \sigma_t^S) \right] dt - \sigma_t^S dz_t, & \text{if } N, \text{ or} \\ \left[ -\nu - \rho_i + \tilde{\beta}_t - \sigma_t^S (\theta_t - \sigma_t^S) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_t^S) \right] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_t^S) dz_t, & \text{if } P. \end{cases} \end{aligned}$$

**Online Appendix:  
Not for publication**

# C Motivating Evidence based on the Michigan Survey of Consumers

Here we present additional findings from our motivating analysis using the University of Michigan Surveys of Consumers.

## C.1 Summary Statistics

The left panel of Figure 10 plots the monthly time series of the number of respondents selected for an interview together with the number subsequently reinterviewed six months later. We further partition the panel sample into entry and exit subsamples based on stock market participation in the initial interview. The exit (entry) subsample consists of respondents who report participating (not participating) in the stock market in the first interview and who therefore can potentially exit (enter) by the second interview. The right panel of Figure 10 plots the share of the exit subsample in the overall panel sample.

Figure 10: **Time-series of Sample Size and Sample Composition.**

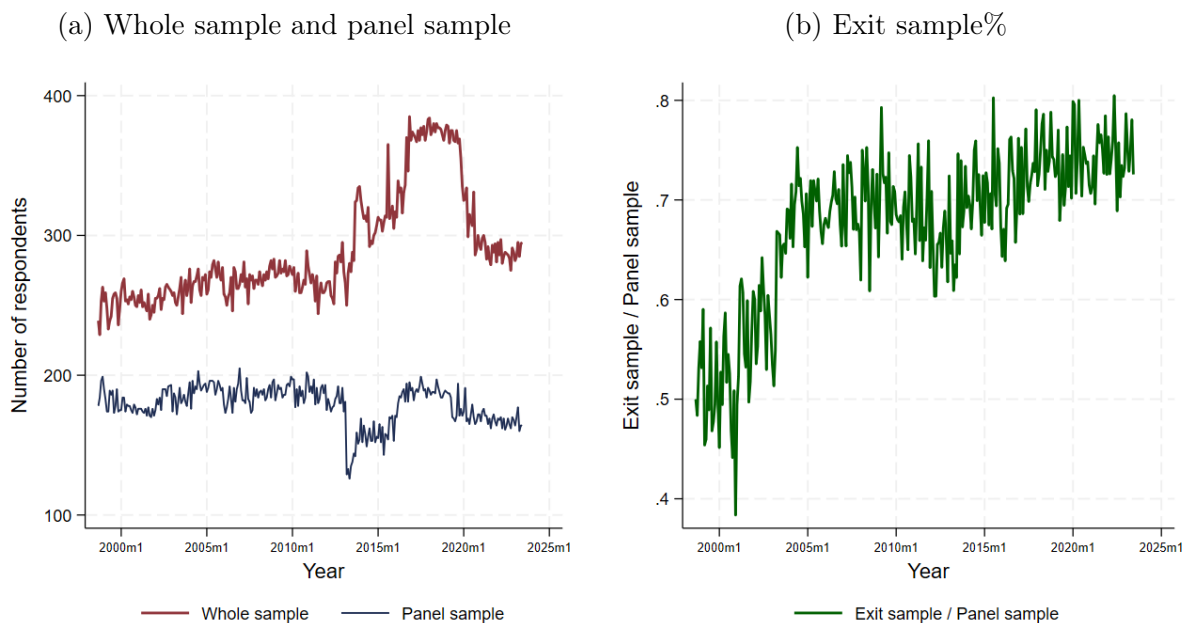


Table 5 reports summary statistics for the full sample, the panel sample, and the entry and exit subsamples.

<b>Panel A: Characteristics - Reported in first interview</b>						
<b>Whole Sample</b>	<b>N</b>	<b>Mean</b>	<b>Std</b>	<b>p25</b>	<b>p50</b>	<b>p75</b>
Age	85864	50	17	37	50	63
Income	85864	84199	78909	35000	62000	105000
Investment Amount	45937	311672	772213	30000	100000	300000
Belief	74539	0.48	0.31	0.20	0.50	0.75
<b>Panel sample - Interviewed Twice</b>						
Age	53002	52	17	39	53	65
Income	53002	84793	77914	35000	65000	105000
Investment Amount	30395	330547	808473	30000	100000	300000
Belief	44959	0.49	0.31	0.20	0.50	0.75
<b>Entry Sample - Not Participating in Round 1</b>						
Age	17212	52	18	37	53	67
Income	17212	44763	43885	19200	34000	56000
Belief	13425	0.37	0.30	0.10	0.35	0.50
<b>Exit Sample - Participating in Round 1</b>						
Age	35790	52	15	40	52	64
Income	35790	104044	83202	50000	80000	125000
Belief	31534	0.54	0.30	0.30	0.50	0.80
<b>Panel B: Control Variables</b>						
		<b>Whole Sample</b>	<b>Panel Sample</b>	<b>Entry Sample</b>	<b>Exit Sample</b>	
<b>Gender</b>	Female	47.83	47.60	53.70	44.67	
	Male	52.17	52.40	46.30	55.33	
<b>Region</b>	North Central	25.87	26.62	25.41	27.21	
	Northeast	17.11	17.16	15.66	17.88	
	South	35.32	34.33	37.15	32.97	
	West	21.71	21.89	21.78	21.94	
<b>Political affiliation</b>	Democrat	12.67	12.19	10.37	13.07	
	Indep / Not answered	76.18	77.34	82.04	75.09	
	Republican	11.16	10.46	7.59	11.84	
<b>Education</b>	Grade 8	1.91	1.54	4.19	0.27	
	Grade 12 - no diploma	3.63	2.99	7.07	1.03	
	Grade 12 - diploma	22.70	21.26	33.35	15.44	
	Grade 16 - college diploma	25.55	26.65	16.61	31.48	
	Grade 17 - no college diploma	18.18	20.48	8.76	26.12	
<b>Home ownership</b>	Grade 17 - no diploma	28.04	27.07	30.02	25.66	
	Own	74.00	78.18	62.28	85.83	
	Rent	26.00	21.82	37.72	14.17	
<b>Panel C: Entry and Exit Frequencies</b>						
<b>Entry sample</b>	3196	<b>Exit sample</b>			3040	
Entry rate	6.02%	Exit rate			5.74%	
Average investment of entrants	88210	Average investment before exit			110397	

Table 5: Summary Statistics, Whole Sample versus Subsamples.

## C.2 Experiences Matter for Beliefs

Motivated by the experience-based learning literature, we next examine whether elicited beliefs are related to experienced stock market returns. We proxy for experienced returns using the average stock market return realized since a given starting age and estimate regressions that include year and age fixed effects. The sample is restricted to respondents between ages 25 and 75, while the starting age ranges from 15 to 23. This construction is equivalent to Bayesian updating with a diffuse prior beginning between ages 15 and 23 and implies a pre-entry learning window ranging from 10 to 2 years. A starting age of 20 minimizes the sum of squared errors; the corresponding estimates are reported in columns (3) and (4) of Table 2. Importantly, the results are similar across all starting ages considered, as shown in Table 6. Overall, we find that higher experienced returns are associated both with a higher probability of stock market participation and with more optimistic beliefs about future stock market returns.

## C.3 Robustness - Subsample Regressions

We re-estimate our baseline regressions on a subsample that excludes respondents who report changes in income quartile or homeownership status across the two survey waves. Excluding these households, which accounts for a reduction of approximately 12000 observations, mitigates the concern that our findings are driven by major liquidity events. As shown in Table 7, the results remain highly robust: while the magnitudes of the coefficients are slightly smaller, they are quantitatively similar to our main specifications.

Starting Age	15	16	17	18	19	20	21	22	23
<i>Panel A: Dependent Variable = Belief<sub>i,t</sub></i>									
Experienced return <sub>age,t</sub>	1.128 (0.395)	1.508 (0.374)	1.544 (0.347)	1.584 (0.326)	1.508 (0.304)	1.503 (0.272)	1.116 (0.246)	0.778 (0.223)	0.581 (0.200)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
R <sup>2</sup>	0.2453	0.2455	0.2455	0.2456	0.2458	0.2458	0.2456	0.2456	0.2456
N	73231	73231	73231	73231	73231	73231	73231	73231	73231
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
<i>Panel B: Dependent Variable = Participation<sub>i,t</sub></i>									
Experienced return <sub>age,t</sub>	0.386 (0.093)	0.407 (0.085)	0.396 (0.078)	0.380 (0.073)	0.378 (0.067)	0.349 (0.060)	0.282 (0.054)	0.246 (0.049)	0.220 (0.043)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Age FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
R <sup>2</sup>	0.2644	0.2645	0.2645	0.2646	0.2646	0.2646	0.2645	0.2644	0.2644
N	73231	73231	73231	73231	73231	73231	73231	73231	73231
Model	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit

Standard errors in parentheses

**Table 6: Starting Ages.** The table reports regression coefficients on experienced returns constructed using alternative starting ages. Experienced returns are measured as the average stock market return realized since the respective starting age. In Panel A, the dependent variable is beliefs, measured as PSTK/100. In Panel B, the dependent variable is participation, defined as an indicator equal to one if the household participates in the stock market and zero otherwise. Controls include indicators for income quartiles, educational attainment, housing status (owner versus renter), region of residence (North, South, Northeast, and Central North), respondent gender, and political affiliation (Democrat, Republican, or non-affiliated). Monthly stock market returns are obtained from Amit Goyal's data library.

	(1)	(2)	(3)	(4)	(5)
	$\Delta\text{Parti}_{i,t,6m}$	$\text{Entry}_{i,t,6m}$	$\text{Exit}_{i,t,6m}$	$\Delta\text{Belief}_{i,t,6m}$	$\Delta\text{Belief}_{i,t,6m}$
$\text{Belief}_{i,t}$	0.002 (0.007)	0.395*** (0.067)	-0.726*** (0.059)	-0.637*** (0.006)	-0.647*** (0.006)
$\text{Parti}_{i,t}$					0.049*** (0.004)
$\Delta\text{Belief}_{i,t,6m}$	0.021*** (0.007)	0.335*** (0.059)	-0.438*** (0.052)		
$\text{Return}_{t,6m}$				0.228*** (0.025)	0.131*** (0.036)
$\text{Parti}_{i,t} \times \text{Return}_{t,6m}$					0.133*** (0.034)
Controls	Y	Y	Y	Y	Y
Dummies	Year-month	Year-month	Year-month	Year-month	Year-month
$R^2$	.011	.13	.13	.335	.339
N	33445	9722	23613	33590	33590
Regression	OLS	Probit	Probit	OLS	OLS
Conditional on		$\text{Parti}_{i,t}=0$	$\text{Parti}_{i,t}=1$		

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 7: **Subsample Regressions - Excluding households who report changes in income quartile or home ownership.** Belief is measured as PSTK/100. Participation is an indicator variable equal to 1 if the household participates in the stock market and 0 otherwise. The change in belief ( $\Delta\text{Belief}$ ) is defined as the belief reported in the second interview minus that reported in the first interview.  $\Delta\text{Participation}$  equals 1 for entry, 0 for no change between interviews, and  $-1$  for exit. Controls include indicators for income quartiles, age groups ( $<40$ ,  $40-60$ ,  $>60$ ), educational attainment, housing status (owner or renter), region of residence (North, South, Northeast, Central North), respondent gender, and political affiliation (Democrat, Republican, non-affiliated). All specifications include year-month (interview-wave) fixed effects. Monthly stock market returns are obtained from Amit Goyal's website.

## D Motivating Evidence based on the RAND American Life Panel

The RAND American Life Panel survey, *Effects of the Financial Crisis and Great Recession on American Households*, comprises 61 waves and spans the financial crisis as well as the subsequent stock market recovery. The survey covers a cross-section of 4,734 individuals, of whom 1,032 respond in at least 50 waves.

Similar to the Michigan survey, the RAND survey includes the following question: “[st010] By next year at this time, what are the chances that mutual fund shares invested in blue chip stocks like those in the Dow Jones Industrial Average will be worth more than they are today?” Respondents answer by reporting a number between 0 and 100. As in the Michigan survey, we use this question as our measure of beliefs about future stock market performance. Further, in waves administered after March 2009, the RAND survey contains questions on stock market investments: Please, do not include stock holdings that are part of an IRA, 401(k), Keogh or similar retirement accounts. Do you and / or your spouse have any shares of stock or stock mutual funds?”

Compared with the Michigan survey, in which only a subset of respondents is interviewed a second time, the RAND survey provides a substantially longer panel for studying the dynamics of beliefs and stock market investments. However, the panel is unbalanced, as respondents frequently drop out and re-enter in later waves. In addition, the intervals between consecutive interviews vary from one to three months.

Overall, the RAND evidence reinforces the three central findings from the Michigan survey. First, stock market participants are systematically more optimistic than nonparticipants. Second, entry and exit are associated with substantial revisions in beliefs. Third, beliefs respond strongly to stock market experiences and return realizations. Despite important differences in survey design and sampling, the RAND data therefore provide independent support for the mechanism emphasized in the paper.

	(1)	(2)	(3)	(4)
	Participation <sub><i>i,t</i></sub>	Participation <sub><i>i,t</i></sub>	Entry <sub><i>i,t,3m</i></sub>	Exit <sub><i>i,t,3m</i></sub>
Belief <sub><i>i,t</i></sub>	0.451*** (0.078)	0.396*** (0.087)	0.485*** (0.143)	-0.538*** (0.157)
$\Delta$ Belief <sub><i>i,t,3m</i></sub>			0.440** (0.189)	-0.617*** (0.207)
Controls	Y	Y	Y	Y
Time FE	Year-month	Year-month	Year-month	Year-month
Individual FE	Y	Y	Y	Y
$R^2$	.14	.143	.062	.107
N	54081	49349	19557	14449
Specification	Logit	Logit	Logit	Logit
Conditional on		$\geq 20$ waves	Participation <sub><i>i,t=0</i></sub>	Participation <sub><i>i,t=1</i></sub>

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 8: **Participation and Beliefs: RAND (Weighted)**. Logit specifications. Belief is measured as  $st010/100$ . The change in belief ( $\Delta$ Belief<sub>*t,t+3m*</sub>) is defined as the difference in beliefs between two survey waves. Participation, entry, and exit are indicator variables. Individual weights are computed as the average survey weights across waves. Column (3) is estimated conditional on not participating in the stock market at time  $t$ , while column (4) is estimated conditional on participating at time  $t$ . Controls include indicators for family income groups (ranging from less than 5,000 to 75,000 or more), household size, retirement status, unemployment status, and temporary layoff status. All specifications include year-month (wave) fixed effects and individual fixed effects.

The RAND survey also directly measures attention to the stock market through the following question: “[st017] How closely do you follow the stock market? 1 Very closely 2 Somewhat 3 Not at all.” This question is not asked in every wave and therefore contains only a limited time dimension. Accordingly, we abstract from the time-series variation in this measure and instead use each individual’s average response across available waves. In the regression table below, *Attention* is an indicator variable equal to 1 if the individual’s average value of  $st017 \leq 2$ , which applies to roughly 30% of individuals.

	(1)	(2)	(3)	(4)
	$\Delta\text{Belief}_{i,t,3m}$	$\Delta\text{Belief}_{i,t,3m}$	$\Delta\text{Belief}_{i,t,3m}$	$\text{Attention}_i$
$\text{Return}_{i,t,3m}$	0.126*** (0.015)	0.107*** (0.019)	0.095*** (0.018)	
$\text{Belief}_{i,t}$	-0.862*** (0.010)	-0.862*** (0.010)	-0.863*** (0.010)	
$\text{Participation}_{i,t}$		-0.006 (0.004)		
$\text{Return}_{t,3m} \times \text{Participation}_{i,t}$		0.062** (0.030)		
$\text{Return}_{t,3m} \times \text{Attention}_i$			0.105*** (0.029)	
Average participation <sub>i</sub>				2.950*** (0.145)
Controls	Y	Y	Y	
Time FE	Year	Year	Year	
Individual FE	Y	Y	Y	
$R^2$	.448	.448	.449	.167
N	69599	69599	69501	4350
Specification				Logit

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 9: **Belief Revisions and Returns: RAND (Weighted)**. Return denotes the stock market return between two survey waves. Belief is measured as  $st010/100$ . The change in belief ( $\Delta\text{Belief}_{t,t+3m}$ ) is defined as the difference in beliefs between two survey waves. Participation is an indicator variable equal to 1 if the respondent participates in the stock market and 0 otherwise. Attention is an indicator variable equal to 1 if the respondent's average value of  $st017 \leq 2$ , and 0 otherwise. Average participation is defined as the number of survey waves in which the respondent reports stock investment divided by the total number of waves in which she answers  $st010$ . Individual weights are computed as the average survey weights across waves. Controls include indicators for family income groups (ranging from less than 5,000 to 75,000 or more), household size, retirement status, unemployment status, and temporary layoff status. All specifications include year-month (wave) fixed effects and individual fixed effects. Stock market returns are obtained from Amit Goyal's website.

## E Wealth Tax

Alternatively to a consumption tax, we can impose a wealth tax on all living agents to finance the consumption of the new-born cohort. With wealth tax at rate  $\tau^W$ , the dynamic budget constraint becomes

$$dW_{i,s,t} = \begin{cases} (r_t W_{i,s,t} + \nu W_{i,s,t} - \tau^W W_{i,s,t} - c_{i,s,t}) dt, & \text{if } N, \text{ or} \\ [r_t W_{i,s,t} + \pi_{i,s,t} (\mu_{s,t}^S - r_t) + \nu W_{i,s,t} - \tau^W W_{i,s,t} - c_{i,s,t}] dt + \pi_{i,s,t} \sigma_t^S dz_{s,t}, & \text{if } P, \end{cases}$$

which implies that the static budget constraint is

$$E_{s,s} \left[ \int_s^\infty e^{-\nu(t-s)} \xi_{s,t} (c_{i,s,t} + \tau^W W_{i,s,t}) dt \right] = W_{i,s,s}.$$

We conjecture and verify that  $\beta_i = \frac{c_{i,s,t}}{W_{i,s,t}}$  is a constant. Using (2), we have  $\frac{1}{\rho_i + \nu} c_{i,s,t} \left(1 + \frac{\tau^W}{\beta_i}\right) = W_{i,s,t} = \frac{c_{i,s,t}}{\beta_i}$ . Rearranging, we have  $\beta_i = \rho_i + \nu - \tau^W$ , which is a constant. It then follows that the equilibrium real short rate of interest and the market price of risk with wealth tax are

$$r_t = \nu - \tau^W \frac{\beta}{\tilde{\beta}_t} + \bar{\rho}_t + \mu_Y - \sigma_Y \left( \sigma_Y \frac{1}{\bar{\Phi}_t} - \bar{\Delta}_t \right) = \nu - \tau^W \frac{\beta}{\tilde{\beta}_t} + \bar{\rho}_t - \sigma_Y^2 \frac{1}{\bar{\Phi}_t} + \bar{\mu}_t, \quad (25)$$

and the market price of risk is

$$\theta_t = \sigma_Y \frac{1}{\bar{\Phi}_t} - \bar{\Delta}_t = \sigma_Y \frac{1}{\bar{\Phi}_t} - \frac{\bar{\mu}_t - \mu_Y}{\sigma_Y}, \quad (26)$$

where  $\tilde{\beta}_t \equiv \frac{Y_t}{W_t} = \int_i \beta_i \int_{-\infty}^t f_{i,s,t}^W ds di$  is the aggregate consumption-wealth ratio at time  $t$ .<sup>19</sup> Imposing a wealth tax instead of a consumption tax does not change the expressions of the stock volatility  $\sigma_t^S$ , the risky portfolio  $\pi_{i,s,t}$ , as well as the dynamics of log consumption  $\log(c_{i,s,t})$  in Propositions 4, 5, and 6. The consumption share at time  $t$  of type  $i$  agents born at  $s$  follows the process

$$\begin{aligned} df_{i,s,t}^c / f_{i,s,t}^c &= \left( -\tau^W \frac{\beta}{\tilde{\beta}_t} + \bar{\rho}_t - \rho_i \right) dt + (\theta_t - \sigma_Y) (\underline{\theta}_{s,t} - \sigma_Y) dt + (\underline{\theta}_{s,t} - \sigma_Y) dz_t \\ &= \begin{cases} \left[ -\tau^W \frac{\beta}{\tilde{\beta}_t} + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y) \right] dt - \sigma_Y dz_t, & \text{if } N, \text{ or} \\ \left[ -\tau^W \frac{\beta}{\tilde{\beta}_t} + \bar{\rho}_t - \rho_i - \sigma_Y (\theta_t - \sigma_Y) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_Y) \right] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_Y) dz_t, & \text{if } P, \end{cases} \end{aligned}$$

<sup>19</sup>Equivalently,  $\tilde{\beta}_t$  is also the wealth-weighted average consumption-wealth ratio in the economy, as  $\frac{Y_t}{W_t} = \frac{\int_i \int_{-\infty}^t \alpha_i \nu e^{-\nu(t-s)} c_{i,s,t} ds di}{W_t} = \frac{\int_i \int_{-\infty}^t \alpha_i \beta_i \nu e^{-\nu(t-s)} W_{i,s,t} ds di}{W_t} = \int_i \beta_i \int_{-\infty}^t f_{i,s,t}^W ds di$ . Therefore,  $\tilde{\beta}_t = \bar{\rho}_t + \nu - \tau^W$ .

and the wealth share at time  $t$  of type  $i$  agents born at  $s$  follows the process

$$df_{i,s,t}^W / f_{i,s,t}^W = \begin{cases} [-\tau^W + \tilde{\rho}_t - \rho_i - \sigma_t^S (\theta_t - \sigma_t^S)] dt - \sigma_t^S dz_t, & \text{if } N, \text{ or} \\ [-\tau^W + \tilde{\rho}_t - \rho_i - \sigma_t^S (\theta_t - \sigma_t^S) + (\theta_t + \Delta_{s,t}) (\theta_t - \sigma_t^S)] dt \\ \quad + (\theta_t + \Delta_{s,t} - \sigma_t^S) dz_t, & \text{if } P. \end{cases}$$

## F Stock Market Participation Data

The data on stock market participation rates cover Finland,<sup>20</sup> Germany, Norway,<sup>21</sup> and the United States. A summary of the data sources is provided in Table 10. We define a stock market participant as an individual or household with direct or indirect stock holdings in a given year. In administrative income data, participation is alternatively identified by the receipt of dividend income during the year. For the United States, participation rates are obtained from the Internal Revenue Service. For Finland and Norway, the rates are based on tax authority records covering all residents with a tax obligation and are measured at year-end. We additionally supplement the U.S. series with survey-based measures and use survey-based data for Germany.<sup>22</sup>

Country	Measure	Time-series	Frequency	Entry and exit	Data Source
Finland	Portfolio	2004 - 2016	Annual	Yes	Statistics Finland
Germany	Survey	1997 - 2022	Annual	No	Deutsches Aktieninstitut
Norway	Wealth	1999 - 2016	Annual	Yes	Statistics Norway
US	Dividend	1990 - 2022	Annual	No	Internal Revenue Service
	Survey	1989 - 2022	Triannual	No	Survey of Consumer Finances
	Survey	1998 - 2023	Monthly	Yes	Michigan Surveys of Consumers
	Survey	2009 - 2016	Monthly	Yes	RAND American Life Panel

Table 10: **Participation Data.** Participation rates are based on registry data, dividends reported on tax returns, and surveys. Entry and exit rates are available through registry data, the Michigan Survey, and the RAND Survey.

We detrend participation rates using country-specific time trends, to remove any potential effects due to changes in participation costs, tax treatment, and demographic compositions.

<sup>20</sup>Data for Finland are compiled by Breitkopf, Knüpfer, and Rantapuska (2021) using data from Statistics Finland; the series covers 2004–2016, the span of the compiled dataset available to us. Change in participation rate in 2004 is calculated using entry and exit data.

<sup>21</sup>We commissioned Statistics Norway to provide annual participation rates. Statistics Norway observes the taxable values for the four categories: (1) securities registered in the Central Securities Depository (VPS); (2) securities not registered in VPS; (3) shares in equity mutual funds; and (4) bonds and money market funds. The first two categories cover listed and unlisted Norwegian shares, bonds, equity certificates, and options, from which we cannot isolate stock market exposure. Therefore, we define a stock market participant as an individual with shares in equity mutual funds. The Norwegian series ends in 2016. In that year, Norway introduced a tax-favored share savings account (aksjesparekonto), broadly analogous to U.S. retirement accounts. Its introduction triggered a multi-year reallocation of existing equity-fund holdings from taxable accounts into the new accounts and a sustained inflow from households with little or no prior stock-market participation. Because both patterns reflect the policy change rather than beliefs-driven participation, post-2016 observations are not comparable to the earlier sample. Consistent with this, Statistics Norway restricted access to post-2016 data for this research question under its data-governance policy.

<sup>22</sup>The data for Germany are annual aggregates of 12 monthly waves.

This removes any significant linear time trend, while keeping the time-series mean participation rate unchanged. Specifically, we remove time-trends for Finland, Norway and the United States, while there appears to be no significant trend in Germany.<sup>23</sup>

For Finland and Norway,<sup>24</sup> we also have data on entry and exit from the stock market. Entry and exit are constructed from stock or portfolio holdings at the year-end. Investors are regarded as entering if they hold stocks or mutual funds at the end of the current year but did not hold any stocks or mutual funds at the end of the previous year. Conversely, investors are regarded as exiting if they owned stocks or mutual funds at the end of the previous year but do not own stocks or mutual funds at the end of the current year.<sup>25</sup>

For the United States, we rely on the dividend income tax as measure of stock market participation because it covers the general population. We supplement the data with Survey of Consumer Finances, the Michigan Survey, and the RAND Survey.<sup>26</sup>

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<sup>23</sup>The original and the detrended time-series of participation rates for Finland, Germany, Norway and the United States are in Figure 12 in Section I in the Online Appendix.

<sup>24</sup>For Norway, entry and exit data for the year 2016 are missing due to change of tax treatment on equity and bond mutual funds.

<sup>25</sup>The original time-series of entry and exit rates for Finland and Norway are in Figure 12 in Section I in the Online Appendix.

<sup>26</sup>Survey of Consumer Finances is conducted every three years, and we use aggregate participation rate time-series by age groups from 1989 to 2022. For the Michigan Surveys of Consumers see Section 2 and Section C in the Online Appendix. For the RAND Survey see Section D in the Online Appendix.

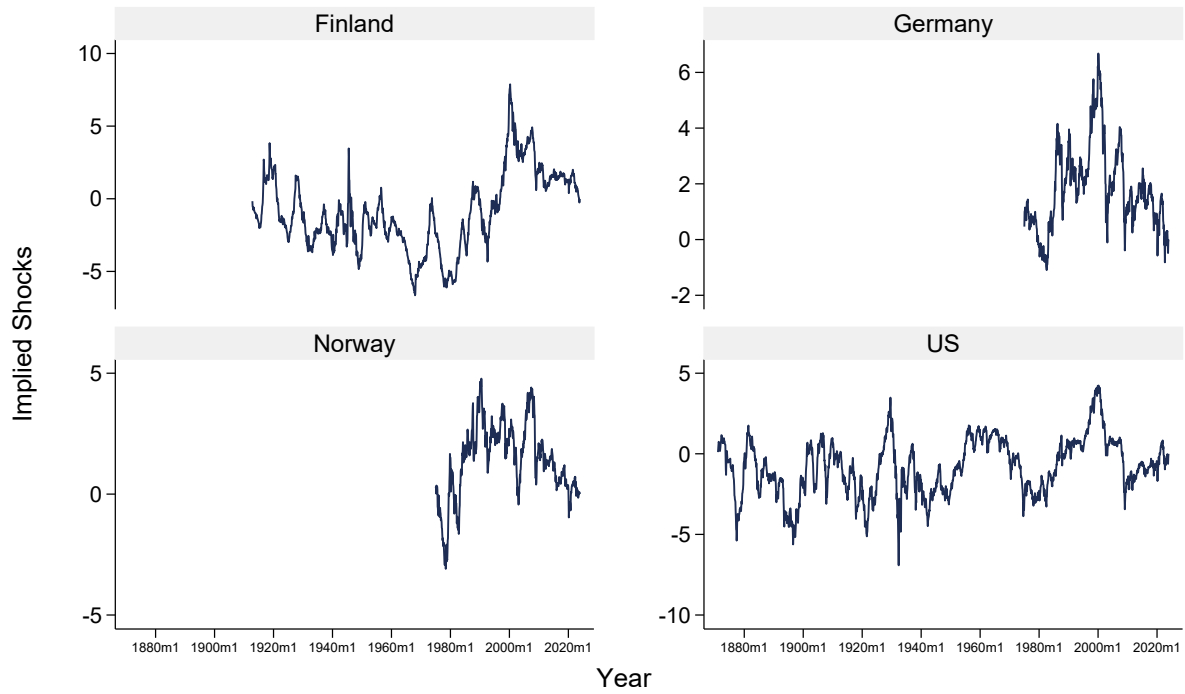
## G Asset Pricing Moments

<b>Moments</b>	<i>Complete Market</i>		<i>Modeled Economy</i>	
	Mean	Std	Mean	Std
$\theta_t$	0.0330	0.0861	0.0580	0.0455
$r_t$	0.0353	0.0028	0.0347	0.0015
$\mu_t^S$	0.0365	0.0004	0.0366	0.0001
$\sigma_t^S$	0.0330	0.0016	0.0330	0.0003

Table 11: **Mean and standard deviation of the asset pricing quantities.** The Table shows the mean and standard deviation of the market price of risk  $\theta_t$ , the real short rate of interest  $r_t$ , as well as the drift  $\mu_t^S$  and diffusion  $\sigma_t^S$  of the stock return, for the modeled economy, as well as a benchmark economy with complete markets with stochastic volatility, similar to the economy in Ehling, Graniero, and Heyerdahl-Larsen (2018b). To compute the averages, we simulate the economies to generate data based on 10,000 simulations, each with 6000 periods or 500 years. For parameters see Subsection 4.1.

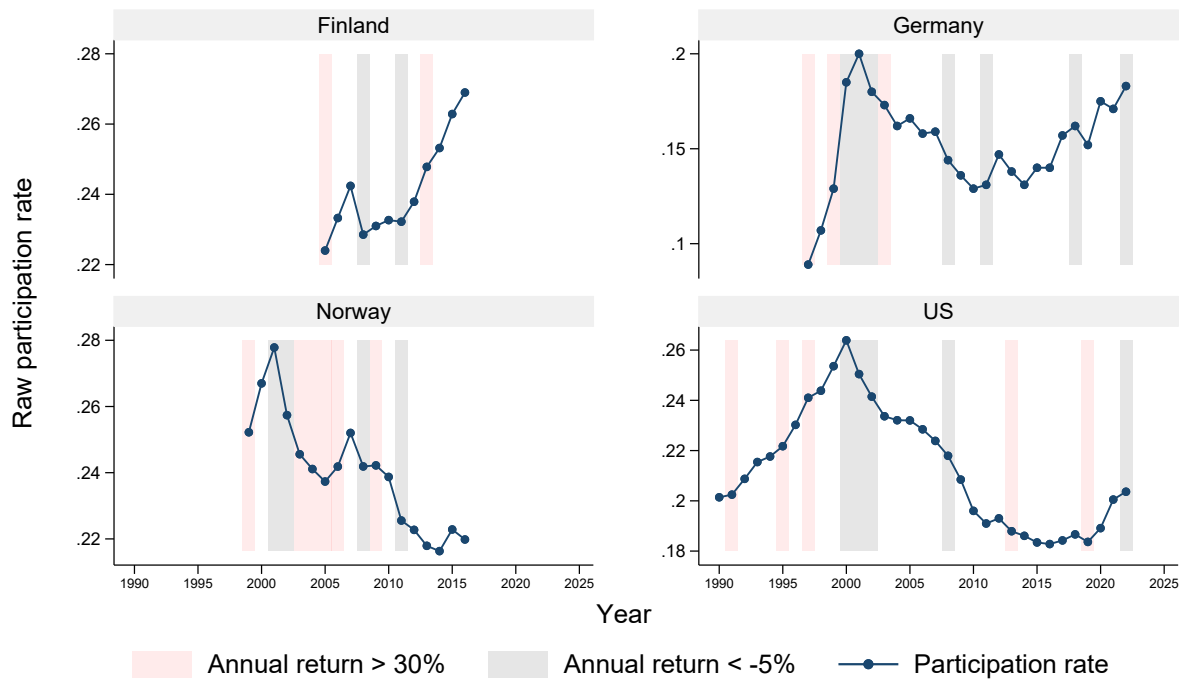
## H Implied Shocks

Figure 11: **Shocks to the Fundamental.** The plots show the implied path of shocks to the fundamental for Finland, Germany, Norway and the US economy. For details on implied shocks see Subsection 4.3.



# I Participation Rate Time-series

Figure 12: **Time-series of Stock Market Participation Rate - Raw.** The plot shows the time-series of participation rate in Finland, Germany, Norway and the US. The gray (red) shaded areas are the years when the total stock returns are lower than -5% (higher than 30%).



## J Alternative Measures of Participation Rate

Figure 13: **Alternative Measure of Participation Rate in the US - Survey of Consumer Finances.** The top plot shows the raw time-series of participation rate from Survey of Consumer Finances, and the bottom plot shows the changes in participation rate, and the model-implied changes over the same horizon.  $T_{n,\vartheta^l,\vartheta^h}$  denotes the t-statistic on the coefficient obtained from regressing changes in actual participation rates on a constant and changes in model-implied participation rates. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The model simulations use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ . The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively.

(a) Raw participation rate time-series, SCF



(b) Participation rate, Data versus Model.

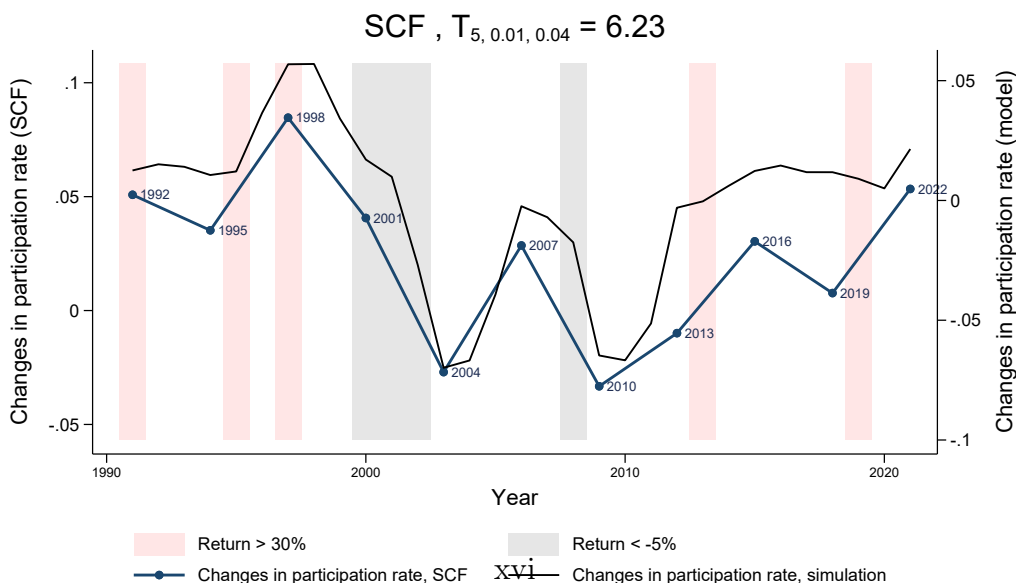


Figure 14: **Alternative Measure of Participation Rate from Simulation - Annual Dividend-based.** In simulation, we use the proportion of agents who have been in the stock market at any point within the past 12 months as the annual participation rate. This definition is analogous to the participation rate measure in the US from the IRS, which is based on annual dividend income.  $T_{n,\vartheta^l,\vartheta^h}$  denotes the t-statistic on the coefficient obtained from regressing changes in actual participation rates on a constant and changes in model-implied participation rates. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The model simulations use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ . The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively.

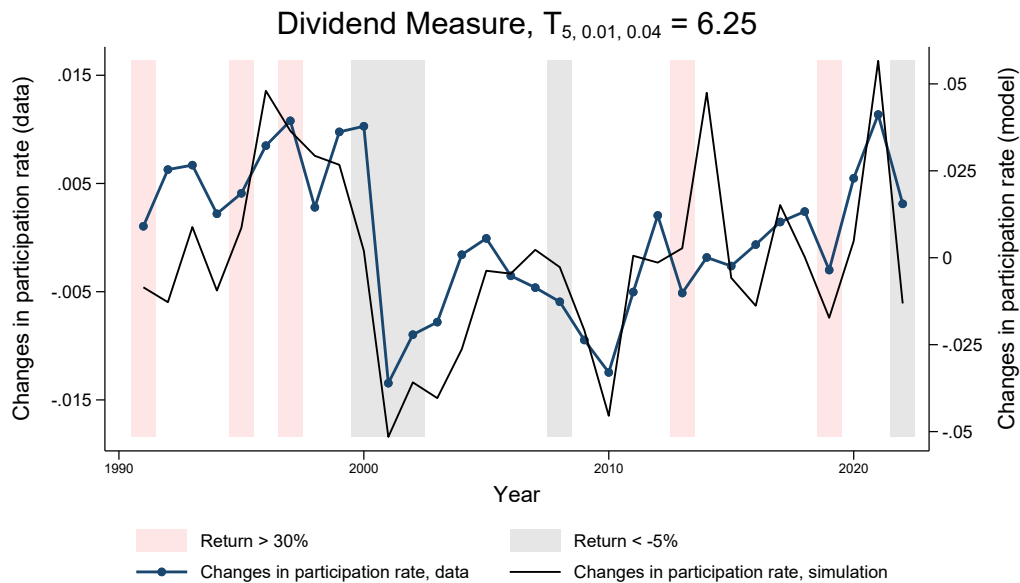
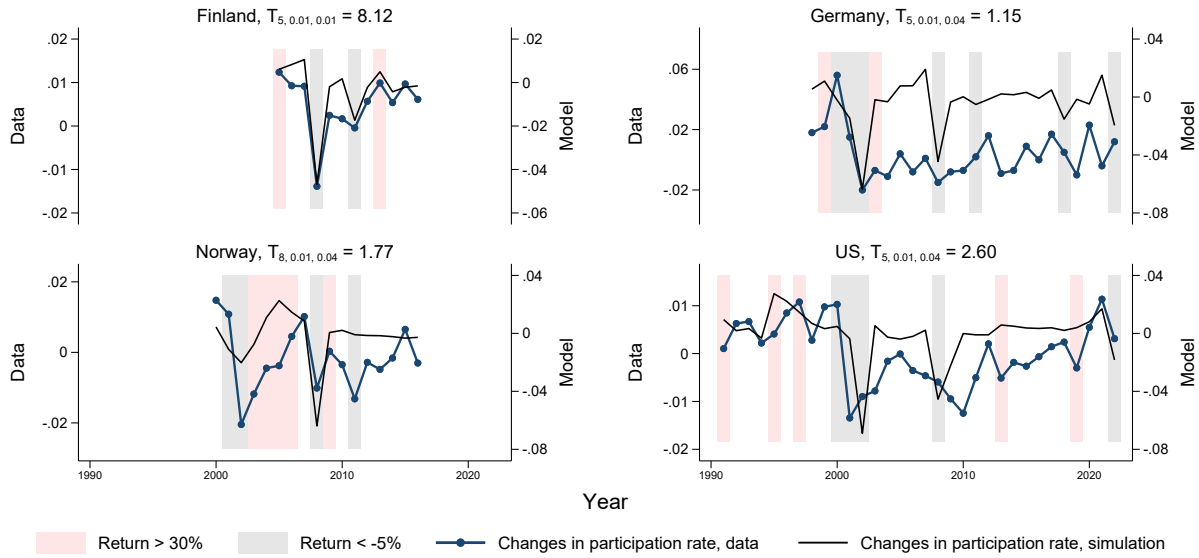


Figure 15: **Alternative Measure of Participation Rate from Simulation - December Observation.** In simulation, we use end of year observation as the annual participation rate.  $T_{n,\vartheta^l,\vartheta^h}$  denotes the t-statistic on the coefficient obtained from regressing changes in actual participation rates on a constant and changes in model-implied participation rates. Parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3. The model simulations use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ . The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively.



## K Alternative Parameters

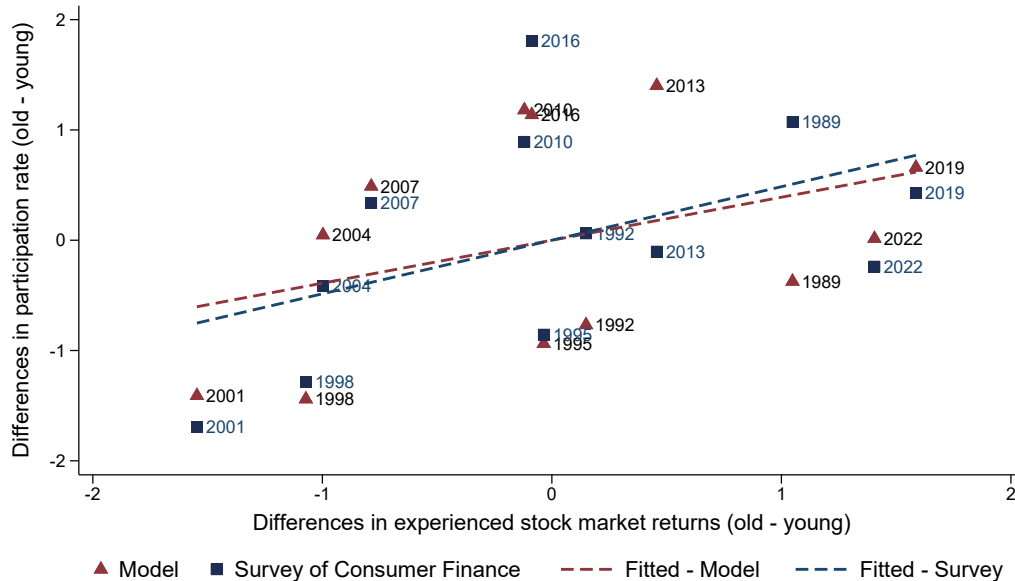
	US	Germany	Norway	Norway Entry	Norway Exit	Finland	Finland Entry	Finland Exit
<b>Baseline</b>	3.15	2.44	2.27	2.98	1.91	6.51	3.39	5.68
<i>Panel A: Pre-entry learning window <math>n = 5</math> years (<math>n = 8</math> for Norway)</i>								
$n = 3(6)$ years	3.20	2.31	2.42	2.46	1.69	6.12	4.62	5.63
$n = 7(10)$ years	3.54	2.32	1.93	2.18	1.86	7.50	2.66	5.59
<i>Panel B: Agent types [0.25, 0.5, 0.25]</i>								
[0.2, 0.5, 0.3]	3.13	2.39	2.25	2.94	1.91	6.66	3.63	5.61
[0.3, 0.5, 0.2]	3.25	2.39	2.31	3.04	1.90	6.31	2.87	5.61
<i>Panel C: Entry threshold <math>\vartheta^h = 0.04</math> (<math>\vartheta^h = 0.01</math> for Finland)</i>								
$\vartheta^h = 0.03(0.00)$	3.11	2.15	2.18	2.69	1.88	.	.	.
$\vartheta^h = 0.05(0.02)$	3.23	2.57	2.25	2.92	2.01	4.31	2.00	4.31
<i>Panel D: Exit threshold <math>\vartheta^l = 0.01</math></i>								
$\vartheta^l = 0.00$	3.24	2.45	2.17	2.88	1.96	4.19	2.24	4.48
$\vartheta^l = 0.02$	3.04	2.25	2.24	2.82	1.83	.	.	.
<i>Panel E: Attention of nonparticipants <math>\varphi = 0.5</math></i>								
$\varphi = 0.4$	3.28	2.74	2.20	2.80	1.98	6.43	3.07	4.81
$\varphi = 0.6$	2.87	2.24	2.21	2.65	1.77	5.53	3.98	6.39

Table 12: **Parameter Sensitivity.** The table reports the t-statistic for alternative parameters around the baseline parameters. The t-statistics are obtained from regressing participation (in changes), entry and exit (in levels) rates in Finland, Germany, Norway, and the United States on a constant and model-implied counterparts. Panel A shows the t-statistics with a pre-entry learning window of 3 and 7 years. For Norway, we use a pre-entry learning window  $n = 8$  years for the baseline, and show results with  $n = 6$  and  $n = 10$  years. Panel C shows the t-statistics with an entry threshold of 0.03 and 0.05. For Finland, we use entry threshold  $\vartheta^h = 0.01$  for the baseline, and show results with  $\vartheta^h = 0.02$ . Panel B, D and E contain results varying agent types, exit threshold  $\vartheta^l$ , and attention of nonparticipants  $\varphi$ . For Finland, we omit results for the pairs  $\vartheta^h = 0.00, \vartheta^l = 0.01$ , and  $\vartheta^h = 0.01, \vartheta^l = 0.02$ , as they violate  $\vartheta^h \geq \vartheta^l$ . Baseline set of parameter values are reported in Subsection 4.1; implied shocks are described in Subsection 4.3.

## L Experience and Participation

We compute model implied differences in participation rates between the old and young (red arrows) to juxtapose these with the differences in participation rates based on data from SCF (blue squares). Specifically, regressing the difference in participation rate between old and young from the simulation on that from the data produces a t-statistic of 4.60, and R-squared of 52.66%.

Figure 16: **Experience and Participation Rate - Data versus Model, Survey of Consumer Finances.** The plot shows the model implied (in red) and the Survey of Consumer Finances (SCF, in blue) based difference in stock market participation rates between the old and young based on experienced returns. The bottom plot also shows the fitted relation between differences in experienced returns and differences in participation rates. We proxy for the difference in experienced stock market returns by taking the (time-series) average stock market return over the prior 50 years minus the return over the prior 20 years. For SCF survey, old refers to households over 75 years old, and young refers to those below 35. In the simulation, we consider agents with under 25 years of experience as young, and with over 50 years of experience as old. The calendar years refer to the respective SCF survey waves. All differences are standardized. For parameters see Subsection 4.1. For implied shocks see Subsection 4.3. The shares of designated participants, designated nonparticipants, and reentry agents at birth are 25%, 50%, and 25%, respectively. The model simulations use  $\vartheta^l = 0.01$  and  $\vartheta^h = 0.04$ .



## M Robustness Tests

Table 13 shows predictive regressions that include the price-dividend-ratio on top of the participation rate as explanatory variables.

	Total returns			Excess returns		
	(1) 12m	(2) 24m	(3) 36m	(4) 12m	(5) 24m	(6) 36m
<b>Participation rate</b>	-0.286** (0.112)	-0.244*** (0.077)	-0.114 (0.074)	-0.329** (0.138)	-0.263*** (0.093)	-0.113 (0.108)
<b>Price-dividend ratio</b>	-0.143 (0.111)	-0.262* (0.135)	-0.367** (0.161)	-0.180 (0.128)	-0.344** (0.161)	-0.483** (0.196)
N	89	89	89	89	89	89

Standard errors in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 13: **Participation Rate and Future Returns - Data versus Model.** The table shows predictive regressions with 12, 24 and 36 month horizons, with detrended participation rate and the price-dividend ratio as explanatory variables for Finland, Germany, Norway and the US, where columns (1) - (3) show regressions with total returns and columns (4) - (6) use excess returns. Interest rates are 12-month T-bill rates from Bloomberg for Finland, Bundesbank for Germany, Statistics Norway for Norway, and Amit Goyal's website for the US. Price-dividend ratio are calculated using rolling 12-month returns from Ken French's website. All the variables are standardized. The panel regressions include country fixed effects and use Driscoll-Kraay standard error with respectively 2, 4, and 6 lags.