THE DYNAMICS OF STOCK MARKET PARTICIPATION

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Abstract

We document novel facts on the exit and reentry margins of stock market participation by retail investors. Using detailed administrative data containing wealth information for every Norwegian resident from 1993 to 2018, we find that many households leave the stock market within just 2 years after entry. Such behavior is more prominent for low income, wealth, and education groups. We also show that the longer households participate for, the less likely they are to exit. In terms of the reentry margin, over 35% of exiters subsequently return to the stock market, often just a year later. A workhorse portfolio choice model requires sizable per-period participation costs to produce such patterns. We propose a theory of experience effects, whereby agents form beliefs over future stock returns based on their realized returns. This model can explain the short-term dynamics in stock market participation without requiring high costs.

Keywords: household finance, stock market participation, dynamics, reentry
JEL Classification: D14, D84, G11, G40, G50

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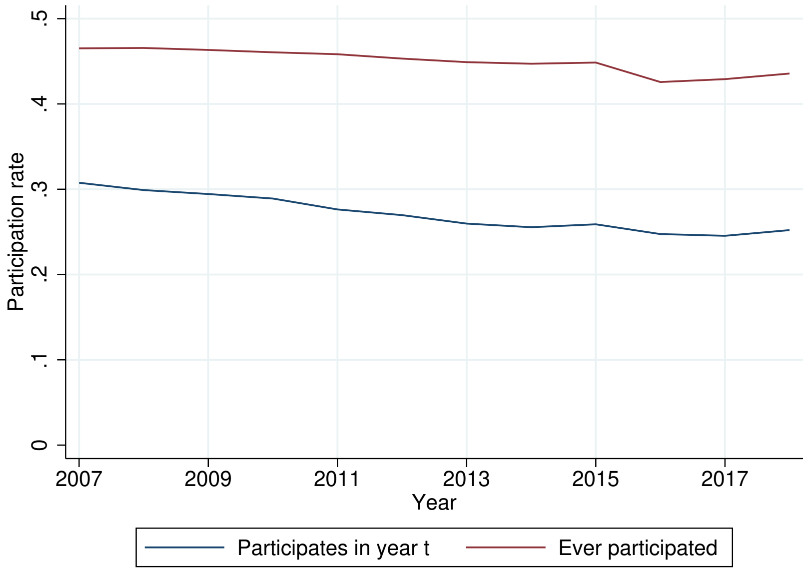
1 Introduction

Despite the large average return on equities relative to bonds, many households choose not to invest in the stock market (Mankiw and Zeldes (1991); Haliassos and Bertaut (1995); Campbell (2006)). While the literature has devoted significant attention to explaining why the aggregate participation rate lies below 100%, much less is known about the movements in and out of the stock market by individual investors. The conventional view is that people either never invest or always invest. However, the data indicate that a sizable proportion of nonparticipants have invested in stocks at some point in the past (Figure 1). Exploring the decision to enter into or exit from the stock market is of first-order importance because portfolio choices matter for wealth accumulation (Benhabib et al. (2011); Gabaix et al. (2016); Xavier (2021)). Furthermore, analyzing these transitions can help distinguish between the wide range of existing theories of participation, given that different models have opposing predictions for such movements. In this paper, we shed light on the dynamics of stock market participation by uncovering novel facts pertaining to exit and reentry at the individual level using detailed Norwegian administrative data, and assess the implications of our findings for theories of participation.

Panel data on wealth holdings over a long time dimension are essential to investigate changes in participation status. We exploit Norwegian administrative tax records to overcome this challenge. As Norway levies a wealth tax, these records contain detailed wealth information for every member of the population. Our data are annual and span 26 years, which is significantly longer than similar administrative datasets from other countries and of higher frequency than most relevant longitudinal surveys.[1] Individuals must file a tax return even if they hold no financial assets, which allows us to confidently identify periods of nonparticipation. This is a significant advantage relative to brokerage accounts data, where exit from such samples may simply reflect a transfer to another account provider rather than a complete withdrawal from the stock market. Financial holdings are directly reported to the tax authority by the financial intermediaries themselves. This third-party reporting alleviates concerns about measurement errors that can arise when using self-reported measures of wealth. In addition, we are able to link the tax records to other administrative datasets,

[1] For example, the Swedish microdata on wealth used by Calvet et al. (2007, 2009a,b) cover the period from 1999 to 2007, and PSID survey waves are biennial.

FIGURE 1: Participation rate in Norway



Notes. This figure plots the stock market participation rate over time (in blue) and the proportion of the population who have participated at least once between 1993 (when our data start) and year t.

thereby giving us additional information about each citizen that is typically not available in survey or brokerage accounts datasets.

We first document novel facts on two margins of stock market participation that have received less attention in the existing literature, namely the exit and reentry margins.[2] Our focus is on participation through nonretirement investment accounts, as existing work has documented inertia in retirement accounts (Brunnermeier and Nagel (2008)). We find that many individuals have very short spells in the stock market; that is, they stay in the stock market for only 1–2 years and then completely liquidate their stock holdings. 15% of all spells end just one year after exit, and a further 8% end in 2 years. We show that this behavior is neither due to liquidity needs, such as house purchases or unemployment, nor involuntary participation coming from inheritances or employee stock options. Our finding implies that the high exit rates documented in other studies are driven by new investors who invest for only a short period.[3]

[2] While our focus is on the speed of exit, others have linked exit to age (Poterba and Samwick (1997); Ameriks and Zeldes (2004); Fagereng et al. (2017a)), house purchases (Brandsaas (2021)), income shocks (Bonaparte et al. (2021)), and portfolio characteristics (Calvet et al. (2009a)).

[3] Bonaparte et al. (2021) show that, on average, 7.3% (8.7%) of year t households enter into (exit from) non-

We then investigate whether the likelihood of a short spell, which we define as a spell that results in complete exit within 2 years, is correlated with certain characteristics. Low income and wealth individuals, as well as those without a college degree, are more likely to exit quickly. Given the correlations between these characteristics and financial literacy (Lusardi and Mitchell (2011); Behrman et al. (2012)), this finding implies that lower financial literacy is associated with an increased likelihood of having a short spell. Men are 20% more likely to exhibit such behavior compared to women, supporting existing evidence that men tend to trade excessively and display overconfidence (Barber and Odean (2001)). We also find that quick exits are significantly more likely among investors who enter into directly held stocks rather than mutual funds. At the aggregate level, the prevalence of short spells in mutual funds rose during the bursting of the dot-com bubble in 2001–2002 and the financial crisis in 2008, whereas short spells in direct stockholding are more common during stock market booms. This distinction by asset class links to existing evidence on the disposition effect in individual stocks (Shefrin and Statman (1985); Odean (1998)) and performance sensitivity in mutual fund flows (Ippolito (1992); Gruber (1996); Frazzini and Lamont (2008)). We then study how the probability of exit evolves with time spent in the market. Using the methodology of Alvarez et al. (2021), we estimate the hazard function for exit from participation to be downward sloping and convex, which means that the longer one stays in the stock market, the less likely they are to withdraw completely from the market. Together with the short spells result, this finding indicates that participation status is particularly fragile in the initial years following entry.

Moving onto the reentry margin, many individuals who completely exit from the stock market subsequently return. Over 35% of exiters reenter the stock market within the following 4 years, and they typically return to the same asset class (mutual funds or direct stockholding) that they previously invested in. Most reentry occurs soon after exit, often just a year later. We find that high income and wealth individuals are more likely to reenter. We also estimate a downward-sloping and highly convex hazard function for reentry, implying negative duration dependence in reentry probabilities: The longer an individual has been away from the stock market, the less likely they are to return. After about a decade of non-participation, the likelihood of reentry is effectively zero.

retirement investment accounts in year $t+2$. See also Hurst et al. (1998) and Vissing-Jørgensen (2002).

We then consider the implications of our empirical findings for theories of stock market participation. In particular, we examine the conditions under which a workhorse life-cycle portfolio choice model à la Cocco et al. (2005) can produce short-term dynamics. In this model, agents can invest in two financial assets, one risky (stocks) and the other safe (bonds), and they receive an exogenous labor income in every period that is stochastic during working life but constant in retirement. Under the core Cocco et al. (2005) model, there is full participation at all ages and thus no entry or exit dynamics.[4]

To generate a motive for nonparticipation, we augment the baseline model with per-period participation costs, which are a popular explanation for limited participation in the stock market (Vissing-Jørgensen (2002, 2003)). These costs are paid in every period in which one holds stocks and represent the opportunity cost of time needed to monitor and rebalance one's investment portfolio every period or, alternatively, broker management fees. In principle, per-period costs could generate both exit and reentry. If they are high relative to wealth, it may be optimal to fully liquidate when faced with adverse income or return shocks. Upon building up enough wealth, those who have exited may reenter. We find that the model requires sizable per-period participation costs of approximately $1,300 per annum to generate the degree of short-term dynamics observed in the data. This value is large relative to average holdings of public equity observed in the Norwegian data and is considerably higher than typical brokerage management fees charged in reality, as well as structural estimates of such costs by Fagereng et al. (2017a), Bonaparte et al. (2021), and Catherine (2021). High costs are required because precautionary savings motives are strong under reasonable degrees of risk aversion, leading to quick wealth accumulation that makes small costs redundant. Adding entry costs that capture the time and effort spent searching for an account provider or learning fundamental investment principles makes it even harder to match the data. This is because entry costs make exiting less attractive, given that these costs need to be repaid upon reentry. Consequently, adding entry costs requires an even higher per-period cost to generate sufficient exit and reentry.

To rationalize our facts under more plausible levels of participation costs, we extend the

[4] Full participation is in line with the predictions of standard portfolio theory, which states that as long as the expected equity premium is positive, everyone should invest at least a small amount in stocks (Samuelson (1969); Merton (1969, 1971)). This occurs because an individual with preferences exhibiting second-order risk aversion (e.g., CRRA utility) is essentially risk neutral with respect to small risks. As such, zero stockholding will be suboptimal given that the average equity premium is positive.

model to allow individuals to form beliefs over the equity premium based on realized returns. This ingredient is motivated by the literature on memory and experience effects documenting how past experiences can have long-lasting effects on beliefs and actions (e.g., Greenwood and Nagel (2009); Malmendier and Nagel (2011, 2015); Afrouzi et al. (2020); Bordalo et al. (2020)).[5] In the model, agents lower their expectations of future stock returns upon receiving a poor return realization, making continued participation less attractive. We allow for a small degree of noise in belief formation to capture the impact of external signals coming from peers (Hong et al. (2004); Kaustia and Knüpfer (2012)), imperfect memory retrieval (Azeredo da Silveira et al. (2020)), or cognitive limitations when forming beliefs (Fehr and Rangel (2011)).

The model with beliefs can explain the patterns of exit observed in the Norwegian data under much lower levels of participation costs. Short spells occur after poor initial returns, leading individuals to think that the return on stocks will be lower in the future. Some people exit because their expected equity premium becomes negative. If per-period participation costs are present, people may exit even if they perceive the equity premium to be positive on average because the expected return becomes too low relative to the costs. The inclusion of beliefs can also generate a downward-sloping hazard function for exit from participation. Individuals who have continuously participated for many years are likely to have experienced good returns, which is why they have not exited yet. As a result, they would require an extremely poor return to dampen their expected returns by a sufficient margin such that they wish to withdraw from the market. In line with the model, our data indicate that investors who exit soon after entry, on average, perform worse than longer-term participants; that is, they are more likely to report losses and less likely to report taxable gains.

The model can also rationalize the fact that many individuals have multiple spells. Reentry occurs in the model for two reasons. First, as we allow for small exogenous fluctuations in beliefs over time, some nonparticipants may reenter following a positive shock to their beliefs. For those with moderate beliefs, receiving such a nudge does not take long, resulting in quick reentry. However, people who are very pessimistic remain permanently out of the stock market. Second, in the presence of per-period participation costs, some individuals

[5] See Malmendier and Wachter (2021) for an overview of the empirical and theoretical literature on how experiences and memory affect choices.

exit because their wealth is insufficient to justify paying the costs. However, upon accumulating further wealth, they may return. Our theory can also produce negative duration dependence in reentry probabilities because those who remain nonparticipants after many years following exit are likely to be individuals who performed so poorly in their past spell that their expected return on equities is too weak to warrant reentry. We provide supporting evidence for this behavior by showing that prior losses are more common among reentrants than among those who chose not to return.[6]

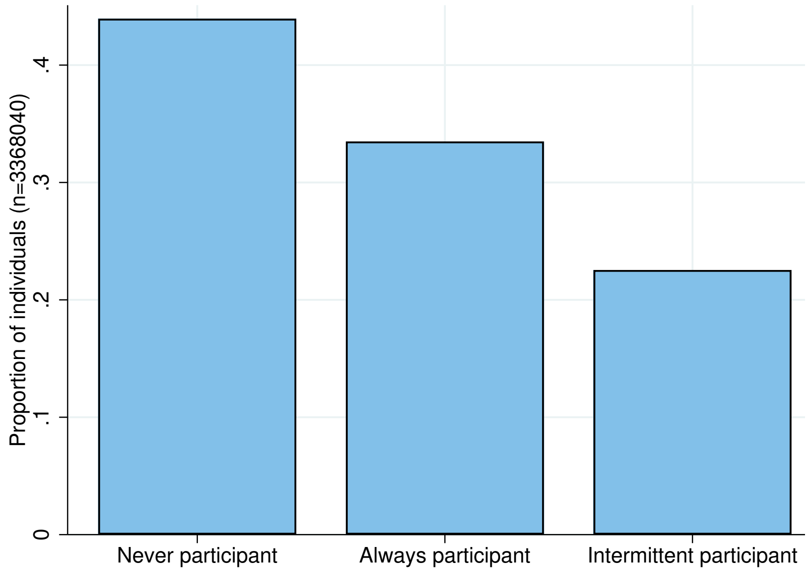
Our findings contribute to the broad literature on underparticipation in the stock market by retail investors (Mankiw and Zeldes (1991); Haliassos and Bertaut (1995); Vissing-Jørgensen (2002, 2003); Campbell (2006); Choi and Robertson (2020)). We approach this puzzle from a dynamic perspective. While the literature typically divides the population into two groups, namely those who never invest in the stock market and those who continually invest, we find that many individuals fall into a third category of being *intermittent* participants. At least 20% of the Norwegian population belongs to this group, which consists of people who either participate once for only a short period (< 5 years) or have multiple spells (Figure 2). Therefore, a snapshot of an individual's participation decision in a single year is not necessarily representative of their choices at other points. Furthermore, we are also able to shed light on existing theories of participation used to rationalize the underparticipation puzzle.[7] We show that a necessary condition for the workhorse portfolio choice model of Cocco et al. (2005) augmented with fixed participation costs to generate the patterns we observe is that per-period costs must be very high.

Our results can have important implications for wealth accumulation. A growing literature has established a link between portfolio choices and wealth inequality (Benhabib et al. (2011); Gabaix et al. (2016); Benhabib et al. (2019); Bach et al. (2020); Hubmer et al. (2021); Xavier (2021)). We find that many individuals have intermittent spells in the stock market, so they may not remain in the stock market for long enough to attain the large average eq-

[6] The lower propensity to return following a bad return in the model relates to empirical evidence in Kaustia and Knüpfer (2008) and Chiang et al. (2011), who find that personally-experienced returns on past IPOs can affect the likelihood of participating in subsequent auctions.

[7] Gomes et al. (2021) groups explanations for the underparticipation puzzle into four categories, namely participation costs (Haliassos and Bertaut (1995); Haliassos and Michaelides (2003); Vissing-Jørgensen (2002, 2003); Choi and Robertson (2020)), nonstandard preferences (Epstein and Zin (1990); Epstein and Wang (1994); Segal and Spivak (1990)), risks faced by households (Benzoni et al. (2007)), and cultural/social factors (Hong et al. (2004); Kaustia and Knüpfer (2012)).

FIGURE 2: Types of individuals



Notes. This figure divides individuals into three categories based on their lifetime stock-market exposure and plots the percentage of the population belonging to each of these three groups. "Never participant" contains individuals who never hold any stocks. "Always participant" covers people who are observed to have one single spell lasting at least 5 years, plus any individuals with right-censored or left-censored spells. "Intermittent participant" contains individuals with one single spell known to last less than 5 years and people who have multiple spells in the stock market. This figure includes only individuals observed in the data for at least 15 years.

uity premium. Although efforts have been made to boost stock market participation (e.g., through tax incentives), our findings indicate that it is not simply about encouraging entry. Perhaps individuals need to be encouraged to continue participating for a prolonged period, particularly when faced with poor short-term returns. Furthermore, we find that individuals of low wealth are more likely than wealthier individuals to exit the stock market soon after entry, which can further exacerbate the wealth gap between these two groups.

Outline: The paper is structured as follows. Section 2 describes the Norwegian data, while Section 3 documents our exit and reentry facts. Section 4 details the workhorse portfolio choice model and our augmented model with beliefs. Section 5 shows the model results, and Section 6 concludes.

2 Data

We use Norwegian administrative data to conduct our analysis. Most administrative datasets contain information on income only. However, due to the existence of a wealth tax in Norway, our data also contain detailed information on wealth holdings by broad asset class for each resident as of December 31 for each year from 1993 to 2018. The Norwegian data are particularly well suited to studying individual-level dynamics in stock market participation relative to other datasets. First, to study dynamics, we need to be able to follow individuals over time. Compared to other datasets, our data provide this panel dimension with a longer time dimension.[8] Second, a concern with brokerage accounts data is that exit from the sample does not necessarily mean an exit from the stock market. For example, if an individual simply switches providers, they would appear as an exiter in the brokerage accounts data. Reentrants could be difficult to identify if account numbers change between spells. The Norwegian data do not have this concern, as the tax data are based on overall holdings across all financial intermediaries and identification is at the individual level. Third, brokerage data can have concerns with sample selection and nonrandom attrition, the latter of which is also a worry with longitudinal survey data. The Norwegian data cover the full population, and attrition should be due to death or emigration only. Fourth, financial institutions directly report information on wealth holdings to the tax authority, which eases concerns about measurement errors.[9] As such, evading taxes in Norway by underreporting asset holdings is very challenging.[10] Last, we are able to link the tax records to other administrative datasets, which contain additional information about each individual that is not necessarily available in survey or brokerage accounts data (e.g., demographics, employment history, and house purchases). This allows us to study whether the behaviors we find are linked to certain characteristics.

While the Norwegian data are particularly promising for our research objective, they

[8]As the wealth tax in Sweden ended in 2007, the Swedish data used by Calvet et al. (2007, 2009a,b) span 9 years (1999–2007 inclusive). The brokerage data of Barber and Odean (2000, 2001) cover 1991–1996.

[9]Following this direct reporting, residents are sent a prefilled tax form to approve. If they do not respond, then the tax authority assumes that the information is correct. In 2009, around 60% of tax payers in 2009 did not respond (Fagereng et al. (2017a)).

[10]As noted by Fagereng et al. (2017a), one source of under-reporting would be if individuals hold but fail to disclose foreign investments. While asset holdings through Norwegian financial intermediaries are directly reported, this is not the case for foreign holdings. For Sweden, Calvet et al. (2007) argue that such holdings are likely to be a small portion of overall assets other than for the wealthiest individuals.

have their shortcomings. The data provide us with asset holdings as of December 31 of each year. As such, we are limited to participation decisions at the annual frequency, although it is worth noting that this is more frequent than most panel survey waves.[11] We are, therefore, unable to capture within-year spells, although the presence of within-year spells would strengthen our result that short spells in the stock market exist. In addition, we do not have information on occupational or public pension wealth. However, in Section 3.3.3, we argue that pensions are unlikely to affect our results. Third, we do not have information on the specific mutual funds held.

2.1 Data construction

We use the tax records to construct wealth by broad asset class and combine them to obtain measures of financial and real wealth.[12] Financial wealth can be decomposed into the following asset classes: (a) cash and deposits (both domestic and foreign), (b) directly held listed stocks, (c) directly held unlisted stocks (typically private equity), (d) stock mutual funds, (e) money market funds, (f) financial wealth held abroad, and (g) other financial assets.[13] Real wealth consists of housing and other real assets.[14] We are most interested in the extensive margin of participation and treat an individual to be participating in a given year if any of directly held listed stock holdings, stock mutual fund holdings, or financial wealth held abroad are strictly positive.[15] We focus on stock market participation through nonretirement investment accounts because there is typically little turnover and trading activity in retirement accounts (Brunnermeier and Nagel (2008); Bonaparte et al. (2021)). We also restrict attention to individuals aged 20 or over to ensure that the person is the main asset holder.[16]

[11] For example, wealth information in the PSID was collected from 1984 at 5-year intervals until 1999, when it began to be collected biennially.

[12] We provide further details on the construction of the wealth variables in Appendix A.

[13] Other financial assets consist of outstanding claims and receivables, shares of capital in housing cooperatives or jointly owned property, own pension insurance and life insurance, and other wealth.

[14] Other real assets include vehicles (e.g., boats, cars, caravans), holiday homes, fixtures and other business assets, contents, and other real estate (e.g., farms, plots).

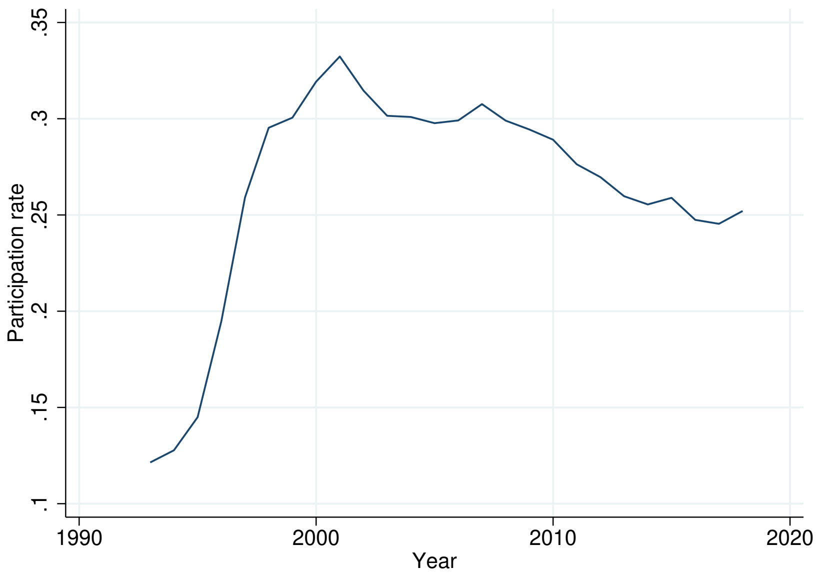
[15] We include financial wealth held abroad in this definition to be conservative because the nature of such wealth is not observed, and hence it could contain foreign stockholdings. However, few people report holding wealth abroad ($< 2\%$ of observations).

[16] Fagereng et al. (2020) also impose an upper bound on age of 75 in their study of return heterogeneity. However, we do not do so, as it can artificially generate right-censored spells.

2.2 Descriptive statistics

Figure 3 plots the stock market participation rate in Norway over time. Only 12% of the population owned stocks at the start of the sample. However, there was an acceleration in participation during the 1990s. Reasons include improved access to financial markets for retail investors, the rise of mutual funds, and the popularity of technology stocks during the dot-com bubble (Guiso et al. (2003a)).[17] After the bursting of the dot-com bubble, the participation rate dropped sharply. It stabilized until the financial crisis and has since shown a persistent decline. Figure 4 plots the entry and exit rates over time. The sharp fall in participation in the early 2000s can be linked to a pronounced rise in the exit rate and a drop in the entry rate. Since the financial crisis, entry rates have been particularly low, which can explain the downward trend in the participation rate.

FIGURE 3: Stock market participation rate over time

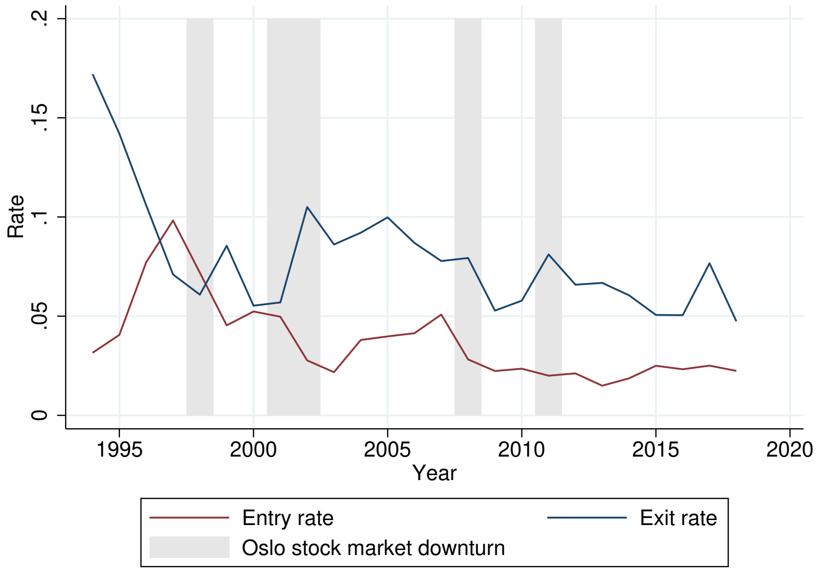


Notes. This figure plots the participation rate in the stock market annually from 1993 to 2018.

Table 1 provides summary statistics at the individual level. The first block shows that there is an even split of men and women in the sample, and 36% of individuals have a college degree. The second block provides information on income and wealth holdings. The

[17] Figure E.1 shows the participation rates separately for stock mutual funds and directly held stocks. Participation in mutual funds rose by more than fivefold from 1993 to the early 2000s. Participation in directly held stocks also rose but by a smaller margin: from just over 8% in 1993 to around 12% in 2000.

FIGURE 4: Entry and exit rates over time



Notes. This figure plots the entry and exit rates for stock market participation. The entry rate in year t is the proportion of nonparticipants in year $t-1$ who enter in year t. The exit rate in year t is the proportion of participants in year $t-1$ who leave the stock market in year t. The shaded areas are stock market downturn years in which the Oslo Børs Benchmark Index fell by at least 10%.

average individual has a total gross wealth holding of $277,000, though the large standard deviation in asset holdings illustrates the vast heterogeneity in wealth across the population. The median wealth holding is less than half of the mean holding, indicating a rightward skew in the wealth distribution. Nonfinancial wealth, of which the major component is housing, accounts for a larger share of total wealth than financial wealth does, with the average individual holding $80,000 in financial wealth compared to $196,000 in nonfinancial wealth. The mean amount of wealth held in public equity, measured as the sum of holdings in stock mutual funds, directly held stocks, and financial wealth abroad, is just over $7,000. Indeed, the median individual does not hold any public equity, a finding that is indicative of broad aggregate underparticipation in the stock market in Norway. The third block further verifies this finding by showing that 25% of individuals invested in the stock market in 2018. Most participants invest in mutual funds rather than directly holding stocks. Conditional on participating in the stock market, 26% of financial wealth is in stocks on average.

TABLE 1: Summary statistics

	Mean	Std. dev	P10	Median	P90	P99
Demographics						
Age (in years)	48.80	18.54	26	47	74	91
Male	0.52	0.50	0	1	1	1
Single	0.34	0.47	0	0	1	1
College degree	0.36	0.48	0	0	1	1
Income and wealth ($'000s)						
Gross income	40.66	48.76	0	36.81	88.66	177.71
Financial wealth	80.04	1,984.23	0.01	10.60	123.79	835.37
Financial wealth in public equity	7.05	137.09	0.00	0.00	8.42	122.72
Nonfinancial wealth	196.49	299.93	0	131.11	487.62	1,185.16
Gross wealth	276.53	2,063.84	0.03	165.27	593.29	1,791.39
Net wealth	185.92	2,025.55	-38.51	42.54	479.71	1,565.64
Participation and wealth shares						
Participates in public equity	0.25	0.43	0	0	1	1
Participates in mutual funds	0.22	0.41	0	0	1	1
Participates in individual stocks	0.06	0.24	0	0	0	1
Cond. risky share (% of total wealth)	8.32	15.64	0.10	2.26	23.23	84.00
Cond. risky share (% of fin. wealth)	26.29	26.77	1.01	16.22	70.32	97.26
Observations	4.64m					

Notes. This table provides summary statistics using data from 2018. The first block gives summary statistics for demographic characteristics. *Single* is a binary variable equal to 1 if the individual is neither married nor cohabiting, and zero otherwise. The second block information on income and wealth measured in USD (in thousands) based on an exchange rate of $1=8.64 NOK at the end of 2018. *Gross income* is income from all sources. *Public equity* is measured as the sum of holdings in stock mutual funds, directly held stocks and financial wealth abroad. The third block gives summary statistics on stock market (i.e., public equity) participation and the share of wealth invested in public equity conditional on holding a nonzero amount of such wealth.

3 Empirical facts

In this section, we study two margins of stock market participation using the Norwegian administrative data, namely exit (Section 3.1) and reentry (Section 3.2). In Section 3.3, we discuss and rule out potential explanations of our findings.

3.1 Exit margin

3.1.1 Short spells are common

We begin by examining the distribution of spell lengths in the data. Figure 5 plots a histogram with the distribution of spell lengths based on spells beginning between 1994 and 2015 inclusive.[18] We restrict attention to spells starting by 2015 to ensure that participants have at least 3 years in which to exit. If, for example, 2017 entrants were also included, they would either have a 1-year completed spell or be right censored. Thus, including such entrants would artificially inflate the bars corresponding to a short spell length. The histogram shows a declining relationship between spell length and the proportion of observations. Almost 15% of all spells end in just 1 year, and 23% end within 2 years. We undertake a variety of robustness checks, namely analysis at the household level (Figure E.2), excluding entrants who receive a gift or inheritance in the year of or before entry (Figure E.3), removing individuals with stocks in the company they work for (Figure E.4), and dropping investors who invest a small sum at the point of entry (Figure E.5). In all cases, similar patterns emerge.

The next step is understanding whether short spells can be linked to observable characteristics. To do this, we estimate the following linear probability model:

$$\Pr(\text{spell ends within 2 years}) = \alpha_i + \delta_t + \beta' X_{it} + \epsilon_{it} \tag{1}$$

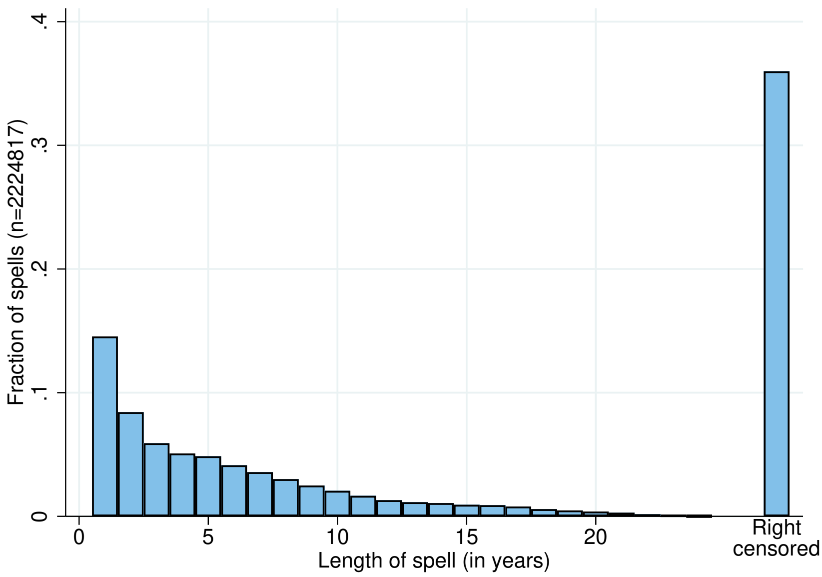
where δ_t denotes entry-year fixed effects and X_{it} is a vector of observable characteristics measured at the point of entry, such as age and wealth. Given that we observe individuals with multiple spells, we are able to include individual fixed effects α_i to absorb time-invariant characteristics.

Table 2 shows the result from this estimation in specifications with and without individual fixed effects. Men are 20% (4.7pps) more likely than women to have a short spell. This result relates to the existing literature on gender differences in confidence and trading behavior, which has found that men tend to be more overconfident and trade excessively, often to the detriment of their own returns (Barber and Odean (2001)).[19] We also see that

[18] Left-censored spells are excluded from this figure, as a spell length cannot be computed for such spells. These spells are typically those that were already ongoing at the start of our data, though other reasons for left-censoring could be immigration of an existing stockholder into Norway.

[19] Grinblatt and Keloharju (2009) study overconfidence using Finnish data and show that individuals with a

FIGURE 5: Distribution of spell lengths



Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data. We take all spells beginning at any point from 1994 to 2015. The x-axis gives the spell length (in years), and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

single individuals are more likely to have short spells, in line with the view that married individuals can influence the investment decisions of their spouse and thus reduce the effect of individual overconfidence (Barber and Odean (2001)). In addition, entrants who invest in stocks directly are 40% (9.1pps) more likely to have a short spell relative to those who invest in mutual funds. Characteristics typically associated with lower financial literacy are also linked to a higher prevalence of short spells.[20] Having a college degree lowers the likelihood of exiting within 2 years by 10% (2.3pps). Figures 6a and 6b show the impacts of income and wealth, respectively.[21] For income, we find a monotonic negative relationship between income and the probability of a short spell, with those in the bottom income decile having an 11% (2.5pps) higher probability of a short spell relative to the median. For wealth, the im-

high degree of self-confidence tend to have higher trading volumes.

[20] Lusardi and Mitchell (2011) give evidence of a positive correlation between educational attainment and financial literacy. Behrman et al. (2012) find this as well and further show a positive correlation between wealth and financial literacy.

[21] In Figure 6a, there is no 2nd decile for income because > 20% of observations have zero income, and these are all grouped in the first decile. The first decile can, therefore, be thought of as a zero-income group. This will also be the case in subsequent plots involving income.

TABLE 2: Determinants of short spells (≤2 years)

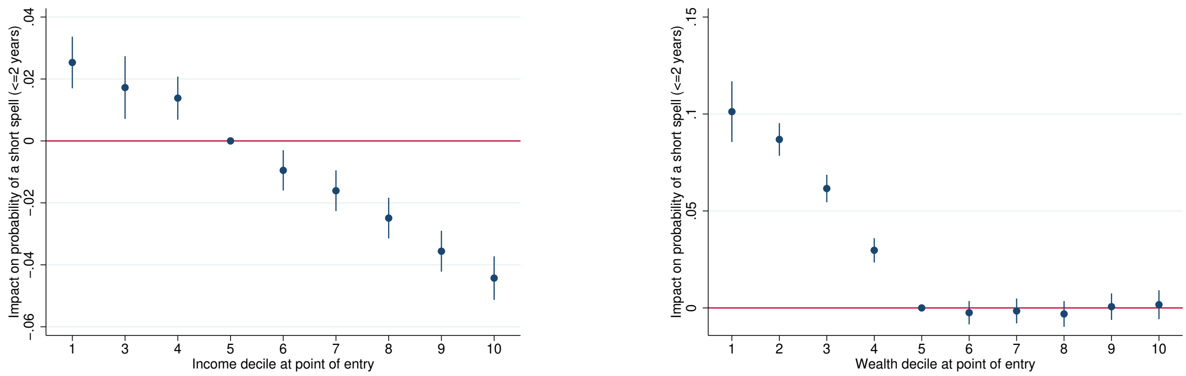
Male	0.047***	
	(0.001)	
College degree	-0.008***	-0.023***
	(0.001)	(0.004)
Homeowner	0.001	-0.009**
	(0.001)	(0.003)
Unemployed	0.017***	0.000
	(0.001)	(0.003)
Single	0.023***	0.016***
	(0.001)	(0.002)
Directly held stocks	0.083***	0.091***
	(0.001)	(0.002)
Sample mean	0.23	0.36
Individual FE	No	Yes
Entry year FE	Yes	Yes
Age group FE	Yes	Yes
Income decile FE	Yes	Yes
Wealth decile FE	Yes	Yes
Observations	2242427	866406
R-squared	0.04	0.47

Notes. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. This table shows the results from estimation of Equation 1. The first column excludes individual fixed effects, while the second column includes them. The dependent variable is a binary variable equal to 1 if the spell ends within 2 years, and zero otherwise. *Homeowner* is a binary variable equal to 1 if the participant owns their own property (either self-owned or ownership through housing cooperatives), and zero otherwise. *Single* equals 1 if the participant is neither married nor cohabiting, and zero otherwise. *Unemployed* equals 1 if the participant receives unemployment benefits at the point of entry, and zero otherwise. *Directly held stocks* equals 1 if the participant buys stocks directly at the point of entry, and zero otherwise. Entry-year fixed effects are included. Age fixed effects by broad age group (20-29, 30-39, 40-49, 50-59, 60-69 and 70+), as well as income and wealth decile fixed effects are included. Observables are measured at the point of entry. Standard errors are clustered at the individual level. The regression uses data on entrants from 1994-2016.

pact of low wealth is even more striking. Entrants belonging to the bottom wealth decile are 43% (10pps) more likely to exit within 2 years relative to the median. For wealth levels above the median, there is no significant difference in the prevalence of short spells, indicating that it is low wealth that particularly matters. Calvet et al. (2009a) show that individuals with less income, wealth, and education are more likely to exit. Our finding suggests that they are not just more likely to exit at any point. Rather, they are also more likely to experience a quick exit. Taken together, short spells are more prevalent for individuals with characteristics linked to lower financial literacy. Regarding age, we see that short spells are more likely for the youngest and oldest age groups (Figure E.6). This finding is in line with Fagereng et al. (2017a), who show that younger households tend to enter and exit frequently. It is important to note, however, that short spells are not exclusive to these subgroups. Indeed, Figure E.7 shows the distribution of spell lengths by income, wealth, education, gender, and asset class. For example, while men are more likely to exit quickly (Figure E.7d), over 20% of women still leave the stock market within 2 years of entry. Thus, short spells are widespread and not purely concentrated among a particular subpopulation, though they are *relatively* more likely for certain groups.

FIGURE 6: Impact of income and wealth on the probability of a short spell

(A) Income (B) Wealth

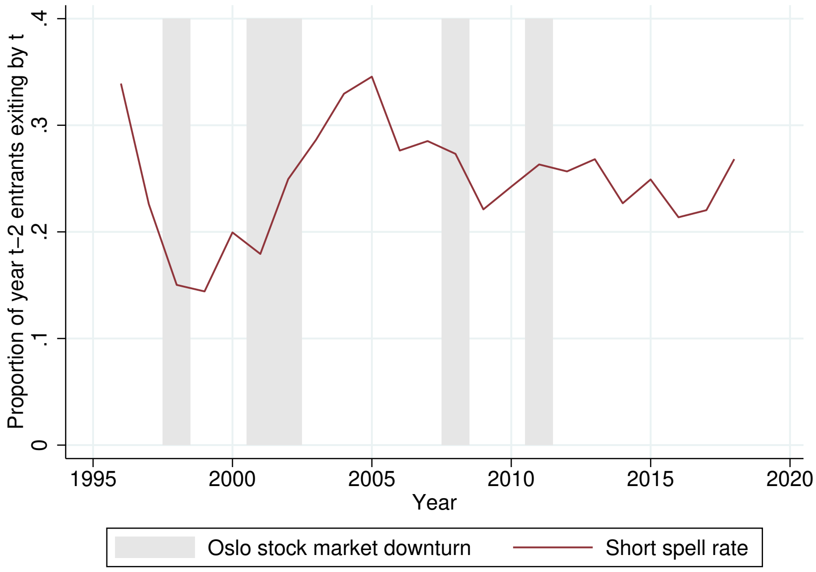


Notes. This figure plots the coefficient estimates for the fixed effects on income (A) and wealth (B) deciles following the estimation of Equation 1 with individual fixed effects. Variables are measured at the point of entry, and deciles are based on the full Norwegian population aged 20 and above in that year. The effects are estimated relative to the median group. 95% confidence intervals are shown. The red line represents a null relative effect.

Our finding that short spells in the stock market are common can have important implications for wealth accumulation. Indeed, much of the policy focus has been on encouraging entry into the stock market (e.g., via tax incentives). However, we see that temporary participation is very common, so from a policy perspective, it is not only about encouraging entry into the stock market. It is also important to encourage participants not to exit impulsively to ensure that they earn the high equity premium on average.

Figure 7 plots the prevalence of short spells over time. We see that short spells be-

FIGURE 7: Prevalence of short spells over time



Notes. This figure plots the proportion of year $t-2$ entrants who leave the stock market by year t. The shaded areas are stock market downturn years in which the Oslo Børs Benchmark Index fell by at least 10%.

came much more likely during the early 2000s, a period that coincides with the booming stock market and subsequent bursting of the dot-com bubble. Indeed, this period exhibited significant trading volumes and stock market inflows and outflows (Ofek and Richardson (2003); Hong and Stein (2007)). However, the timing of short spells differs based on the asset class. For mutual funds (Figure E.9a), this prevalence of short spells rises during stock market downturns, such as the bursting of the dot-com bubble (2001–02), the financial crisis (2008), and the European sovereign debt crisis (2011). Instead, for direct stockholding (Figure E.9b), short spells were most prevalent in the late 1990s and the mid-2000s, periods when the stock market was booming. This distinction relates to findings in Calvet et al. (2009a) that households are more likely to exit direct stockholding when their individual stocks have performed well in line with the disposition effect.[22] However, households are more likely to exit from mutual funds following poor returns.[23] Therefore, short spells in

[22]The disposition effect refers to the tendency of investors to sell stocks trading at a gain and to hold stocks trading at a loss (Shefrin and Statman (1985); Odean (1998)).

[23]The literature has found a strong positive correlation between mutual fund flows and past performance (Ippolito (1992); Gruber (1996); Frazzini and Lamont (2008)).

mutual funds are more likely during stock market downturns, whereas they are more prevalent during booms for direct stockholding.[24]

3.1.2 Exit probability falls with spell duration

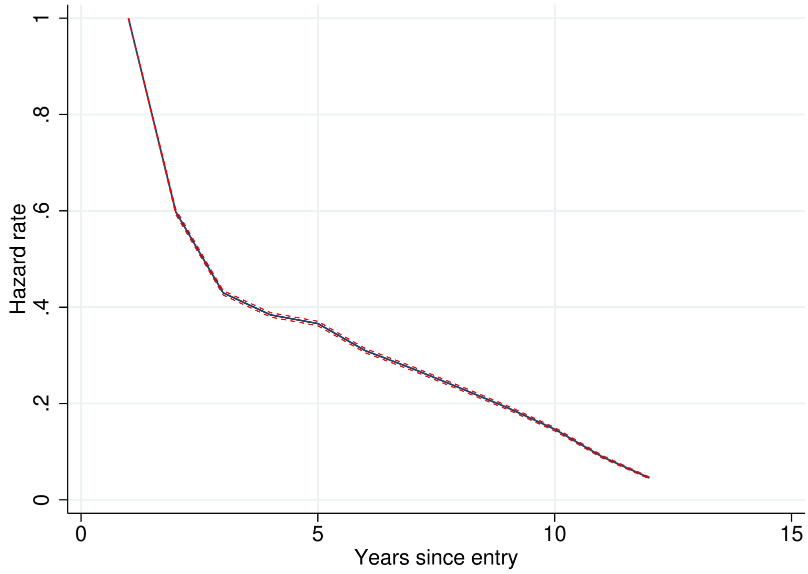
Are investors more likely to exit the stock market in the initial periods following entry or after staying in the market for a prolonged period? To answer this question, we estimate the hazard function for exit from participation. The hazard function $h(d)$ denotes the probability of exiting the market d years after entry, conditional on not exiting until then. A standard challenge with hazard function estimation is separating true duration dependence from (unobserved) heterogeneity. Estimating hazard functions based on pooled samples with heterogeneous individuals can lead to a downward bias in the slope of the hazard function because individuals who are less likely to "survive" exit the sample earlier than others (Lancaster (1979); Kiefer (1988)).

To address this concern, we apply the linear GMM estimator of Alvarez et al. (2021) and estimate a discrete-time proportional hazard model of duration. The main advantage of this approach is that it gives a consistent estimator of the slope of the hazard function, even in the presence of time-invariant individual heterogeneity. The Alvarez et al. (2021) methodology can do so by exploiting the presence of individuals with multiple spells in the stock market. However, the resulting limitation is that the set of people experiencing multiple spells used in the estimation can be fundamentally different from the rest of the population. Further details on the approach are provided in Section C.

Figure 8 plots the estimated baseline hazard function. The hazard function is monotonically declining in duration, indicating negative duration dependence; that is, the longer one has been participating in the stock market, the less likely they are to exit completely at that point in time. As described in Section C, we are able to recover the slope of the baseline hazard rather than its level using the Alvarez et al. (2021) approach, so we normalize the hazard rate at $d = 1$ to 1. A striking feature of the hazard function is the steepness of the slope in the initial years following entry. The hazard rates at $d = 2$ and $d = 3$ are 60% and 40% that of $d = 1$, respectively. By $d = 12$, the hazard rate is close to zero, suggesting that if an in-

[24] Figure E.10 plots the exit rates for the two asset classes separately and shows similar time-series patterns to the prevalence of short spells.

FIGURE 8: Baseline hazard function for exit from participation



Notes. This figure plots the estimated baseline hazard for exit from participation following the methodology of Alvarez et al. (2021) described in Section C. The dotted red lines denote 95% confidence intervals. The hazard rate at duration $d = 1$ is normalized to 1.

dividual remains in the market for a prolonged period, the likelihood of them completely withdrawing from the market is minimal. Combined with the fact that many stock market participants stay in the stock market for a short time, this finding indicates strong dynamics in the initial years following entry.

3.2 Reentry margin

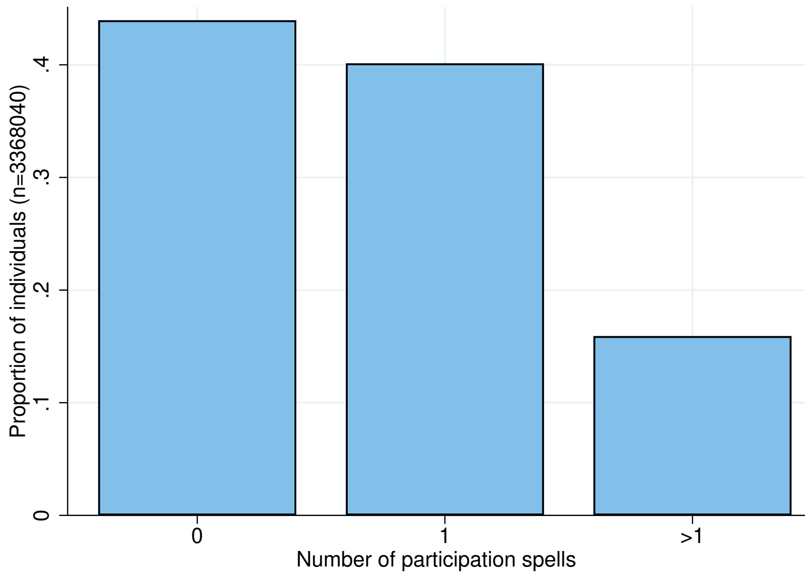
3.2.1 Many exiters reenter the stock market

We now turn to understanding whether exiters ever reenter following exit. Figure 9 plots the distribution of the number of spells an individual experiences.[25] 43% of the population never participates in stocks, while 40% are observed to participate just once, meaning that around 17% of the entire population has multiple spells. Hence, reentry does occur for a sizeable fraction of people. Indeed, this finding negates the conventional view in the literature that upon entering the stock market, individuals should rarely leave. Here, we see that

[25] We restrict attention to individuals who appear in the data for at least 15 years, as those who appear for fewer years are likely to have either zero or one spell, which would skew the distribution to the left.

a large share of people liquidate their stock holdings completely but subsequently reenter. We also find that investors tend to return to the same asset class in which they previously participated. Figure E.11 shows that over 80% of reentrants who previously participated in funds choose to return to funds. Of those reentrants who previously invested in individual stocks, over 60% go back into direct stockholding. This result suggests that investors tend to divide themselves into types, namely fund investors and direct stockholders, with very few participating in both.

FIGURE 9: Number of spells



Notes. This figure plots the distribution of the number of spells using individuals who appear in the data for at least 15 years.

We now examine which characteristics are associated with reentry. For this purpose, we run the following linear probability model:

$$\text{Pr(reenter within 4 years)} = \alpha_i + \delta_t + \beta' X_{it} + \epsilon_{it} \tag{2}$$

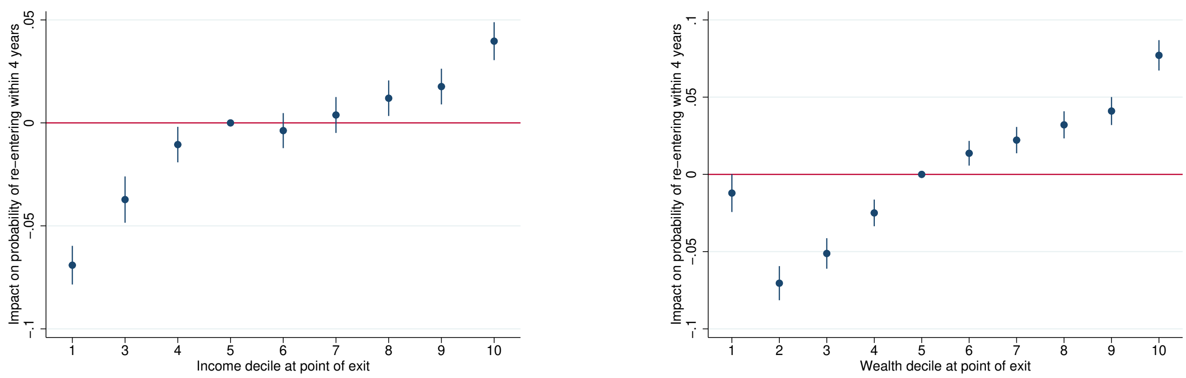
where δ_t now denotes exit-year fixed effects. We use a fixed window of 4 years to reenter because those who exit early in the sample have more years remaining in which to reenter. A fixed window means all exiters have the same amount of time to reenter. Furthermore, to preview the findings in Section 3.2.2, most reentry occurs soon after exit, and so a 4-

year window should capture a large proportion of reentry. To ensure that all individuals are observed for at least 4 years following exit, we restrict attention to those who left the stock market by 2014.[26]

Figure 10 plots the estimated effects of income and wealth and shows that reentry is more likely for individuals with higher income and wealth. The top income decile is 11% (4pps) more likely to reenter relative to the median (Figure 10a), and the highest wealth decile group is about 23% (8pps) more likely to reenter relative to the median (Figure 10b). Indeed, Calvet et al. (2009a) show that entry is more likely for individuals with high income and wealth.[27] Reentry is less likely for the youngest and oldest age groups (Figure E.8), in line with the finding in Fagereng et al. (2017a) that permanent exit rises sharply after retirement. The estimated coefficients for the other variables are provided in Table E.1.

FIGURE 10: Impact of income and wealth on the probability of reentry

(A) Income (B) Wealth



Notes. This figure plots the coefficient estimates for the fixed effects on income (A) and wealth (B) deciles following the estimation of Equation 2 with individual fixed effects. Variables are measured at the point of exit, and deciles are based on the full Norwegian population aged 20 and above in that year. The effects are estimated relative to the median group. 95% confidence intervals are shown. The red line represents a null relative effect.

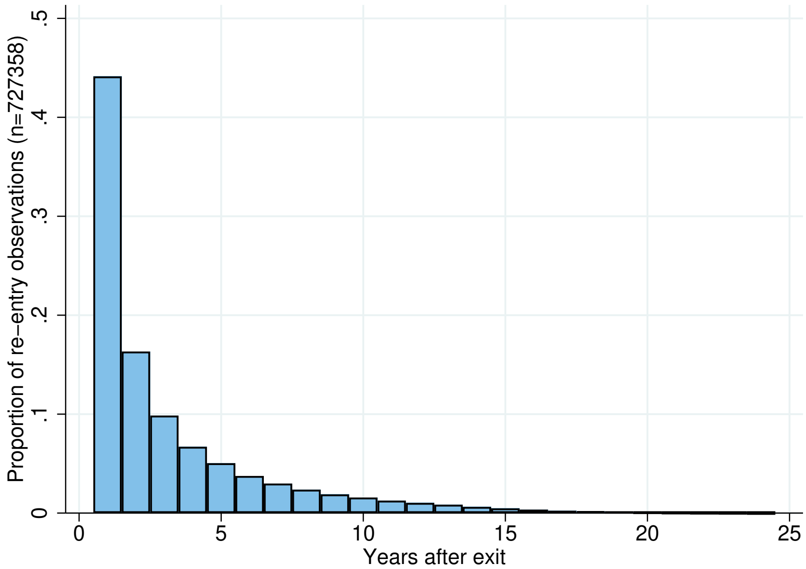
[26] Figure E.12 plots a time series of the reentry rate. It is highest at the start of our sample but remains fairly steady from around 1998 onward, though there are drops during the stock market crashes in 2001–02 and 2008.

[27] They also find a positive effect of education. We find a similar positive effect of a college education in the specification without individual fixed effects, but the coefficient becomes insignificant after including them.

3.2.2 Reentry often occurs soon after exit

Conditional on occurring, how soon after exit do individuals reenter? Figure 11 plots the distribution of reentry times observed in the data. Almost half of all reentry occurs just 1 year after exit, indicating that reentry tends to be quick. Combined with the evidence for short spells given in Section 3.1.1, this implies that there is a high degree of turnover between participation and nonparticipation states, with many individuals dropping out of participation spells after only a few years and a nonnegligible number reentering soon after exit. These findings are robust to excluding recipients of gifts or inheritances (Figure E.13) and individuals holding stocks in the company they work for when they reenter (Figure E.14).

FIGURE 11: Distribution of reentry times

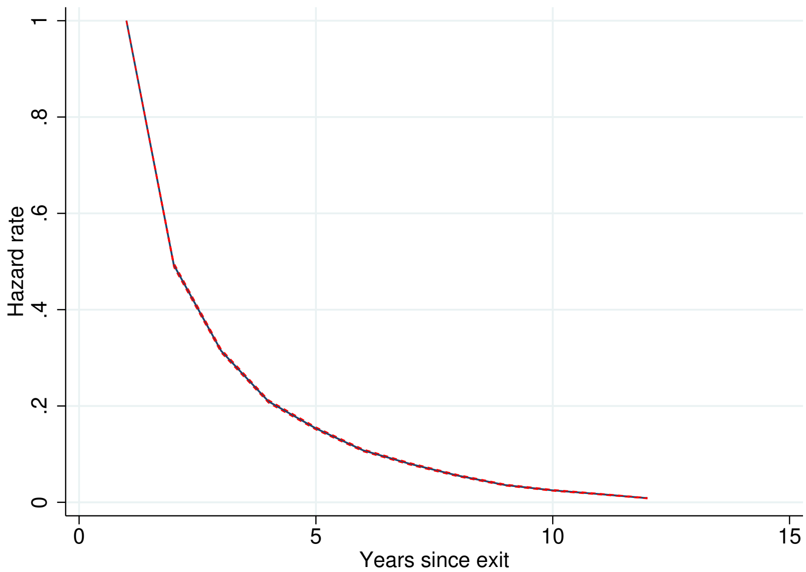


Notes. This histogram shows the distribution of reentry times in the Norwegian data.

3.2.3 Probability of reentry falls with time since exit

Our final fact studies how the likelihood of reentry changes with the duration since exit. Our object of interest is the hazard function $h(d)$, which denotes the probability of reentering d years after exit conditional on not having reentered until then. We exploit the fact that some individuals have multiple spells out of the stock market and again apply the GMM estimator of Alvarez et al. (2021). Figure 12 plots the estimated hazard function for reentry. The hazard function is downward sloping and highly convex, indicating negative duration dependence in reentry following exit: The longer it has been since one has been out of the stock market, the less likely they are to return. There is a sharp decline in the hazard rate in the initial years following exit, with the hazard rate at $d = 2$ being less than half that of $d = 1$. By $d = 12$, the hazard rate is very low, indicating that the likelihood of reentering is virtually zero by about a decade after exit.

FIGURE 12: Baseline hazard function for reentry



Notes. This figure plots the estimated baseline hazard for reentry following exit using the methodology of Alvarez et al. (2021) described in Section C. The dotted red lines denote 95% confidence intervals. The hazard rate at duration $d = 1$ is normalized to 1.

3.3 Ruling out potential explanations

In this section, we assess whether the quick exit and reentry patterns that we observe could be explained by certain factors, namely liquidity shocks, sophisticated market timing, pensions, or tax optimization.

3.3.1 Liquidity shocks

In principle, individuals might have to leave the stock market due to liquidity needs. For example, people may lose their job or face unexpected health expenses. Upon the "completion" of such liquidity needs, individuals may subsequently reenter the market. In general, one might expect a constant Poisson arrival of such shocks. However, a constant arrival rate would imply a flat hazard of exit from participation, which contradicts the downward-sloping hazard estimated in Figure 8. One might even expect liquidity needs to generate an upward-sloping hazard, as people would likely not enter the stock market in the year before any expected liquidity needs (e.g., house purchase) given the risk of a stock market downturn. To directly verify that liquidity needs are unlikely to drive our results, we undertake two checks. First, we identify observable liquidity needs in the data and study whether their prevalence varies with spell length. In particular, we look at house purchases, divorce, unemployment, and a large drop in income (> 50%) as our liquidity shocks.[28] Figure E.16 plots the proportion of exiters of different spell lengths experiencing at least one of these shocks in their exit year. For comparison, we also show the proportion of continuing participants experiencing a liquidity shock. We can see that some exit is correlated with such needs: about 10% of nonexiters experience a liquidity shock compared to around 15% for exiters. This is in line with papers linking exit to house purchases (Brandsaas (2021)), marital status (Christiansen et al. (2015)), and unemployment (Basten et al. (2016)). However, the prevalence of liquidity shocks is very similar across spell lengths, suggesting that short spellers do not have a higher likelihood of facing a liquidity shock compared to longer spellers. Furthermore, if 15% of exiters leave because of one of these observed shocks, it means that 85% of exiters are leaving for other reasons.

Second, we examine what happens to safe financial asset holdings. If individuals face liquidity needs, presumably they would withdraw from their safe liquid asset holdings first. Figure E.17 shows the proportion of exiters of different spell lengths withdrawing from their safe financial asset holdings. We do not find short spellers to be any more likely to be drawing down their safe asset holdings. All together, it appears that liquidity shocks are unlikely to explain the prevalence of short and multiple spells in the stock market.

[28]Two other liquidity needs could be health shocks and education costs. However, higher education is free in Norway. While healthcare is not free, there is an annual deductible above which healthcare is free. This deductible is fairly small at NOK 2,460 in 2021 ($410 in 2011 USD). Across OECD countries, Norway has the highest share of healthcare financed through government schemes and the largest per-capita spending on healthcare relating to long-term care (Cooper (2019)). As such, Norwegians in general do not seem to be susceptible to large financial costs linked to healthcare needs.

3.3.2 Sophisticated market timing

Could the short-lived entry and exit observed in the data be driven by sophisticated market timers? Perhaps these individuals pursue short-term investment strategies and reenter whenever a promising investment opportunity arises. If this were the case, we would expect short spelling to be correlated with proxies for financial sophistication. However, Table 2 and Figure 6 show that short spelling is negatively correlated with characteristics typically associated with higher financial literacy (college education, income and wealth). Furthermore, we might expect higher returns for more sophisticated investors. However, in Section 5.4, we show that those who invest for only 1–2 years perform worse than longer spellers.

3.3.3 Pensions

One may worry that the existence of pension wealth could affect individuals' desire to actively invest in the stock market out of their nonpension wealth. In principle, a rational agent should consider their overall portfolio, comprising both pension and nonpension wealth, when deciding upon their optimal portfolio allocation. If, for example, one's pension wealth is already invested in the stock market, they may invest less (or nothing at all) out of nonretirement wealth. Therefore, nonparticipation out of nonpension wealth could simply be a rational choice given existing exposure through pensions.

If pensions are to be able to explain the dynamics, the following would need to be the case: 1) the desired risky asset share out of *total* wealth changes, and individuals adjust their nonpension holdings to achieve this new goal, and/or 2) exposure to the stock market coming from pension wealth is changing at a high frequency, and individuals identify these changes and adjust their portfolio accordingly. Explaining frequent exit and (re)entry through this rebalancing channel is arguably difficult, as it requires individuals to regularly follow movements in their pension holdings and to actively rebalance accordingly. However, various papers have shown that portfolio adjustments are sluggish in both retirement and nonretirement accounts (Agnew et al. (2003); Ameriks and Zeldes (2004); Brunnermeier and Nagel (2008); Calvet et al. (2009a); Karlsson et al. (2009)). In Section B, we provide a discussion of the Norwegian pension system and argue that the nature of the system is such that pensions are unlikely to explain the behaviors we observe.

3.3.4 Tax optimization

Could the quick exit and reentry from the stock market be due to tax optimization? Perhaps individuals choose to exit in order to reduce their tax liability in a given year. There are two possible tax margins that could be relevant here. The first is the wealth tax, whereby individuals are taxed on net wealth above a given threshold.[29] However, the majority of Norwegians do not reach the threshold. This is partly due to favorable tax treatments on certain asset classes. For example, the tax value on housing is 25% of its market value. Stocks and mutual fund holdings are given a valuation discount of 45% (in 2021), whereas cash and deposit account holdings are not given a discount. It is therefore actually better for wealth tax purposes to retain wealth in stocks and funds rather than liquidating and holding cash. Consequently, it is very unlikely that wealth tax considerations can explain entry and exit decisions for most Norwegian households. The second relevant tax is capital gains tax. In Norway, losses made from the sale of stocks and equity funds are tax deductible, while gains above a risk-free return are taxed. One might be worried that the quick exit we observe is because individuals are liquidating their loss-making shares to reduce their tax liabilities.[30] However, capital gains taxation in Norway is tied to the realization for each individual security, not the performance of the overall portfolio. To explain the complete exit that we observe, we would need to see every security in one's portfolio making a loss. In addition, if tax incentives are driving this behavior, we might expect to see reentrants purchasing the same stock when they return. While we do not observe specific mutual fund holdings, the Shareholder Registry provides information on direct stock ownership from 2004. We find that only 28% of directly held stocks owned just before exit are then repurchased upon reentry, meaning most reentrants are purchasing different securities. Therefore, we argue that tax-motivated selling is unlikely to drive our results.

[29] In 2021, net wealth above 1.5m NOK (≈$250,000 in 2011 USD) was taxed at 0.85% (0.7% to the municipality and 0.15% to the state). The threshold is doubled for couples.

[30] Using US data, Odean (1998) shows that the prevalence of selling losing stocks is highest in December, which can be linked to the end of the tax year and attempts to reduce tax liability.

4 Model

Our empirical results established novel patterns in the individual-level dynamics of stock market participation. This section first describes the workhorse portfolio choice model of Cocco et al. (2005) with participation costs. We then modify the model to allow agents to form beliefs over the equity premium based on realized returns, a feature motivated by a large body of literature on experience effects and memory (e.g., Kaustia and Knüpfer (2008); Chiang et al. (2011); Malmendier and Nagel (2011); Bordalo et al. (2020); Anagol et al. (2021)). While our model embeds the participation cost story of nonparticipation, we discuss alternative theories of participation in Appendix D, namely nonstandard preferences, risks faced by households, and cultural/social factors.

4.1 Model setup

4.1.1 Preferences

Individuals are born at age t_b and die for certain by age T. They have Epstein-Zin preferences over consumption C_{it}:

$$U_{it} = \left[(1-\beta)C_{it}^{1-\frac{1}{\psi}} + \beta E_t(\pi_t U_{i,t+1}^{1-\gamma})^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\right]^{\frac{1}{1-\frac{1}{\psi}}}$$

where ψ is the elasticity of intertemporal substitution, β is the subjective discount factor, and γ is the coefficient of relative risk aversion. π_t is the conditional survival probability (i.e., the probability of surviving to age $t+1$ conditional on being alive at age t). The use of Epstein-Zin preferences allows for the separation of ψ and γ, which is not possible under CRRA preferences.[31]

4.1.2 Labor market

Life is split into working age ($t \leq t_r$) and retirement ($t > t_r$), where t_r denotes retirement age. In each period, individuals receive an exogenous income Y_{it}. During working age, labor income is stochastic and depends on a deterministic function of age $f(t)$ that is calibrated

[31]The elasticity of intertemporal substitution equals the inverse of the coefficient of relative risk aversion under CRRA utility, a restriction that does not hold in the data.

to capture the hump-shaped nature of earnings during working life, as well as a transitory component u_{it} and a persistent component p_{it} modeled as a random walk.

$$\ln(Y_{it}) = f(t) + p_{it} + u_{it} \quad \text{for } t \in \{t_b, ..., t_r\},\ u_{it} \sim N(0, \sigma_u^2)$$

$$p_{it} = p_{i,t-1} + z_{it}\ ,\ z_{it} \sim N(0, \sigma_z^2)$$

We define the current level of permanent income Y_{it}^p as:

$$Y_{it}^p \equiv \exp(p_t)\exp(f(t))$$

During each year of retirement, agents receive a fraction ϕ_{ret} of their permanent income in the last year of working life. This means that upon reaching retirement age, they face no uncertainty over their future labor income.

$$\ln(Y_{it}) = \ln(\phi_{ret}) + \ln(Y_{it_r}^p) = \ln(\phi_{ret}) + f(t_r) + p_{it_r} \quad \text{for} t \in \{t_r + 1, ..., T\}$$

4.1.3 Financial markets and participation costs

Individuals can invest in a riskless bond with a safe net return R_f or a risky asset (stocks) with a stochastic return R_{it} given by the following:

$$1 + R_{it} = 1 + R_f + \bar{R} + \epsilon_{it} \quad \text{where } \epsilon \sim N(0, \sigma_\epsilon^2)$$

where $\bar{R}$ denotes the average equity risk premium. We do not allow agents to borrow or short sell in the model. We augment the Cocco et al. (2005) model by adding two types of stock market participation costs: an entry cost (F_{it}^0), which has to be paid at the start of any new participation spell, and a per-period cost (F_{it}^1) paid in any period where the agent chooses a positive quantity of stocks. The entry cost can reflect time and money spent figuring out how to set up an investment account, deciding on the initial portfolio, and learning fundamental investment principles. Per-period costs capture the time spent monitoring one's portfolio and deciding whether to reallocate funds, as well as any fixed account management fees (Vissing-Jørgensen (2002)). We follow Gomes and Michaelides (2005) and assume that both costs are proportional to the level of permanent income ($F^d_{it} = \bar{F}^d Y^p_{it}$ for $d \in \{0,1\}$). We make this assumption for computational tractability. In particular, we can exploit the scale invariance of the problem and normalize the current level of permanent income Y^p_{it} to 1. However, it can be motivated by the view that participation costs reflect the opportunity cost of time.

To capture experience effects, we assume that individuals use their realized returns to update beliefs over the average equity premium $\bar{R}$. For simplicity, we assume that individuals are uncertain over whether the average premium equals its true historical value $\bar{R}_h > 0$ or a negative value $\bar{R}_l < 0$. In each period, individuals adjust their belief b_{it} that $\bar{R} = \bar{R}_h$ using Bayes rule:

$$b_{i,t+1} = \begin{cases} \frac{b_{it} f(R_{it}|\bar{R}_h)}{b_{it} f(R_{it}|\bar{R}_h) + (1-b_{it}) f(R_{it}|\bar{R}_l)} + \nu_{it} & \text{if individual } i \text{ participates at age } t \\ b_{it} + \nu_{it} & \text{otherwise} \end{cases} \tag{3}$$

where $\nu_{it} \sim N(0, \sigma^2_\nu)$. $f(R_{it}|\bar{R}_h)$ is the probability density function evaluated at R_{it} under $\bar{R} = \bar{R}_h$, and similarly for $f(R_{it}|\bar{R}_l)$. Individuals are endowed with an initial belief b_{it_b} at birth.

Under this setup, when individuals experience a poor return, b_{it} is updated downwards, which means a lower expected return from participating in equities $E(R_{i,t+1})$. Our formulation aims to capture in a simple way the impact of past personal return experiences on subsequent investment behavior that has been documented in other studies. For example, Malmendier and Nagel (2011) show that a 1pp rise in experienced returns is associated with a 0.5–0.6pp rise in expected returns for the following year, which suggests that realized returns can determine participation choices through a beliefs channel. We include some noise ν_{it} in the belief formation process.[32] This means that beliefs are not completely sticky when not participating. This noise can capture various facets of behavior in a reduced-form way, such as private signals coming from external sources (e.g., from peers), limitations to retrieving memories perfectly (Azeredo da Silveira et al. (2020)) or neural randomness when making choices (Fehr and Rangel (2011)).[33] We assume that individuals do not internalize the

[32] To ensure that all beliefs remain within the unit interval, we truncate values to this range. When simulating the model, the standard deviation of this noise will be small, meaning minimal movement out of this interval.

[33] Noise in beliefs can relate to the wavering mechanism in Barberis et al. (2018).

possibility of a future belief shock $\nu_{i,t+1}$ when making their optimal decision today. Shocks to beliefs are therefore completely unexpected, zero-probability events from the perspective of individuals in the model. In Section 5.3.1, we discuss how the results change under different degrees of noise including no noise at all. An implicit assumption made here is that labor income is uninformative about returns and hence it does not feature in Equation 3. Empirical studies have typically found the correlation between labor income and stock returns to be very close to zero (Cocco et al. (2005); Fagereng et al. (2017a)), and therefore, for simplicity we assume zero correlation in the model.[34]

4.1.4 Optimization problem

Individuals choose consumption C_{it} and the risky asset share α_{it} (i.e., the share of savings allocated to the risky financial asset). The state variables are age t, cash on hand X_{it} (i.e., total resources available for consumption and saving), beliefs b_{it}, and whether one participated last year $\mathbb{1}(\alpha_{it-1} > 0)$. The latter determines whether one has to pay the entry cost. Using a recursive formulation, the optimization problem can be written as follows:

$$V_t\big(X, b, \mathbb{1}(\alpha_{-1} > 0)\big) = \max_{C \geq 0, \alpha \in [0,1]} \left[(1-\beta) C^{1-\frac{1}{\psi}} + \beta E_t \Big(\pi_t V_{t+1}^{1-\gamma}\big(X', \tilde{b}', \mathbb{1}(\alpha > 0)\big) \Big)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right]^{\frac{1}{1-\frac{1}{\psi}}}$$

where

$$X' = \tilde{R}' \Big(X - C - F^0 \mathbb{1}(\alpha_{-1} = 0 \,\&\, \alpha > 0) - F^1 \mathbb{1}(\alpha > 0) \Big) + Y'$$

$$\tilde{R}' = 1 + R_f + \alpha (R' - R_f)$$

$$\tilde{b}' = \begin{cases} \frac{b \cdot f(R|\bar{R}_h)}{b \cdot f(R|\bar{R}_h) + (1-b) \cdot f(R|\bar{R}_l)} & \text{if } \alpha > 0 \\ b & \text{otherwise} \end{cases}$$

4.2 Calibration

Table 3 shows the externally calibrated parameter values used in our model simulations. Individuals are born at age $t_b = 25$ and die after age $T = 100$. For preferences, we use the

[34] A different view of our setup is that it can reflect individuals having imperfect knowledge of the true returns distribution and learning about its parameters (Collin-Dufresne et al. (2016); Collard et al. (2018)), or alternatively individuals learning about their own inherent ability in the stock market (Gervais and Odean (2001); Seru et al. (2010); Linnainmaa (2011); Anagol et al. (2021)).

median values for the coefficient of relative risk aversion ($\gamma = 5.3$) and the elasticity of intertemporal subsitution ($\psi = 0.42$) reported in Calvet et al. (2021), who estimate the cross-sectional distribution of preferences for Swedish households. We take $\beta = 0.96$ as is standard in the literature.[35] Parameter values for the income process are taken from Fagereng et al. (2017a), who estimate the process specifically for Norway. We set the high value of the average equity premium $\bar{R}_h$ equal to the historical average equity premium of 3.14% for Norway, as documented in Fagereng et al. (2017a). We assume that initial financial wealth at age t_b is drawn from a Pareto distribution, for which we take estimates of the shape and scale parameters from Fagereng et al. (2017a), who fit a Pareto distribution to the age-25 financial wealth distribution in Norway.

In the baseline simulations with beliefs, we set $\bar{F}^0 = \bar{F}^1 = 0.5\%$ ($\approx$ \$230 on average). These values are in line with the dollar per-period cost of \$250 estimated in Catherine (2021) and the portfolio adjustment cost of \$222 estimated in Choukhmane and de Silva (2022). We set the low equity premium at $\bar{R}_l = -2\%$ and allow for a small amount of noise in belief formation $\sigma_\nu = 1\%$. We provide a discussion of results under alternative parameter values in Section 5.3.

5 Results

In this section, we show the results from a model simulation of 20,000 individuals. We first consider the workhorse model with costs and quantify the size of participation costs needed to obtain reasonable short-term dynamics. Upon finding that such a model requires sizable per-period costs, we discuss how the inclusion of beliefs can produce dynamics without the need for high costs. We then test the predictions of the model using the Norwegian data.

5.1 A model without beliefs

Under what conditions on participation costs can the standard model with only per-period costs and no belief heterogeneity (i.e., $b_{it} = 1 \; \forall i, t$) generate short-term dynamics?[36] Figure 13 plots the simulated participation rates over the life cycle for different levels of per-period

[35] This value is effectively equivalent to the median found in Calvet et al. (2021).

[36] In setting $b_{it} = 1 \; \forall i, t$, this also means we switch off noise in beliefs ($\sigma_\nu = 0$).

TABLE 3: Calibrated parameters

Parameter	Description	Value	Source
Preferences			
γ	Relative risk aversion	5.3	Calvet et al. (2021)
ψ	EIS	0.42	Calvet et al. (2021)
Institutional			
t_r	Retirement age	67	Norwegian law
π_t	Cond'l survival probabilities	-	SSB Life Tables 2010
Labor market			
$f(t)$	Deterministic wage profile	-	Fagereng et al. (2017a)
ϕ_{ret}	Replacement ratio	0.842	Fagereng et al. (2017a)
σ_z	Std. dev of permanent shock	0.110	Fagereng et al. (2017a)
σ_u	Std. dev of temporary shock	0.152	Fagereng et al. (2017a)
Financial market			
R_f	Risk-free return	0.0143	Klovland (2004)
$\bar{R}_h$	Average premium (high)	0.0314	Fagereng et al. (2017a)
σ_ϵ	Std. dev of stock return	0.238	Fagereng et al. (2017a)
μ_{x_0}	Shape of Pareto distribution	0.452	Fagereng et al. (2017a)
σ_{x_0}	Scale of Pareto distribution	5,711.7	Fagereng et al. (2017a)

Notes. This table shows the externally-calibrated parameter values used in our model simulations.

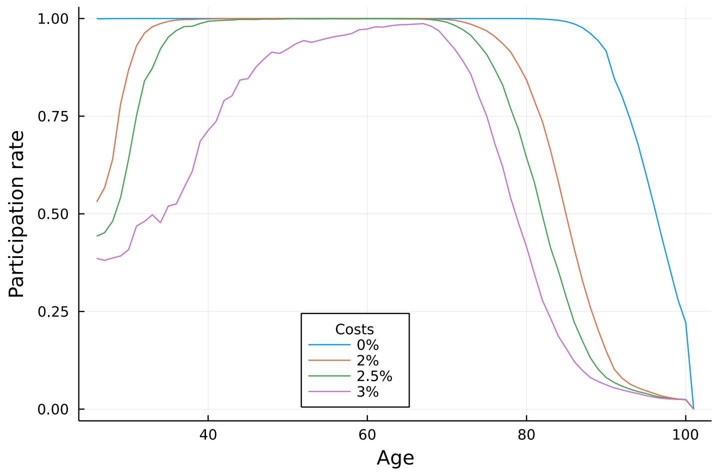
participation costs. In the absence of costs, individuals would invest at least a small amount in the stock market in every period in accordance with the standard Merton (1969) rule. This is because when preferences exhibit second-order risk aversion (as is the case here with Epstein-Zin preferences), risk has no first-order effect. Individuals are risk-neutral with respect to small risks, and given the positive average equity premium, zero stockholding would not be optimal (Haliassos and Bertaut (1995)). During retirement, individuals decumulate the wealth they have built up during working life to fund consumption. From around age 90, some individuals will leave the stock market because their wealth is sufficiently low to the point that they prefer to consume all of their current wealth and save nothing in either financial asset.[37]

Adding a per-period cost can delay initial entry until individuals have accumulated sufficient wealth to justify these costs. Under costs of 2% of permanent income (approximately $900 on average), we see that the model reaches full participation quickly. The intuition for this is discussed in Gomes and Michaelides (2005) and is linked to the degree of risk aver-

[37] Individuals receive a certain pension income during retirement, and so not saving does not mean zero consumption in the following year.

sion. A high γ generates two opposing forces: on one hand, higher risk aversion means a greater aversion to risk-taking, which directly reduces one's demand for stocks. On the other hand, it means the degree of prudence is also high, leading to strong precautionary savings motives and more wealth accumulation. As wealth increases, it will eventually be worthwhile to pay the participation costs and invest in stocks. Under $\gamma = 5.3$, this latter force dominates, which explains why the model produces full participation even with participation costs. As participation costs increase further, participation rates do not necessarily hit 100% and some nonparticipation is observed at most ages.[38]

FIGURE 13: Model without beliefs: simulated participation rates



Notes. This figure plots the simulated participation rate over age in the model without beliefs ($b_{it} = 1\ \forall i, t$) for different levels of per-period participation costs. Entry costs are set to zero.

Is there much churn in participation in these models? Figure 14 plots the proportion of simulated spells ending within 2 years under different levels of per-period costs. To reach the prevalence of short spells observed in the data, the model requires high per-period participation costs of 2.8% of permanent income, which approximately amounts to $1,300 per annum on average. If participants are hit by an adverse shock to their income or experience a bad return, their investable wealth may be sufficiently low to no longer warrant paying the

[38] Figure E.21 plots the average conditional risky share over the life cycle under different values of per-period costs. This share broadly falls over working age. The intuition for this follows from Jagannathan and Kocherlakota (1996), Cocco et al. (2005) and Gomes (2020). Labor income can be thought of as an implicit holding of the riskless bond given that labor income is a closer substitute to bonds than stocks (Heaton and Lucas (1997)). Over working age, income-to-financial wealth ratios decline as individuals build more wealth, leading individuals to tilt their portfolios away from stocks.

participation cost. However, this value is much higher than estimates of per-period costs in the literature (e.g., Fagereng et al. (2017a); Bonaparte et al. (2021); Catherine (2021)), and is also a large share of the median amount held in the stock market by Norwegian investors in a given year, which is $4,600. High costs are required because the savings motive in this model is so strong that small costs become redundant for the participation decision.

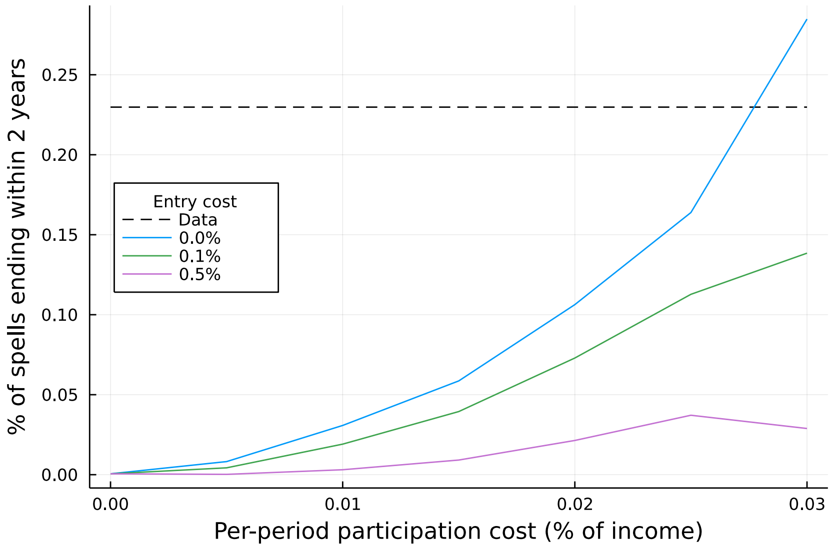
Adding even small entry costs does not help to reduce the required size of per-period costs in the model. Instead, they slow down dynamics and mean the model requires an even larger per-period cost. The intuition for this is that entry costs must be paid at the start of any new spell. Individuals recognize that exiting the market today will mean having to repay these costs again in the future should they want to reenter. As such, entry costs act as a cost of exit and lower the value of exiting today.

Figures E.22–E.25 show the corresponding figures for the other dimensions of dynamics explored in the empirical analysis when entry costs are set to zero and per-period costs are set at 2.8%.[39] A downward-sloping hazard function for exit arises (Figure E.22) because the longer one has been participating, the more wealth has been accumulated, which makes the costs less binding and allows them to continue participating even when faced with adverse shocks to income or returns. Reentry occurs (Figure E.23) because exit is driven by experiencing an adverse shock and consequently having insufficient wealth to justify the participation cost. However, upon building up enough wealth, some exiters will reenter. This typically occurs very quickly owing to the fast wealth accumulation (Figure E.24). The downward-sloping reentry hazard function (Figure E.25) is driven by age. Given that savings motives are strong during working life, exiters during this period are certain to return. Therefore, if the agent has not returned to the stock market following a few years after exit, it must mean that they are in the retirement phase of life when individuals are drawing from their savings and thus will not reenter. Overall, the results from this analysis show that a workhorse model with income shocks and fixed participation costs can generate the short-term dynamics observed in the data provided that per-period costs are sufficiently high. However, dynamics are purely due to fluctuations in wealth in a pure cost model, and therefore, intermittent participation is concentrated in the early part of life when individuals are building up their wealth. Figure E.26 shows that after age 40, there is virtually no exit until

[39] Figures E.27–E.29 show dynamics under other values of per-period costs.

one reaches retirement. The pure cost model will therefore struggle to explain why middle-aged individuals may have short spells.

FIGURE 14: Model without beliefs: proportion of simulated spells ending within 2 years



Notes. This figure plots the proportion of simulated spells ending within 2 years in the model without beliefs ($b_{it} = 1 \ \forall i, t$) for different levels of per-period participation costs and entry costs.

5.2 A model with beliefs

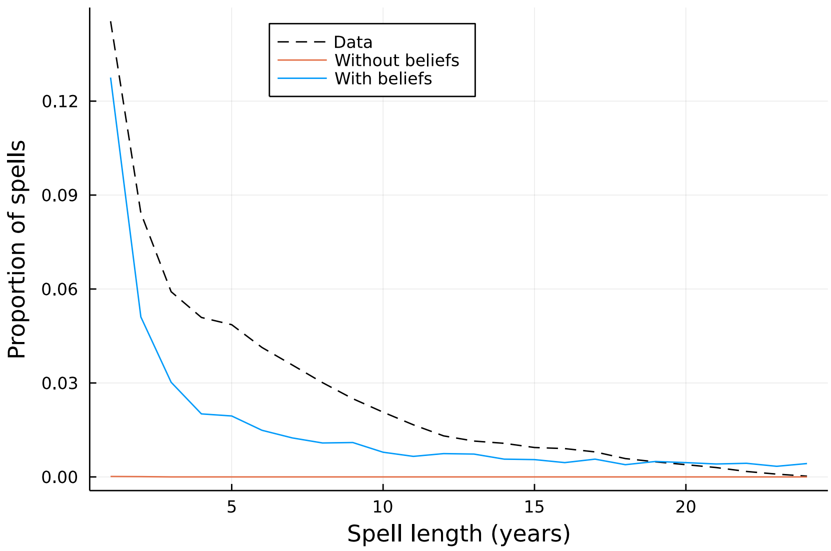
We now analyze whether the inclusion of heterogeneous beliefs and experience effects can generate short-term dynamics under smaller levels of per-period participation costs and higher levels of entry costs (both set at 0.5%). In these simulations, all individuals draw from the true returns distribution ($\bar{R} = \bar{R}_h$), but adjust their beliefs over the average equity premium following Equation 3.[40] Figure E.30 plots the simulated participation rate over the life cycle. Some people are born with very pessimistic beliefs about returns. Hence, they will never enter the stock market. As a result, the participation rate is far below 100% and closer to participation rates in the data.

Figure 15 plots the spell length distribution for the models with and without beliefs under costs of 0.5%. Short spells are nonexistent in the pure cost model. Individuals invest at the very start of life and only exit as they approach death. Instead, the model with beliefs

[40] Initial beliefs b_{it_b} are drawn from a uniform [0,1] distribution.

can produce a spell length distribution reasonably close to the data, with over 17% of spells ending within 2 years. Short spells occur because some individuals will draw poor returns, thus lowering the expected return on stocks. Some individuals will now have beliefs such that the expected return on stocks lies below the risk-free rate, and because agents are risk averse, they will then prefer to save exclusively in bonds. The presence of participation costs generates an additional margin of exit by further reducing the net gain from stock market participation. Figure E.31 plots the minimum wealth required to continue participating at each age for different levels of beliefs b_{it}. When the agent is certain that the average equity premium takes the higher value ($b_{it} = 1$), the wealth required is minimal. Lowering b_{it} to 0.8 raises the minimum required wealth but only marginally and mainly at the very end of life. However, if b_{it} falls further to 0.5, a belief level for which the expected equity premium is still positive, one requires a much larger level of wealth to continue participating. As a result, there is an interaction between beliefs and participation costs that can exacerbate exit. Upon experiencing a bad return, the threshold wealth an individual needs to continue investing increases, which may drive some individuals out of the market even if they believe that stocks will outperform bonds on average.

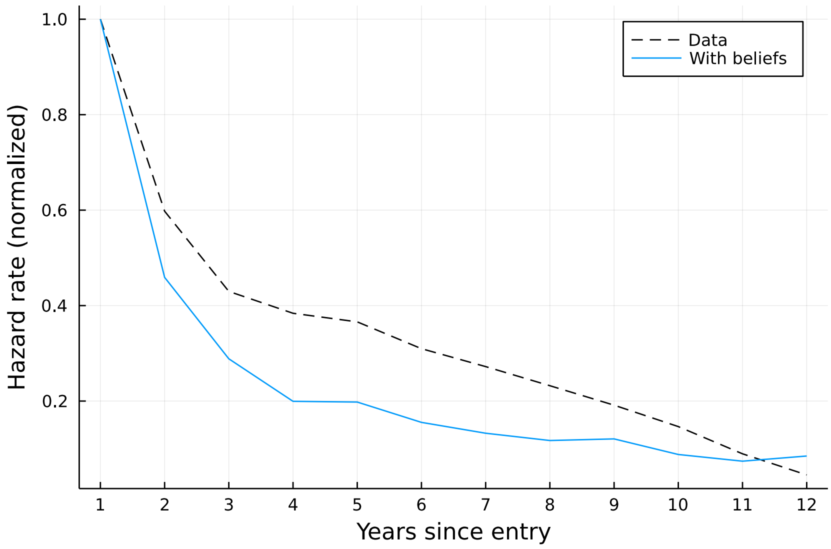
FIGURE 15: Model with beliefs: spell length distribution



Notes. This figure plots the distribution of spell lengths in the data and the models with and without beliefs. Entry and per-period costs are both set to 0.5% of permanent income in the two models.

Figure 16 plots the hazard function for exit in the model with beliefs.[41] The model can generate a downward-sloping hazard function. As time spent in the stock market increases, the fact that the agent has not yet left the market must mean that they performed well in their spell thus far, and therefore, they should be optimistic about the equity premium. Consequently, one requires a very low return to undo this confidence and be driven out of the market.

FIGURE 16: Model with beliefs: hazard rate for exit



Notes. This figure plots the hazard rate for exit under the model with beliefs. The hazard rate at 1 year after entry is normalized to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified (see Section 3.1.2).

Moving on to reentry, Figure 17 plots the distribution of the number of spells. In the model without beliefs, virtually everyone has one single, long spell lasting from birth until close to death, meaning that reentry does not occur and there are no "never participants". Instead, in the model with beliefs, some individuals never participate in the stock market, as they are too pessimistic about returns. This proportion of "never participants" is almost identical to the actual proportion coming from the Norwegian data. We also observe a sensible proportion of single spellers. Such individuals are a combination of people who have one long spell lasting into retirement, as well as short spellers who exit following poor returns.

[41] As short spells essentially do not occur in the model without beliefs, this model does not give a meaningful hazard function.

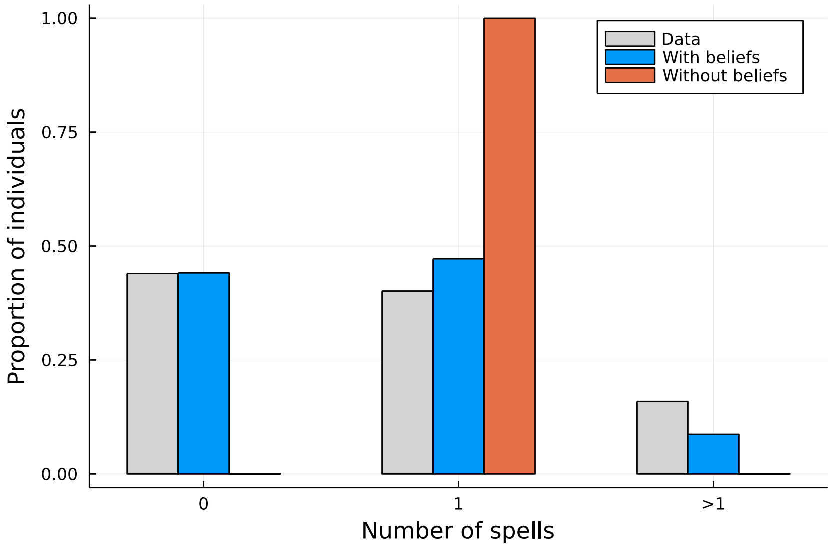
The model also generates reentry, albeit slightly less than is observed in the data. There are two ways in which reentry is generated in the model. First, noise in beliefs means some people may exogenously become slightly more optimistic. Note that the standard deviation of the noise shocks is set at just 1%, and thus, only nonparticipants with beliefs close to the threshold for participating (given their wealth) can be induced back into the stock market. Therefore, those who did terribly in their past spells will have weaker beliefs and will be more likely to remain out of the market indefinitely. Second, some individuals may exit because their current wealth is insufficient to warrant paying the participation costs *given their beliefs*. However, with time they may accumulate enough wealth such that it now becomes worthwhile to reenter. Figure 18 plots the simulated reentry times. While the model does not generate as many 1-year reentry observations as in the data, 1-year reentry remains the modal outcome. The model produces quick reentry because the noise in beliefs can drive recent exiters with beliefs close to the participation threshold back into the market. We obtain more longer-term reentry relative to the data because of the second channel for reentry. Some exiters have beliefs such that the expected equity premium is positive, but with participation costs, they need to accumulate more wealth to justify participating, and this can take some time. We obtain a downward-sloping hazard function reasonably close to the data. The intuition for this result is that those who have not reentered after many years will typically have pessimistic beliefs. Such individuals will likely not be drawn back in through the optimistic swings in beliefs coming through the noise term. Hence, their reentry is less likely.

5.3 Sensitivity to different parameter values

5.3.1 Degree of noise in beliefs

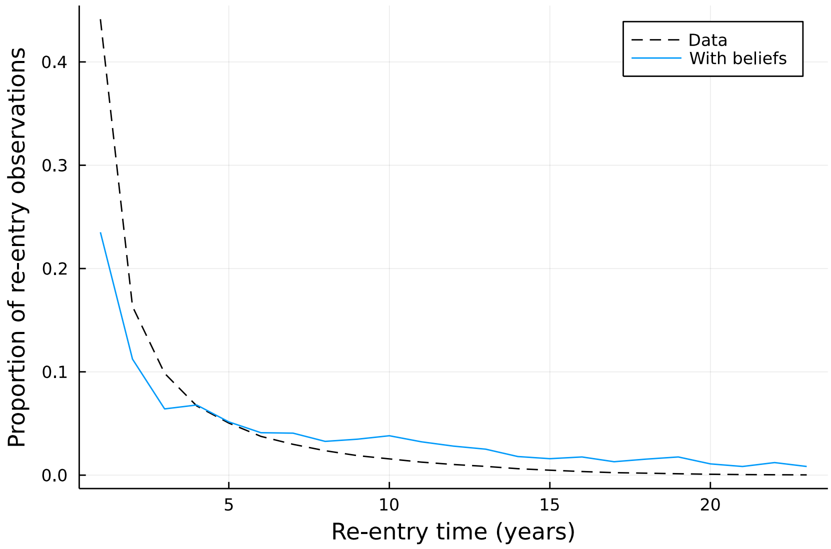
We consider different values for the standard deviation of belief shocks $\sigma_\nu \in \{0\%, 1\%, 2\%\}$ in Figures E.33–E.39. A lower degree of noise in belief formation reduces the participation rate at all ages (Figure E.33) because the presence of noise can help drive some individuals back into the stock market. In the extreme case of zero noise, beliefs are completely sticky for nonparticipants. The case of zero noise does not mean no reentry. Some individuals exit because they do not currently have sufficient wealth to justify the participation costs given

FIGURE 17: Model with beliefs: number of spells



Notes. This figure plots the distribution of the number of spells in the simulated population in the models with and without beliefs. The empirical distribution for the Norwegian population is also shown (see Figure 9).

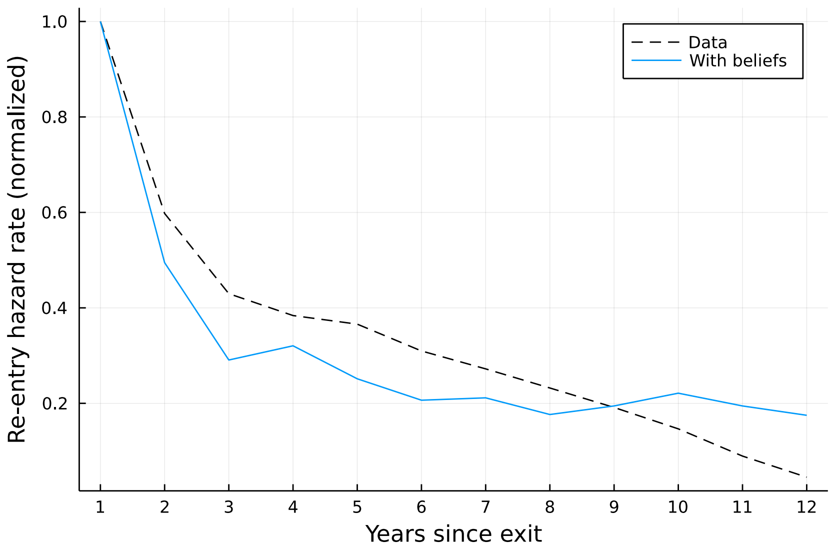
FIGURE 18: Model with beliefs: reentry times



Notes. This figure plots the distribution of reentry times in the model with beliefs. The empirical proportion from the Norwegian data is also shown (see Figure 11).

their beliefs. Upon accumulating more wealth, they may eventually reenter. However, the degree of reentry will be less compared to the case with noise (Figure E.37). In addition,

FIGURE 19: Model with beliefs: hazard rate for reentry



Notes. This figure plots the hazard rate for reentry under the model with beliefs. The hazard rate at 1 year after exit is normalized to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified (see Sections 3.1.2 and 3.2.3).

noise can generate quicker reentry. Without noise, the only way individuals can reenter is by accumulating more wealth such that they can now justify the costs, and this can sometimes take time. With noise in beliefs, people may become a bit more optimistic, which can induce quicker reentry because they need a smaller amount of wealth to warrant paying the per-period costs and reenter (as depicted in Figure E.31). The presence of noise can also lead to more short spells (Figure E.35) because individuals can experience negative swings in optimism, which can drive those with beliefs close to the threshold out of the market. Therefore, the presence of some noise in belief formation can help to better match the degree of short spells and reentry observed in the data.

5.3.2 Participation costs

In the baseline simulations, we set per-period and entry costs to 0.5% of permanent income. However, the model does not require the existence of participation costs to generate short-term dynamics (Figures E.40–E.46). Reducing costs right down to zero means insufficient wealth is no longer a driver of exit. Instead, beliefs become the sole reason to exit.[42] Figure E.42 shows that the prevalence of short spells is actually higher under zero costs than under 0.5% costs. Furthermore, Figure E.44 shows that a higher share of individuals have multiple spells in the model without costs. This is because entry costs deter exit, and therefore, its removal encourages more temporary exit. Overall, the model does not rely on participation costs to generate reasonable degrees of short-term dynamics.

5.4 Supporting evidence for the model mechanisms

Our model gives predictions regarding who should exit from or reenter the stock market. First, in the model with beliefs, those who stop participating soon after entry should have weaker average performance relative to those who stayed in the market for longer. At the aggregate level, as discussed in Section 3.1.1, the prevalence of short spells in mutual funds rises during stock market downturns (Figure E.9a). At the individual level, Figure 20 suggests that short spellers do poorly relative to longer spellers. We measure performance by computing the proportion of exiters of different spell lengths reporting only taxable gains from the sale of stocks and equity funds (Figure 20a) or only losses (Figure 20b) in their exit year.[43] The unconditional probability of reporting only gains is 30% for short spellers compared to around 40% for those participating for longer. Similarly, the unconditional probability of reporting only losses for short spellers (≈28%) is twice that of longer spellers (≈13–15%).[44] While one may be concerned that the higher prevalence of losses among short spellers reflects a liquidity need that forces them to liquidate at a loss, the discussion in Section 3.3.1 suggests that these shocks cannot explain the quick exit observed in the data.

[42] This is the case other than the years just before death. During this period late in life, some people may not save at all (in either asset), as they have very low values of wealth. They prefer to consume everything because they know they will receive a pension income in the next period. In other periods of life, precautionary savings motives are sufficiently high that everyone would have enough wealth to warrant saving.

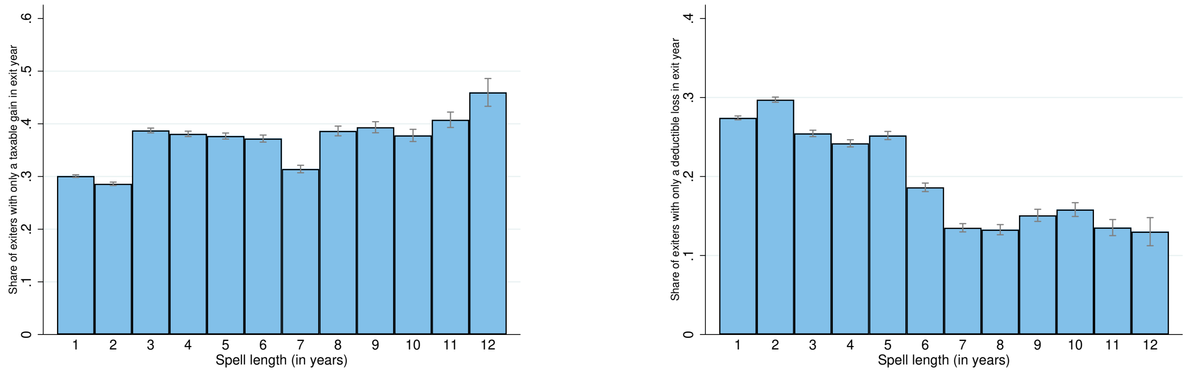
[43] For this analysis, we restrict attention to exiters who entered from 2006 onward because of changes in the Norwegian tax system that make it difficult to interpret the tax record variables prior to this point. Since 2006, individuals are only taxed on capital gains above a risk-free return. However, before 2006 the taxable amount depended on the share's proportion of retained taxed capital, and thus, it may necessarily not be linked to achieving a high/low return relative to a risk-free asset. Taxed capital refers to undistributed income that has been previously subject to tax at the company level. Focusing only on exiters who entered from 2006 onward aids with the interpretation of the tax variables because these individuals would be subject to the "new" tax system based on returns relative to a risk-free rate.

[44] Figure E.15 plots the corresponding figures based on reporting any gains or any losses rather than only gains or losses. We obtain broadly similar findings.

FIGURE 20: Performance of exiters by spell length

(A) Report only gains

(B) Report only losses



Notes. This figure shows the performance of exiters by spell length based on records of taxable gains and tax-deductible losses in the income tax data. In panel (A), we plot the proportion of exiters of a given spell length reporting only gains from the sale of stocks and funds (computed as the sum of items TR 3.1.8, TR 3.1.9, and TR 3.1.10 in the tax records) in their exit year. In panel (B), we plot the proportion of exiters reporting only losses (computed as the sum of items TR 3.3.8, TR 3.3.9, and TR 3.3.10). We use exiters who enter from 2006 onward in these plots.

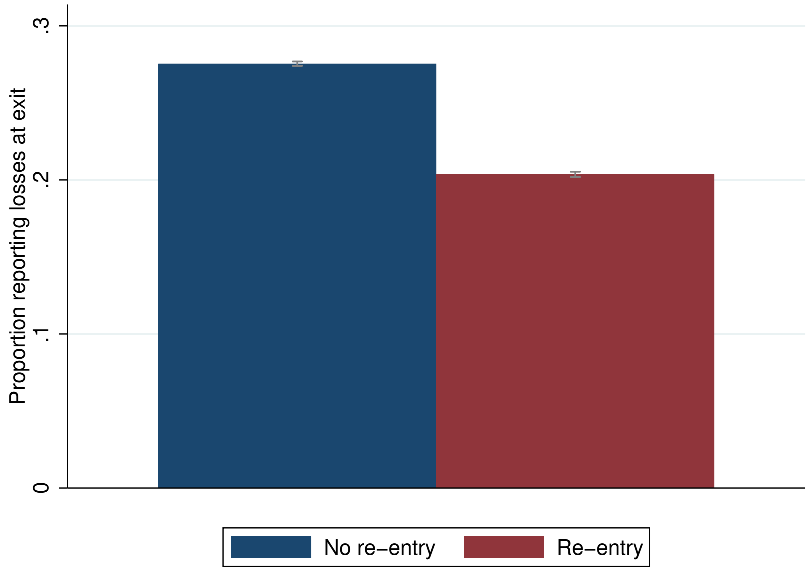
Second, in terms of reentry, the model predicts those who end up returning to the stock market should on average have done better in their prior spell compared to those who chose to remain out of the market. Figure 21 shows this to be the case. About 27% of those who do not reenter experience losses compared to 20% for individuals who reenter.[45]

6 Conclusion

While there is a large body of literature that studies why many individuals do not invest in stocks, much less is known about the dynamics of stock market participation by retail investors. How long do individuals stay in the stock market for? Is the probability of exit a function of time since entry? Do individuals reenter after exit, and if so, when? Using Norwegian administrative data, we document new facts regarding the exit and reentry decisions of individual investors. The unifying message from these facts is that short, multiple spells in the stock market are common. We show that the workhorse portfolio choice model needs

[45]Figure E.32 also shows that exiters in Norway who report only taxable gains are about 11% (3pps) more likely to reenter than those who report only losses.

FIGURE 21: Prevalence of losses by reentry status



Notes. This figure plots the share of people experiencing losses separately for those who reentered into the stock market and those who did not. We use exiters who enter from 2006 onward in these plots.

high per-period participation costs to generate these patterns. Extending the model to allow for experience effects à la Malmendier and Nagel (2011), whereby individuals adjust their expected stock returns based on realized returns, is able to produce short-term dynamics without the need for high participation costs.

Our findings leave various avenues for future research. First, the current setup of the model does not contain aggregate signals from which nonparticipants can learn about stock returns. Extending the model to allow for this can help to explain patterns in the data such as why entry rates tend to drop during stock market downturns. Second, what does noise in belief formation in the model exactly represent? One possible explanation is imperfect memory recollection. While the neuroscience and psychology literatures have established that memory is imperfect, there is little empirical evidence directly testing imperfect memory in the context of financial markets. Further work trying to see how well former participants recall their past return experiences and what biases they are prone to would thus help to establish whether noisy memory is a feature of investor behavior. Third, the Norwegian data allows one to identify family networks. It would be informative to directly test whether peer effects play a role in determining spell length and reentry. Last, our finding that a large share of the population have short-lived spells in the stock market can have important implications for wealth accumulation. If individuals are liquidating their entire stockholdings soon after entry, they are not staying in the stock market for long enough to earn the average equity premium, which can hurt their wealth accumulation going forward. This is particularly the case when individuals are permanently scarred by past adverse returns. Policies should therefore not solely focus on encouraging entry into the stock market. They also need to address the fact that many people quickly exit. Identifying policies that can achieve longer-term participation is important, particularly as individuals of lower wealth and education appear to be more prone to such intermittent spells in the stock market.

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Appendix

A Variable construction

Here, we describe the steps undertaken to translate the tax records into consistent measures of wealth by broad asset class. TR x.y denotes item x.y in the tax records based on 2018 item codings by the Norwegian Tax Administration (Skatteetaten). Note that while tax values are reported in the raw data, we translate these values into market values for our analysis. For financial wealth, we create the following subclasses:

- Cash and deposits are computed as the sum of deposits in Norwegian banks (TR 4.1.1), cash (TR 4.1.3), deposits in foreign banks (TR 4.1.9), and (from 2017 onward) cash holdings in share savings accounts (TR 4.1.8.6).
- Directly held listed stocks are given by the value of listed Norwegian shares and equity certificates, bonds, etc. in the Norwegian Central Securities Depository (TR 4.1.7).
- Directly held unlisted stocks are given by capital in unlisted shares, share savings accounts, and securities not listed in the Norwegian Central Securities Depository (TR 4.1.8).
- Stock mutual fund holdings are given by the value of the share component in holdings of securities funds (TR 4.1.4) plus (from 2017 onward) equity holdings in share savings accounts (TR 4.1.8.5).
- Money market/bond funds are given by the value of the interest component in holdings of securities funds (TR 4.1.5).
- Financial wealth held abroad is given by other taxable capital abroad such as foreign shares, outstanding claims, bonds, and endowment insurance (TR 4.6.2).
- Other financial assets are the sum of outstanding receivables in Norway (TR 4.1.6), the share of capital in housing cooperatives or jointly-owned property (TR 4.5.3), pension insurance and life insurance (TR 4.5.1 + TR 4.5.2), and other taxable capital, such as cryptocurrency (TR 4.5.4).

Real wealth can be decomposed into the follow:

- Housing wealth is the sum of housing owned through housing cooperatives (TR 4.3.2.2) and self-owned property (TR 4.3.2.1 + TR 4.3.2.3).
- Other real wealth is the sum of boats (TR 4.2.4), cars (TR 4.2.5), caravans (TR 4.2.6), holiday homes (TR 4.3.3.1 + TR 4.3.2.3), other real estate (TR 4.3.4 + TR 4.3.5 + TR 4.3.2.3), home contents and movable property (TR 4.2.3), fixtures and other business assets (TR 4.4.1 + TR 4.4.2 + TR 4.4.3 + TR 4.4.4), and real wealth abroad (TR 4.6.1 + TR 4.3.6.1).

B The Norwegian pension system

There are three main components to the Norwegian pension system. First is the National Insurance Scheme ("*folketrygden*"), which is the basic public pension scheme. It ensures that everyone receives a minimum pension income. Furthermore, workers are guaranteed a supplement that is proportional to their income during working age.[46] The system is defined-benefit in nature, so citizens face no stock market exposure through it. As such, the decisions to exit and enter the stock market cannot be attributed to portfolio rebalancing between private accounts and public pension wealth.

Second, there are occupational pensions. Public occupational pensions are also defined-benefit schemes. Hence, there is no stock market exposure through them.[47] Private sector occupational pensions operate differently. Until 2001, only defined-benefit pensions existed. While defined-contribution pensions, for which the pension benefit depends on how

[46]Under the current system, 18.1% of wages in each year of employment up to a certain ceiling is transferred to a pension account. This pension income is then indexed to nominal wage growth. Upon retirement, the accumulated amount is not given as a lump sum. Instead, an annual sum is given based on the expected number of years to be spent as a pensioner, which itself depends on when the individual starts withdrawing from their pension and life expectancy. While there are some differences based on year of birth, the overall premise of pensionable income being linked to employment earnings still holds. For further details, see Fagereng et al. (2019) and Fredriksen and Halvorsen (2019).

[47]Until 2020, the public occupational pension scheme was such that workers were entitled to the maximum pension after 30 years of service and can receive a pension equal to 66% of their pension base (final salary converted into a full-time equivalent) before adjustments for life expectancy. However, from 2020 occupational pension earnings became similar to that in the National Insurance Scheme, in particular having a share of earnings each year be accumulated in a pension pot. However, this remained a defined-benefit system. For further details on public occupational pensions and the reforms, see Fredriksen and Stølen (2018).

well the contributions are invested, have been allowed since 2001, they did not gain momentum until 2006 when occupational pensions were made mandatory by law. Indeed, before 2006 occupational pensions were mainly provided by larger employers (OECD (2009)).[48] One may be concerned that because private sector defined-contribution occupational pensions have some exposure to the stock market, this could influence choices made in nonretirement investment accounts. However, Figure 7 shows that short spells in the stock market are not exclusive to the post-2006 period.

Third, individuals may have personal private pensions that they invest in. As payments into an Individual Pension Scheme (IPS) in Norway are tax deductible up to a certain limit, one can infer from the tax records whether an individual holds such pensions.[49] Figure E.18 provides a time series of participation in private pension accounts separately for the whole population and the subset of the population aged 60 and under (who are unlikely to have drawn from such pensions yet). In either case, the participation rates are in single digits, indicating that the vast majority of the population do not hold such accounts. To further ease concerns, we plot the proportion of exiters of different spell lengths who hold private pensions as of their exit year. If these schemes were driving our short spell result, we might expect to see a greater prevalence of private pensions among short spellers. However, Figure E.19 shows the opposite. We also reproduce our spell length histogram but exclude any individual who at any point in the sample holds a private pension account. Figure E.20 shows that our results are robust to this. We therefore believe that pension holdings cannot explain the short-term dynamics we observe.

C Further details on the Alvarez et al. (2021) GMM estimator

The Alvarez et al. (2021) GMM estimator is based on the following environment. There is a proportional hazards data generating process for durations $d \in \{\underline{D}, ..., \bar{D}\}$, where $h_i(d) = \theta_i b_d$. θ_i is the time-invariant frailty parameter specific to individual i and captures individ-

[48] As of 2018, 90% of private sector employees are under a defined-contribution pension (Fredriksen and Halvorsen (2019)).

[49] There are two relevant variables in the tax data. TR 3.3.5 records the deductible amount from payments into an IPS, while TR 4.5.1 indicates capital in an Individual Pension Account (IPA). Note that IPAs were replaced by the IPS in 2006, from which point new money could not be placed into one's existing IPA, and new IPAs could not be opened. We consider an individual to be a private pension contributor if they report a positive value for either of these two variables, either in the current year or in any past year.

ual heterogeneity in hazard rates. b_d is the baseline hazard at duration d and is assumed to be common across individuals. The objective is to obtain an estimate of b_d, as this reflects true duration dependence rather than unobserved heterogeneity. Individual i experiences K^i spells, for which the measured duration of spells is $\zeta^i = \{\zeta_0^i, \zeta_1^i, ..., \zeta_{K^i}^i\}$. Note that measured duration is not necessarily equal to the true length of the spell because of censoring. Assume that the spells $\zeta = (\zeta_0, \zeta_1, ..., \zeta_K)$ are drawn from a proportional hazards model with a baseline hazard $\mathbf{b}_0$. Defining

$$f_{d_1,d_2}^{[b]}(\zeta; \mathbf{b}) \equiv \sum_{(j,k):1 \leq j \leq k \leq K} (b_{d_2} \mathbb{1}_{\zeta_j = d_1, \zeta_k \geq d_2} - b_{d_1} \mathbb{1}_{\zeta_j = d_2, \zeta_k \geq d_1})$$

then $\mathbb{E}[f_{t_1,t_2}^{[b]}] = 0 \ \forall \ \underline{D} \leq d_1 < d_2 \leq \bar{D}$ if and only if $\mathbf{b} = \lambda \mathbf{b}_0$ for some $\lambda > 0$. This gives $\frac{\tilde{D}(\tilde{D}+1)}{2}$ moment conditions, where $\tilde{D} \equiv \bar{D} - \underline{D}$. It is important to note that under this procedure, we recover the baseline hazards $\mathbf{b}$ up to a multiplicative constant, and so we normalize $b_1 = 1$. To estimate $\mathbf{b}_0$:

$$\hat{\mathbf{b}}_0 = \arg\min_{\mathbf{b}} \Big(\frac{1}{N} \sum_{i=1}^{N} f_{d_1,d_2}^{[b]}(\zeta^i; \mathbf{b})\Big)^T W \Big(\frac{1}{N} \sum_{i=1}^{N} f_{d_1,d_2}^{[b]}(\zeta^i; \mathbf{b})\Big)$$

where W is a positive definite weighting matrix. We use two-step feasible GMM à la Hansen (1982). In the first step, we use the identity matrix as the weighting matrix. In the second step, we take our estimates from the first step, $\mathbf{b}_0^{(1)}$, and use $\hat{W}(\hat{\mathbf{b}}_0)^{-1}$ as the weighting matrix in the second step where:[50]

$$\hat{W}(\hat{\mathbf{b}}_0) = \left(\frac{1}{N} \sum_{i=1}^{N} f_{d_1,d_2}^{[b]}(\zeta^i; \hat{\mathbf{b}}_0) f_{d_1,d_2}^{[b]}(\zeta^i; \hat{\mathbf{b}}_0)^T\right)^{-1}$$

There are several advantages of this approach. First, while Honoré (1993) provides continuous time identification results for duration models with multiple spells, the moment conditions used in the GMM estimator are based on discrete time identification results. Second, some approaches rely on specification of a frailty distribution. For example, Nakamura and Steinsson (2008) apply the empirical model of Meyer (1990) in their analysis of price spell duration and assume that the frailty parameter follows a gamma distribution for their

[50] Hansen (1982) show that $\hat{W}(\hat{\mathbf{b}}_0)$ converges in probability to $\Omega \equiv \mathbb{E}[f_{d_1,d_2}^{[b]}(\zeta^i; \mathbf{b}_0) f_{d_1,d_2}^{[b]}(\zeta^i; \mathbf{b}_0)^T]$ and that $W = \Omega^{-1}$ is the most efficient weighting matrix.

baseline specification. Heckman and Singer (1984) note that misspecification of the frailty distribution can bias the hazard function. Instead, the approach of Alvarez et al. (2021) imposes no restrictions on the frailty distribution. Third, the GMM estimator is consistent when the number of individuals is large, but it allows for a short time dimension. The latter is important in our setting given that we rely on annual data covering 26 years.

D Alternative theories of participation

D.1 Nonstandard preferences

Expected utility maximizers with standard preferences exhibiting second-order risk aversion (e.g., CRRA utility) should always be willing to invest some money in stocks as long as the expected risk premium is positive (Haliassos and Bertaut (1995)). This is because such individuals are effectively risk neutral for small risks and risk has no first-order effect. As such, a model where all agents exhibit second-order risk aversion would need to be augmented with additional ingredients to motivate nonparticipation, such as participation costs or background risks. Some papers have allowed for time-varying levels of risk aversion, with one popular method being to have habit-formation preferences. Such preferences generate a negative relationship between wealth and risk aversion.[51] However, this will simply lead to time-varying risky asset shares with no impact on the extensive margin of participation as long as preferences still exhibit second-order risk aversion.[52]

To generate nonparticipation exclusively through preferences, first-order risk aversion is needed (Segal and Spivak (1990)).[53] Under such preferences, individuals have a kink in the utility function at some certainty point, which can make risk aversion locally infinite and zero stockholdings an optimal outcome. To generate dynamics in participation, we would need some agents to exhibit time-varying first-order risk aversion (Gomes et al. (2021)). In

[51] These studies have typically used habit-formation preferences to help reproduce empirical patterns of equity premia (e.g., Constantinides (1990); Campbell and Cochrane (1999)).

[52] Brunnermeier and Nagel (2008) empirically test whether wealth fluctuations affect risky asset shares and find no clear relationship, which they argue lends support to a CRRA model over a model with habit-formation preferences.

[53] A range of preferences exist that exhibit first-order risk aversion including, but not limited to prospect theory (Kahneman and Tversky (1979)), rank-dependent expected utility (Quiggin (1982); Epstein and Zin (1990)), disappointment aversion (Gul (1991); Ang et al. (2005); Routledge and Zin (2010)), news utility (Pagel (2018)) and ambiguity aversion (Gilboa and Schmeidler (1989); Cao et al. (2005)).

addition, preferences would need to fluctuate at a reasonably high frequency to generate short-term dynamics. However, such models would likely struggle to explain the downward-sloping hazard functions for exit and reentry. Indeed, if such preference "shocks" have a constant Poisson arrival rate, the hazard rates should be flat. Furthermore, empirical studies have typically found positive and significant autocorrelations in individuals' risk preferences, suggesting that preferences are moderately stable, although correlations are usually below 1 (Chuang and Schechter (2015); Dohmen et al. (2016)).[54]

D.2 Risks faced by households

A strand of the literature studies how background risks, particularly labor income risk, can affect portfolio allocations. Theoretically, the impact of labor income risk depends on the nature of the risk (Vissing-Jørgensen (2002)). First, if labor income is riskless, this should lead to a higher investment in risky financial assets because such labor income is effectively equivalent to holding a riskless bond. Second, if labor income is risky but uncorrelated with stock returns, then individuals should tilt their portfolio away from stocks, as there is already risk coming from human wealth.[55] Third, if labor income is risky and correlated with stock returns, then there is a hedging component that runs with the opposite sign of the correlation. For example, if business cycle risk produces a positive correlation between labor income and stock returns, then the optimal portfolio choice requires one to reduce stockholdings (Haliassos and Bertaut (1995)). It is important to note that zero stockholding cannot be an optimal solution in the first two cases. Risky labor income that is uncorrelated with stock returns reduces the optimal portfolio share but would not push it to zero. However, Haliassos and Bertaut (1995) show that zero stockholding can be an optimal choice for sufficiently low wealth if labor income and stock returns are positively correlated, particularly if coupled with a no short-selling constraint. For a model to generate dynamics through labor income risk alone, we would require that 1) the correlation between labor income and stock returns is time-varying, and/or 2) wealth fluctuates around the participation thresh-

[54] Part of these imperfect correlations could reflect measurement error (Schildberg-Hörisch (2018)).

[55] Fagereng et al. (2017b) studies the impact of uninsurable wage risk on portfolio shares using Norwegian data. They find a significant marginal effect of such risk on portfolio shares, although the economic impact is limited because the size of this wage risk is small. Vissing-Jørgensen (2002) finds a negative impact of the volatility of nonfinancial income on both the probability of stock market participation and the proportion of wealth invested in stocks conditional on participating.

old for some individuals, leading to entry and exit. The first can be hard to justify given that most individuals do not change jobs at a high frequency such that the underlying correlations could change. Regarding the second route, Figure E.7b shows that short spells, while being relatively more likely for less wealthy individuals, still occur for high wealth groups at a nonnegligible frequency. In any case, empirical estimates for the correlation between labor income and stock returns are typically very close to zero, making such channels hard to rationalize from the data (e.g., Cocco et al. (2005); Fagereng et al. (2017a)).

D.3 Cultural and social environment

Cultural factors can influence an individual's beliefs and preferences, which in turn affect economic outcomes (Guiso et al. (2006)).[56] Various papers have provided empirical evidence of a causal link running from cultural environments to savings behavior.[57] While underparticipation in the stock market could be linked to cultural factors, these factors need to be time-varying to obtain dynamics in participation. However, Guiso et al. (2006) define culture as *"customary beliefs and values that ethnic, religious, and social groups transmit fairly unchanged from generation to generation"*. As such, cultural factors are very slow-moving and thus would not be able to reproduce the high frequency entry and exit that we observe.

However, social interactions could generate more frequent changes in beliefs and preferences. Shiller et al. (1984) argue that investing is a social activity, and therefore, investment decisions can be affected by the actions of those one interacts with. A growing literature has provided empirical evidence for the influence of peer effects on financial behavior.[58] In principle, communication between peers could lead to entry and exit. If my neighbor decides to leave the stock market – perhaps due to experiencing poor returns – this could induce me to also leave. If my neighbor claims that stock returns will be good in the near future, this might induce me back into the market. Testing these effects directly could be an

[56] For example, ethnic origin has been shown to affect trust (Guiso et al. (2003b)).

[57] Haliassos et al. (2017) study migrants to Sweden and find significant differences in financial behavior and the propensity to hold stocks based on the degree of cultural similarity to Sweden. Other papers that find significant effects of culture on financial behavior include Osili and Paulson (2008), Guin (2017), and Fuchs-Schündeln et al. (2020). However, some papers do not find such effects (Carroll et al. (1994, 1999)).

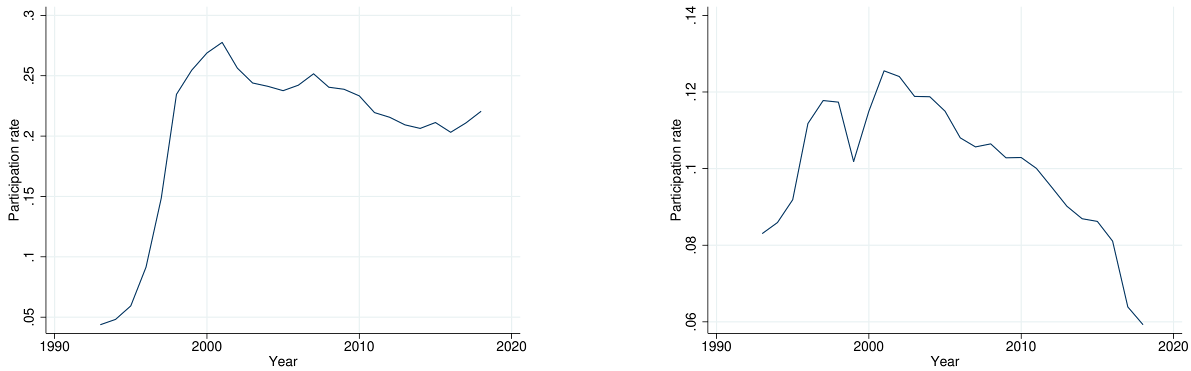
[58] Hong et al. (2004) show that households who report interacting with their neighbors and attending church are more likely to participate in the stock market even after controlling for individual characteristics and personality traits. Brown et al. (2008) find a causal link between individual stockholding and the average participation of the individual's community, which they argue occurs through word-of-mouth communication.

interesting avenue for future research, although it seems unlikely that peer effects alone can explain all of the dynamics we observe for a variety of reasons. First, Kaustia and Knüpfer (2012) show that good stock returns experienced by local peers can positively affect an individual's decision to enter the stock market. However, the authors do not find evidence of a discouragement effect following poor realizations, from which they infer that peers primarily share good outcomes with each other. Therefore, peer effects could struggle to explain exit. Second, it is difficult to rationalize the downward-sloping hazard functions through peers alone. Third, our focus is on the extensive margin of participation. We, therefore, require social interactions to generate complete exit rather than just exit from a particular stock. One could imagine individuals discussing particular stocks, and perhaps a bad return experienced by a peer may deter them from also investing in that security. However, it may not necessarily put the person off investing in other stocks or funds.

E Additional tables and figures

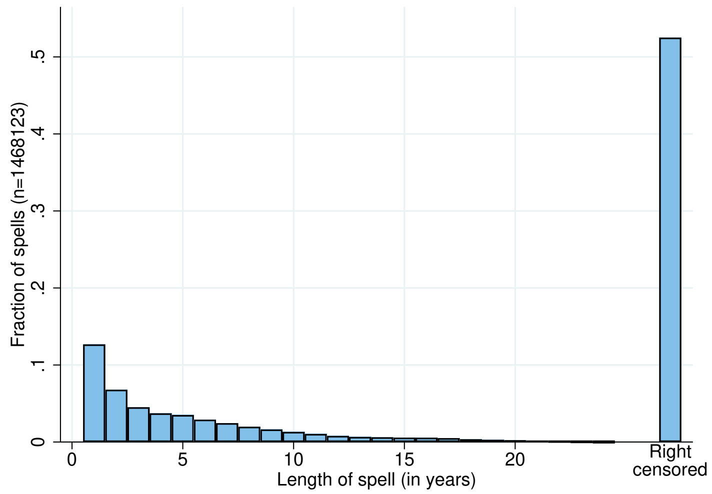
FIGURE E.1: Stock market participation rates over time by asset class

(A) Mutual funds (B) Direct stockownership



Notes. This figure plots the participation rate in the stock market by asset class annually from 1993-2018. The left panel shows the participation rate in mutual funds, while the right panel is for directly held stocks.

FIGURE E.2: Spell length distribution at the household level



Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data based on the household-level balance sheet. A household is treated as participating in the stock market in year t if at least one spouse has some assets held in public equity. We take all spells beginning at any point from 1994-2015. The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

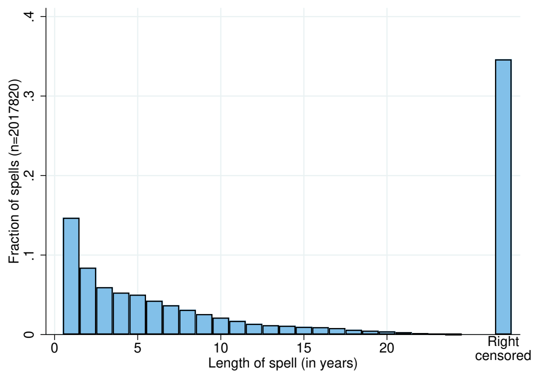
TABLE E.1: Determinants of reentry

	Reentry in 4y	
Male	0.037***	
	(0.001)	
College degree	0.030***	0.011
	(0.001)	(0.007)
Homeowner	-0.063***	-0.022***
	(0.001)	(0.004)
Unemployed	-0.005**	0.001
	(0.002)	(0.004)
Single	-0.028***	-0.056***
	(0.001)	(0.003)
Sample mean	0.35	0.59
Individual FE	No	Yes
Exit-year FE	Yes	Yes
Age group FE	Yes	Yes
Income decile FE	Yes	Yes
Wealth decile FE	Yes	Yes
Observations	1436019	518995
R-squared	0.14	0.54

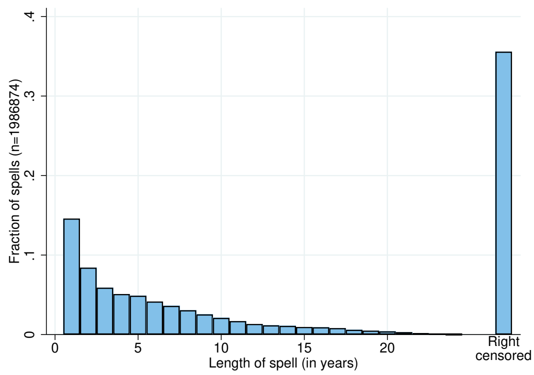
Notes. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. This table shows the estimation of the linear probability model in Equation 2. The first column excludes individual fixed effects, while the second column includes them. The dependent variable is a binary variable equal to 1 if the exiter reenters within 4 years following exit, and zero otherwise. *Homeowner* equals 1 if the participant owns their own property (either self-owned or ownership through housing cooperatives), and zero otherwise. *Single* equals 1 if the participant is neither married nor cohabiting, and zero otherwise. *Unemployed* equals 1 if the participant receives unemployment benefits at the point of exit, and zero otherwise. Exit-year fixed effects are included. Age fixed effects by broad age group (20-29, 30-39, 40-49, 50-59, 60-69 and 70+), as well as income and wealth decile fixed effects are included. Observables are measured at the point of exit. Standard errors are clustered at the individual level. The regression uses data on exiters from 1994-2014.

FIGURE E.3: Spell length distribution (robustness to gifts/inheritance)

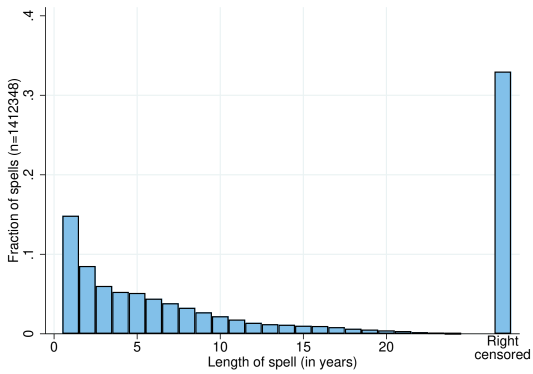
(A) No gift above 10,000 NOK



(B) No (grand)parent death

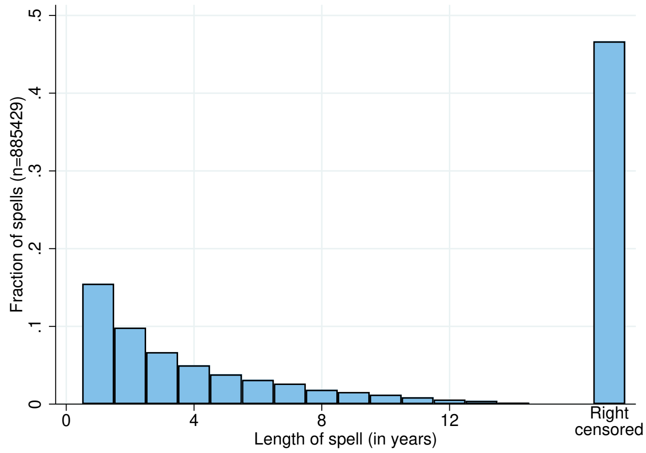


(C) No (grand)parent participation



Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data for different subsamples intended to deal with concerns that short spells are driven by gifts and inheritances. For all panels, we take spells beginning at any point from 1994-2015. The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored. Panel (A) excludes all individuals who receive a gift or inheritance above 10,000 NOK (based on tax records) in the year of or before entry. Panel (B) excludes all entrants who experience the death of a parent or grandparent in the year of or before entry. Panel (C) excludes all entrants for whom a parent or grandparent participated in the year of or before entry.

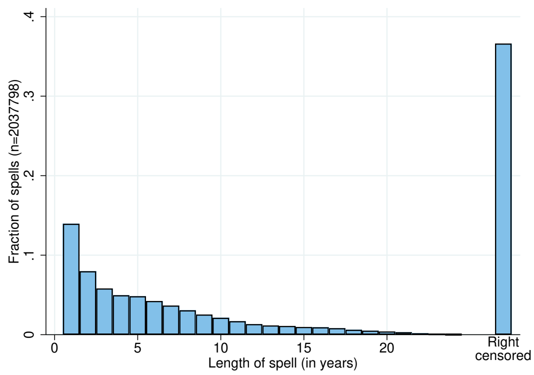
FIGURE E.4: Spell length distribution excluding employee stocks



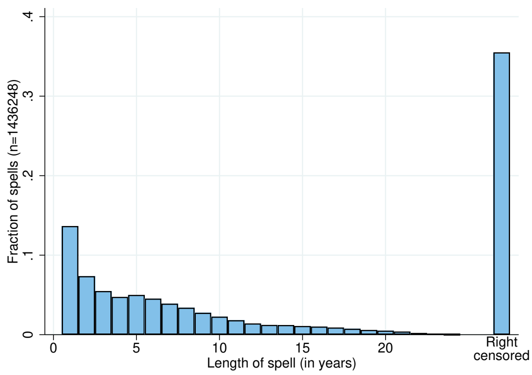
Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data excluding entrants who hold stocks in the company they work for. Such individuals are identified using the Shareholder Registry and demographic information about place of work. We take all spells beginning at any point from 2004-2015 (Shareholder registry data begin in 2004). The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

FIGURE E.5: Spell length distribution excluding small investors

(A) Invest > $100

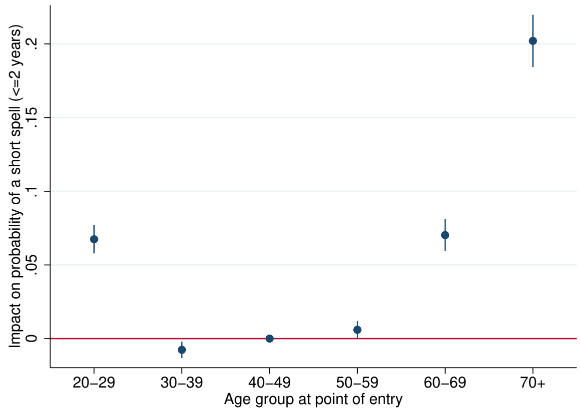


(B) Invest > $1000



Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data excluding entrants who invest a “small” amount of money at the point of entry. The left panel only uses individuals who invest at least $100 at the point of entry, while the right panel requires an investment of at least $1,000. For both panels, we take spells beginning at any point from 1994-2015. The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

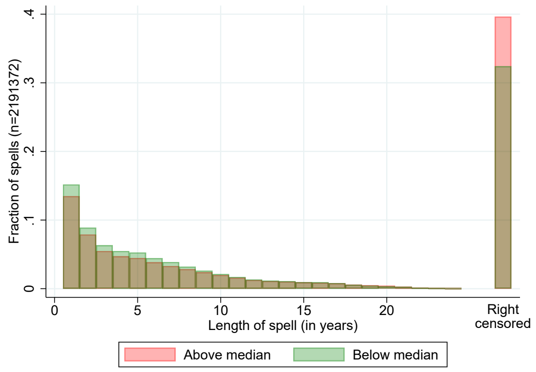
FIGURE E.6: Impact of age on the probability of a short spell



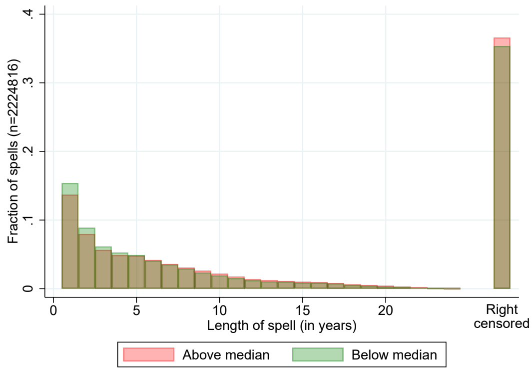
Notes. This figure plots the coefficient estimates for the fixed effects on age following estimation of Equation 1. Individual fixed effects are included in this specification. Age is measured at the point of entry and individuals are grouped into 10-year bins. 95% confidence intervals are shown. The red line represents a null relative effect.

FIGURE E.7: Spell length distribution by observable characteristics

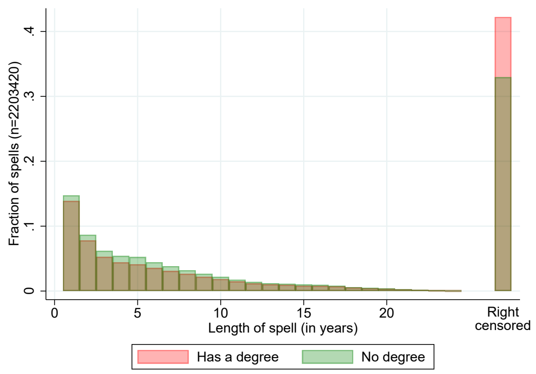
(A) Income



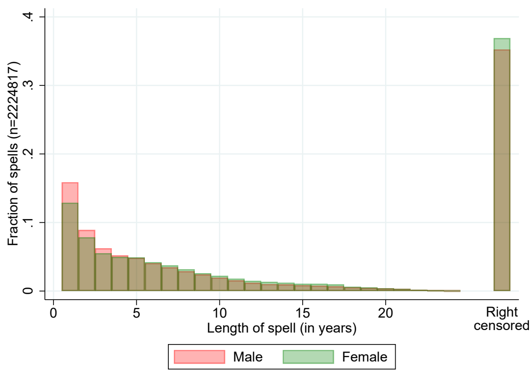
(B) Wealth



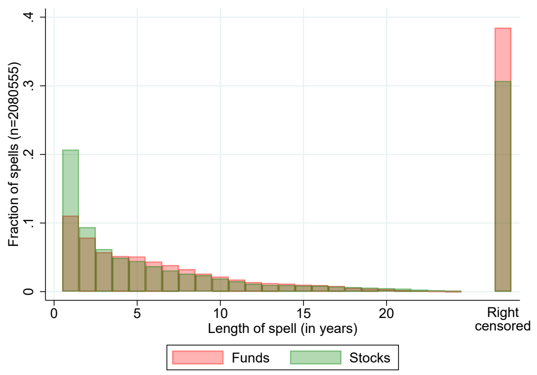
(C) Education



(D) Gender

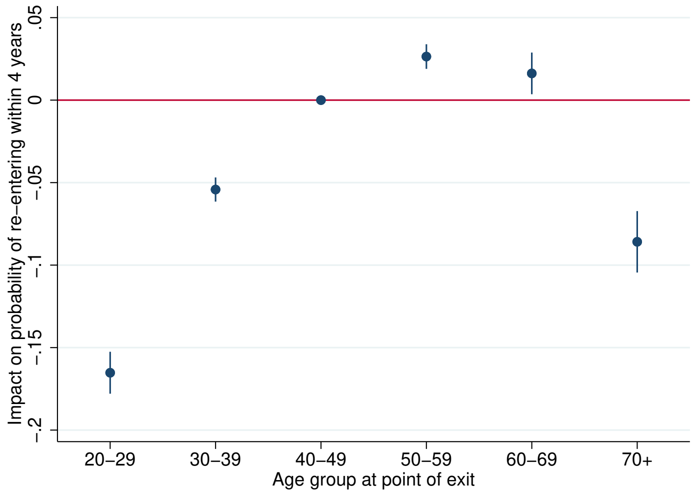


(E) By asset class



Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data for different observable characteristics, namely income (A), wealth (B), education (C), and gender (D). Panel (E) looks at individuals who enter into mutual funds vs. directly held stocks. For this panel, we exclude those entrants who choose to invest in both at the point of entry. For all panels, we take all spells beginning at any point from 1994-2015. The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

FIGURE E.8: Impact of age on the probability of reentry

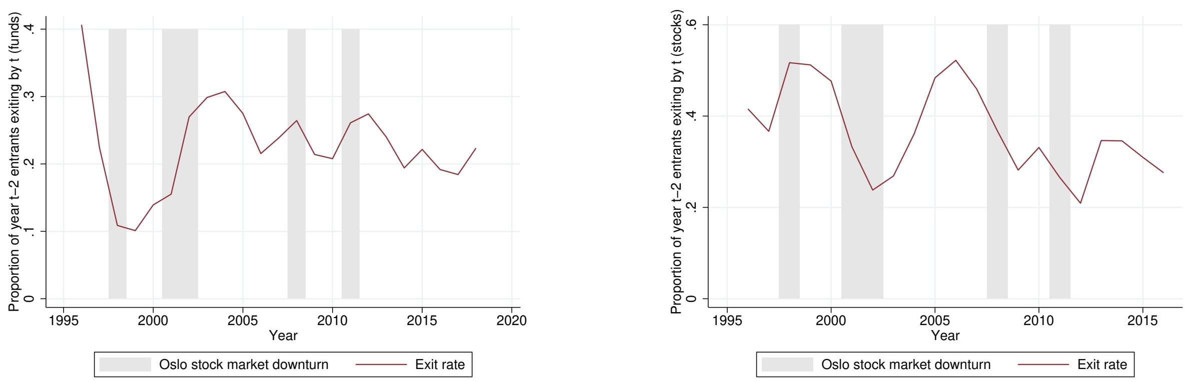


Notes. This figure plots the coefficient estimates for the age group fixed effects following estimation of Equation 2. This specification includes individual fixed effects. Age is measured at the point of exit, and individuals are grouped into 10-year bins. 95% confidence intervals are shown. The red line represents a null relative effect.

FIGURE E.9: Prevalence of short spells over time by asset class

(A) Mutual funds

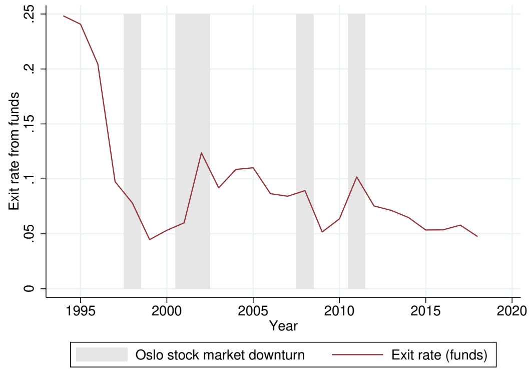
(B) Direct stockholding



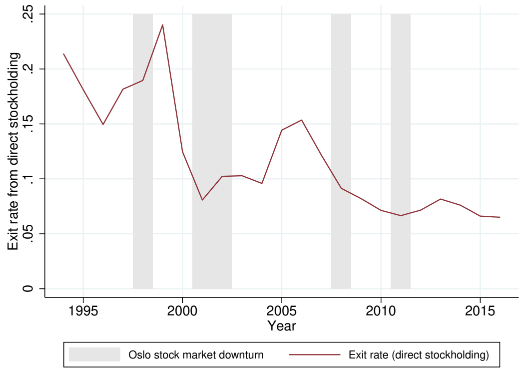
Notes. This figure plots the proportion of year $t-2$ entrants who leave the stock market by year t separately based on asset class. Panel (A) corresponds to individuals who entered into mutual funds, while panel (B) is for direct stockholders. The shaded areas are stock market downturn years in which the Oslo Børs Benchmark Index fell by at least 10%.

FIGURE E.10: Exit rate over time by asset class

(A) Mutual funds

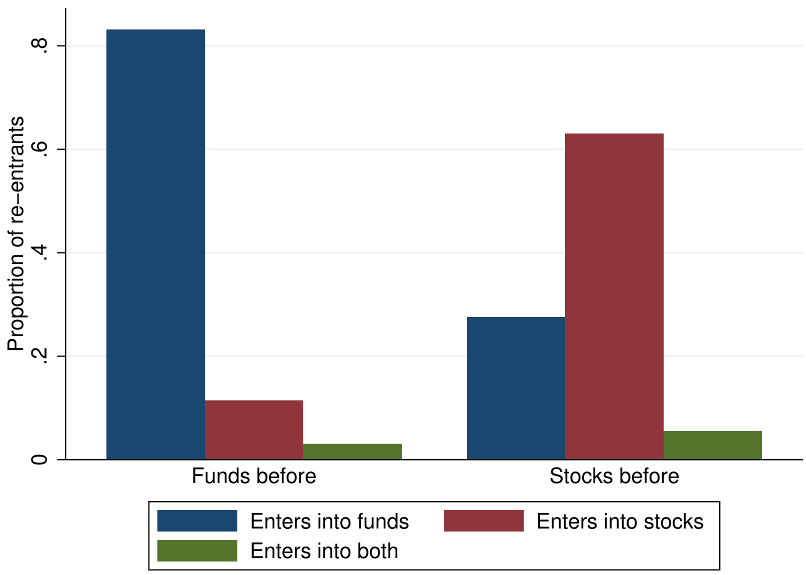


(B) Direct stockholding



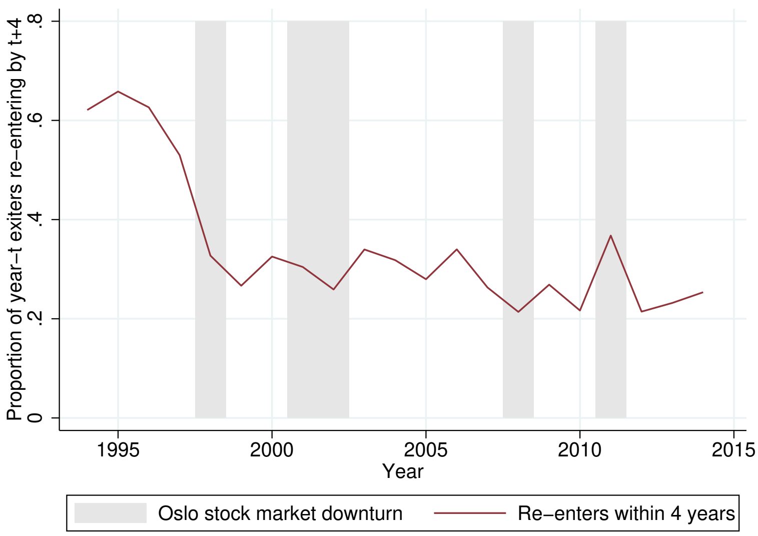
Notes. This figure plots the exit rate separately for mutual funds (A) and direct stockholding (B). The exit rate in year t is computed as the proportion of participants in year $t-1$ who leave that asset class in year t. The shaded areas are stock market downturn years in which the Oslo Børs Benchmark Index fell by at least 10%.

FIGURE E.11: Reentry into different asset classes by previous asset class choice



Notes. This figure plots the proportion of reentrants going into funds, stocks or both by the choice of funds vs. stocks in their previous spell.

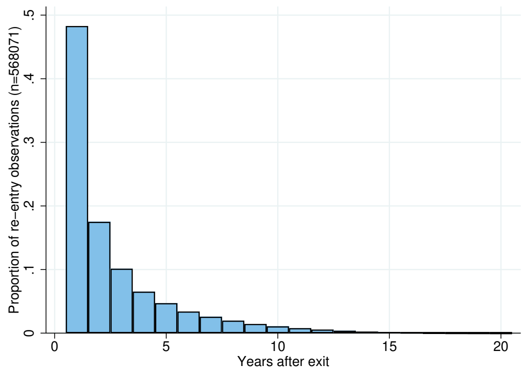
FIGURE E.12: Reentry rate over time



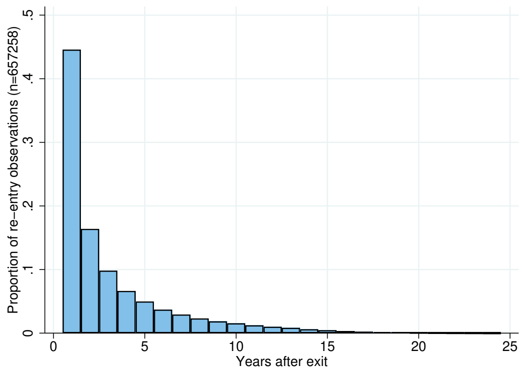
Notes. This figure plots the proportion of exiters of a given year who reenter within the next 4 years. The shaded areas are stock market downturn years in which the Oslo Børs Benchmark Index fell by at least 10%.

FIGURE E.13: Distribution of reentry times (robustness to gifts/inheritance)

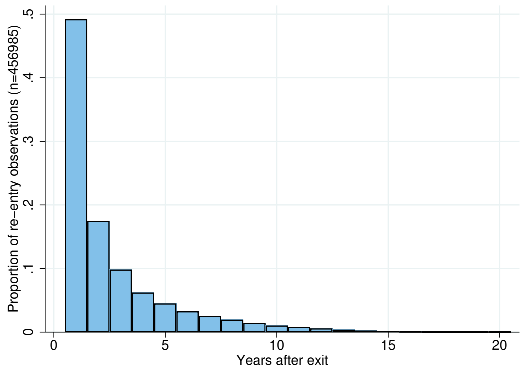
(A) No gift above 10,000 NOK



(B) No (grand)parent death

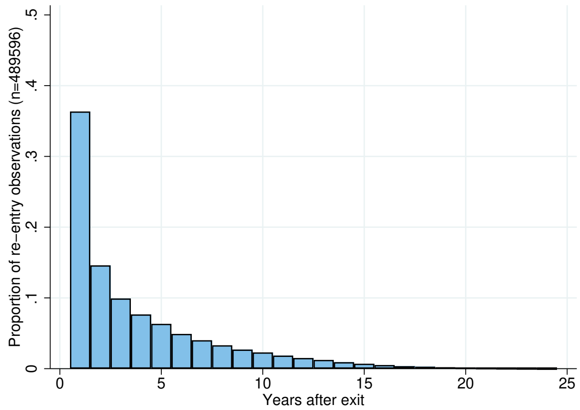


(C) No (grand)parent participation



Notes. This histogram shows the distribution of reentry times in the Norwegian data for different subsamples intended to deal with concerns that short spells are driven by gifts and inheritances. The x-axis gives the reentry time (in years) and the y-axis shows the proportion of reentry observations belonging to a particular length. Panel (A) excludes all reentrants who receive a gift or inheritance above 10,000 NOK (based on tax records) in the year of or before reentry. Panel (B) excludes all reentrants who experience the death of a parent or grandparent in the year of or before reentry. Panel (C) excludes all reentrants for whom a parent or grandparent was participating in the year of or before reentry.

FIGURE E.14: Distribution of reentry times (excluding employee stocks)

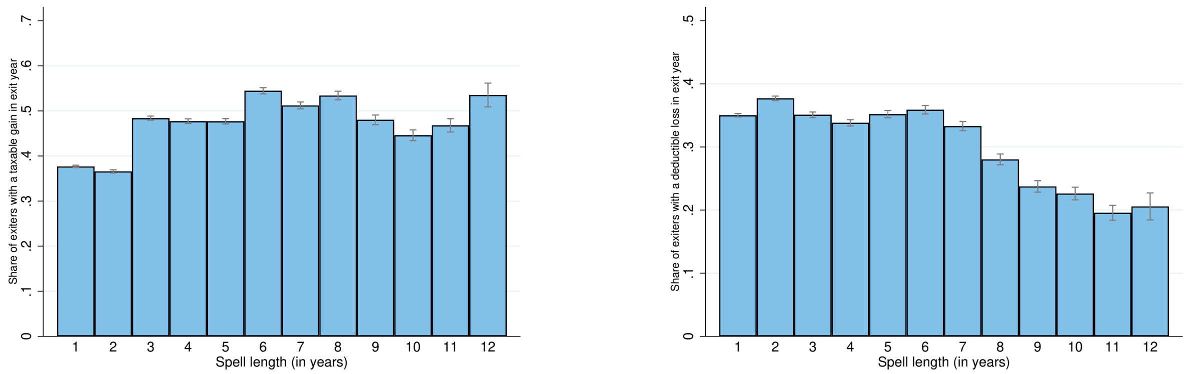


Notes. This histogram shows the distribution of reentry times in the Norwegian data excluding reentrants who hold stocks in the company they work for. The x-axis gives the reentry time (in years) and the y-axis shows the proportion of reentry observations belonging to a particular length. As the Shareholder Registry data are only available from 2004, we only consider reentry observations where the year of reentry is no earlier than 2004.

FIGURE E.15: Performance of exiters by spell length

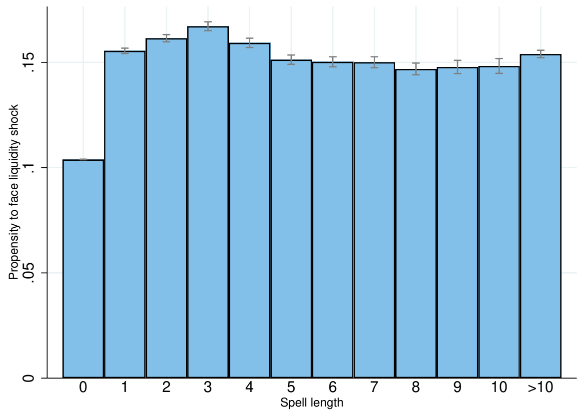
(A) Report gains

(B) Report losses



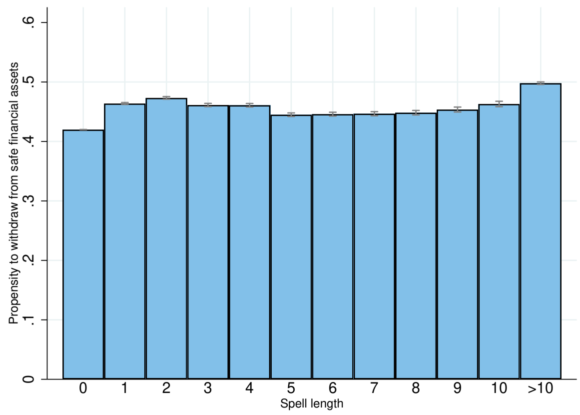
Notes. This figure shows the performance of exiters by spell length based on records of taxable gains and tax-deductible losses in the income tax data. In panel (A), we plot the proportion of exiters of a given spell length reporting some gains (irrespective of losses) from the sale of stocks and funds (gains are computed as the sum of items TR 3.1.8, TR 3.1.9, and TR 3.1.10 in the tax records) in their exit year. In panel (B), we plot the proportion of exiters reporting some losses (irrespective of gains). Losses are computed as the sum of items TR 3.3.8, TR 3.3.9, and TR 3.3.10 in the tax records. We use exiters who enter from 2006 onward in these plots.

FIGURE E.16: Prevalence of liquidity shocks in exit year by spell length



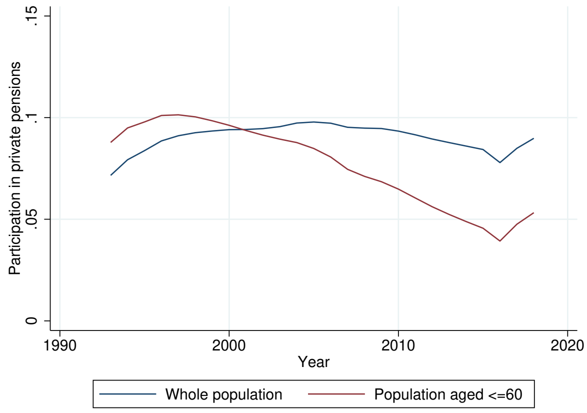
Notes. This figure shows the proportion of exiters of different spell lengths experiencing at least one of four potential liquidity needs in the exit year. The four shocks considered are buying a house (observed in housing transactions data), divorce, unemployment (inferred through receipt of unemployment benefits), and a large fall in income of > 50%. The far-left bar (spell length of zero) gives the prevalence of liquidity shocks over nonexit observations (i.e., continuing participants). The far-right bar groups all exiters with spell lengths above 10 years. 95% confidence intervals are shown.

FIGURE E.17: Propensity to reduce safe financial asset holdings in exit year by spell length



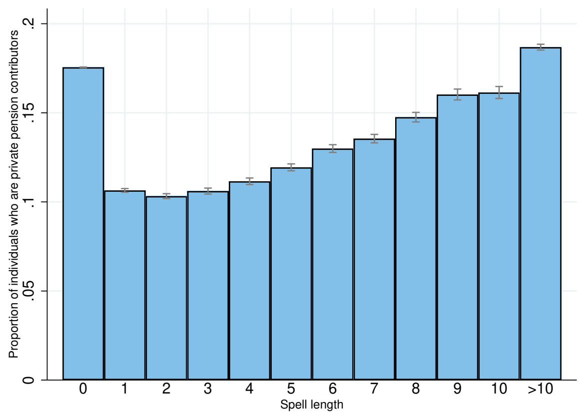
Notes. This figure shows the proportion of exiters of different spell lengths withdrawing from their safe financial asset holdings in their exit year (i.e., where safe asset holdings in exit year t is below holdings in year $t-1$). The far-left bar (spell length of zero) gives the propensity to withdraw over nonexit observations (i.e., continuing participants). The far-right bar groups all exiters with spell lengths above 10 years. 95% confidence intervals are shown.

FIGURE E.18: Participation in private pensions over time



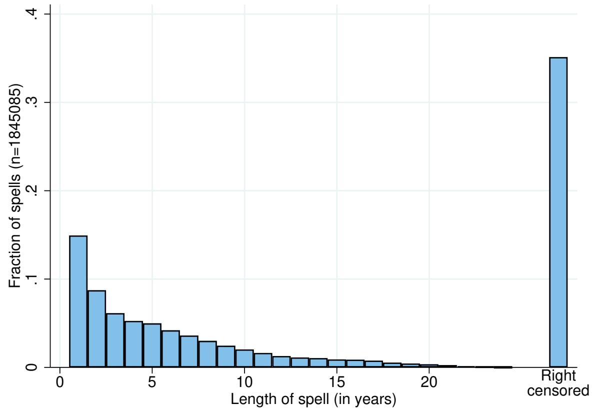
Notes. This figure plots a time series of participation in private pensions over time. The blue line gives the participation rate for the whole population, while the red line restricts attention to those aged 60 or under. An individual is said to be participating in private pensions in a given year t if they put money into a private pension either in the current year or in a past year. Participation has occurred if either of the following two items in the tax records is nonzero: TR 3.3.5, which records deductible payments to an Individual Pension Scheme (IPS), or TR 4.5.1, which records capital in an Individual Pension Account (IPA).

FIGURE E.19: Prevalence of private pensions amongst exiters by spell length



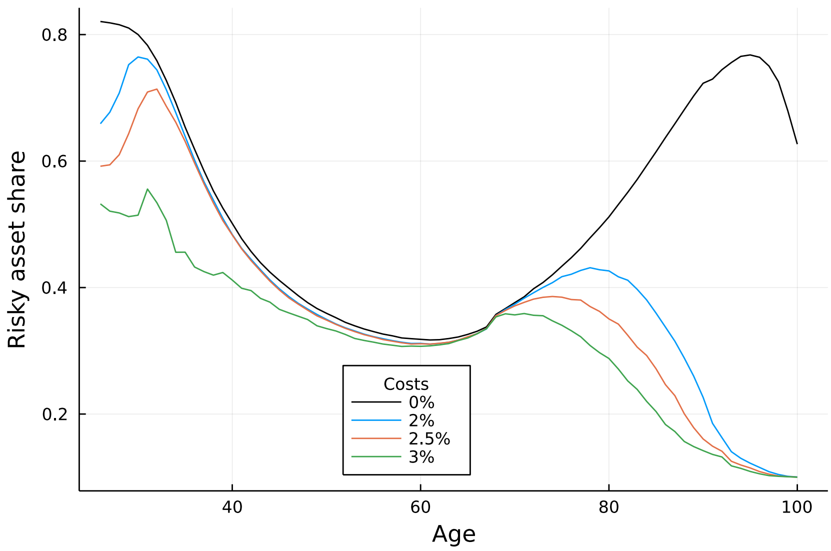
Notes. This figure shows the proportion of exiters of different spell lengths participating in private pension accounts as of their exit year. An individual is said to be participating in private pensions in their exit year if they put money into a private pension either in the current year or in a past year. Participation has occurred if either of the following two items in the tax records is nonzero: TR 3.3.5, which records deductible payments to an Individual Pension Scheme (IPS), or TR 4.5.1, which records capital in an Individual Pension Account (IPA). The far-left bar (spell length of zero) gives the prevalence of private pensions shocks over nonexit observations (i.e., continuing participants). The far-right bar groups all exiters with spell lengths above 10 years. 95% confidence intervals are shown.

FIGURE E.20: Spell length distribution excluding individuals with a private pension account



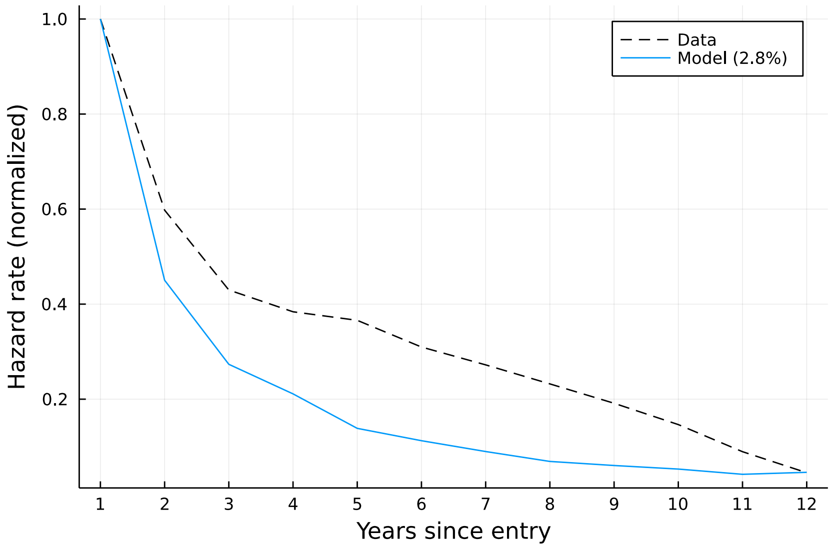
Notes. This histogram plots the proportion of spells of different lengths in the Norwegian data excluding individuals who at any point in the sample hold a private pension account. Participation has occurred if either of the following two items in the tax records is nonzero: TR 3.3.5, which records deductible payments to an Individual Pension Scheme (IPS), or TR 4.5.1, which gives capital in an Individual Pension Account (IPA). The x-axis gives the spell length (in years) and the y-axis shows the proportion of spells belonging to a particular spell length. The far-right bar gives the proportion of these spells that are right censored.

FIGURE E.21: Model without beliefs: conditional risky share



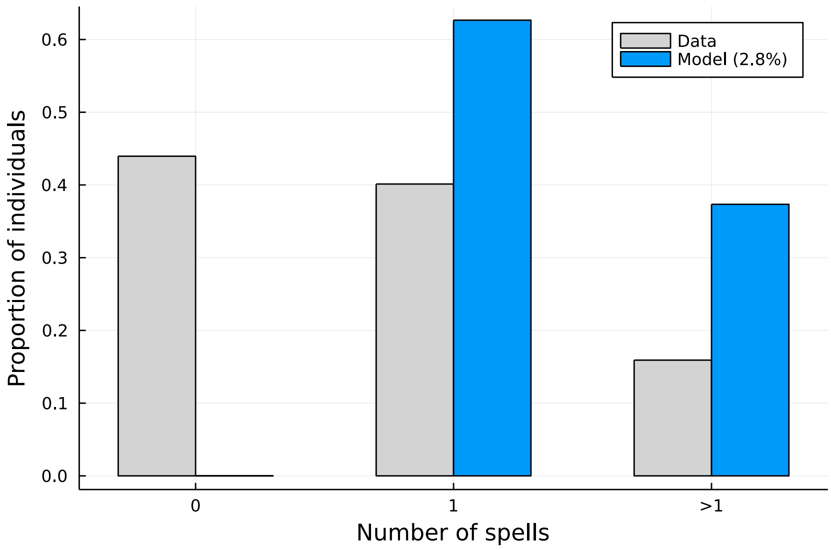
Notes. This figure plots the average risky asset share α_{it} conditional on participating in the stock market ($\alpha_{it} > 0$) for the model without beliefs ($b_{it} = 1\ \forall i, t$). The share is plotted for different values of per-period costs. Entry costs are set to zero in all cases.

FIGURE E.22: Model without beliefs: hazard rate for exit



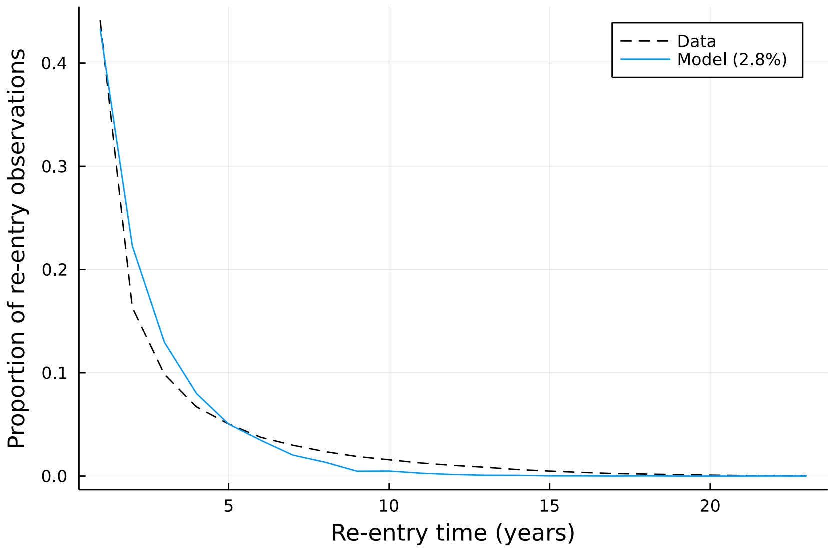
Notes. This figure plots the hazard rate for exit in the model without beliefs ($b_{it} = 1\ \forall i, t$). Per-period costs $\bar{F}^1$ are set at 2.8% of permanent income and entry costs are set to zero. The hazard rate at 1 year after entry is normalized to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified (see Section 3.1.2).

FIGURE E.23: Model without beliefs: number of spells



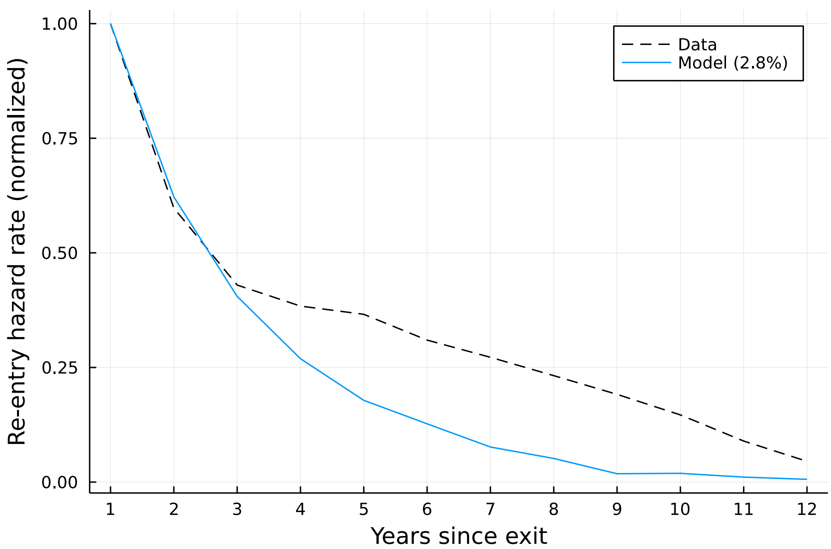
Notes. This figure plots the distribution of the number of spells in the simulated population for the model without beliefs ($b_{it} = 1\ \forall i, t$). Per-period costs $\bar{F}^1$ are set at 2.8% of permanent income and entry costs are set to zero. The empirical distribution for the Norwegian population is also shown (see Figure 9).

FIGURE E.24: Model without beliefs: reentry times



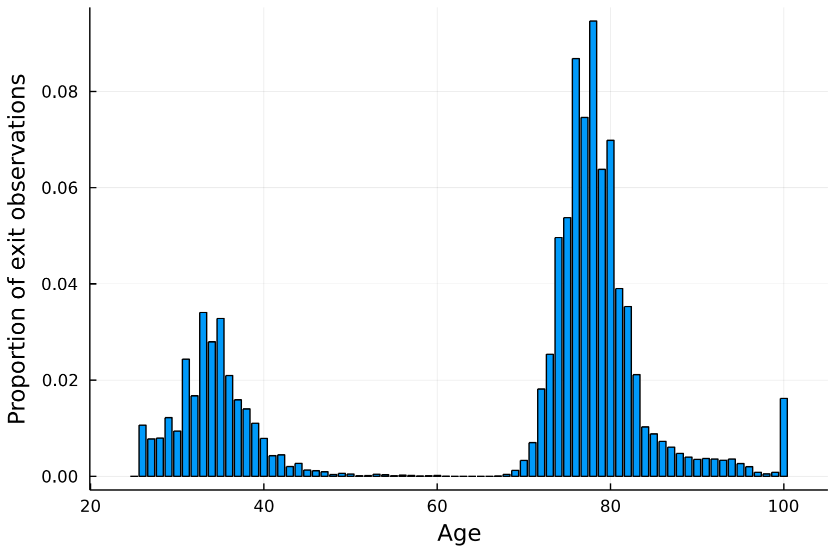
Notes. This figure plots the distribution of reentry times in the model without beliefs ($b_{it} = 1\ \forall i, t$). Per-period costs $\bar{F}^1$ are set at 2.8% of permanent income and entry costs are set to zero. The empirical proportion from the Norwegian data is also shown (see Figure 11).

FIGURE E.25: Model without beliefs: hazard rate for reentry



Notes. This figure plots the hazard rate for reentry in the model without beliefs ($b_{it} = 1\ \forall i, t$). Per-period costs $\bar{F}^1$ are set at 2.8% of permanent income and entry costs are set to zero. The hazard rate at 1 year after exit is normalized to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified (see Sections 3.1.2 and 3.2.3).

FIGURE E.26: Model without beliefs: exit points by age

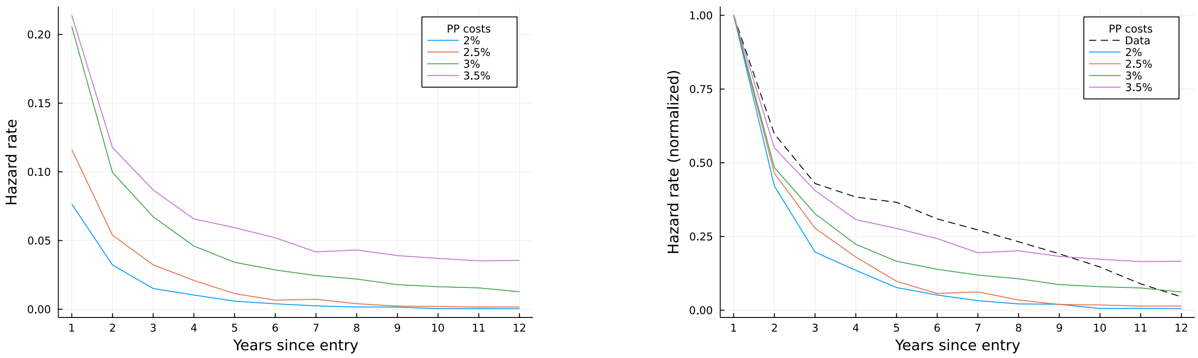


Notes. This figure plots the proportion of exit observations by age in the model without beliefs ($b_{it} = 1\ \forall i, t$). Per-period costs $\bar{F}^1$ are set at 2.8% of permanent income and entry costs are set to zero.

FIGURE E.27: Model without beliefs: hazard rate for exit under different per-period costs

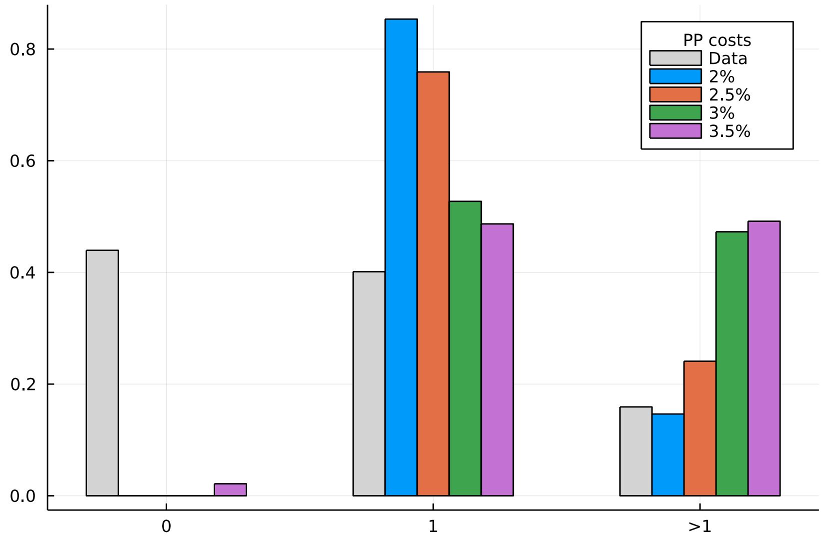
(A) Levels

(B) Slope (normalized)



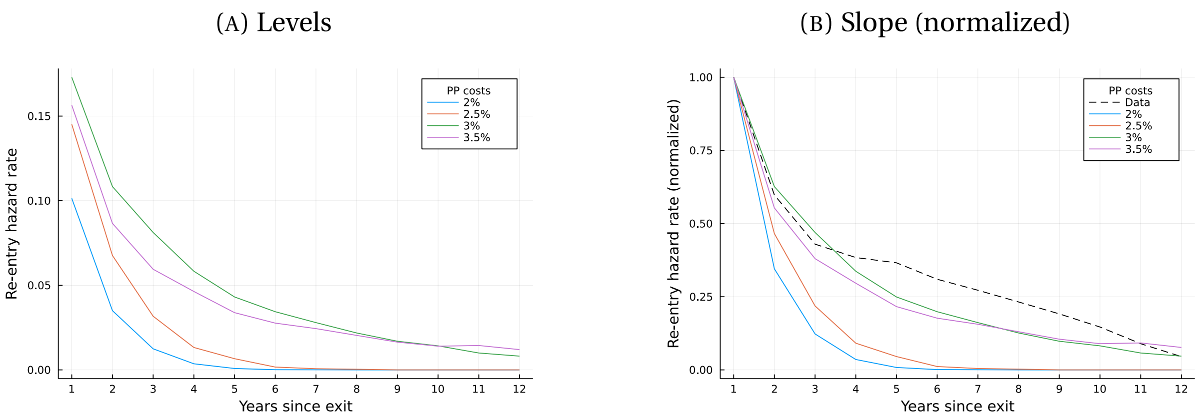
Notes. This figure plots the hazard rate for exit in the model without beliefs ($b_{it} = 1\ \forall i, t$) for different levels of per-period participation costs $\bar{F}^1$. Entry costs are set to zero. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after entry to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified. The empirical hazard function is also shown in panel (B).

FIGURE E.28: Model without beliefs: number of spells under different per-period costs



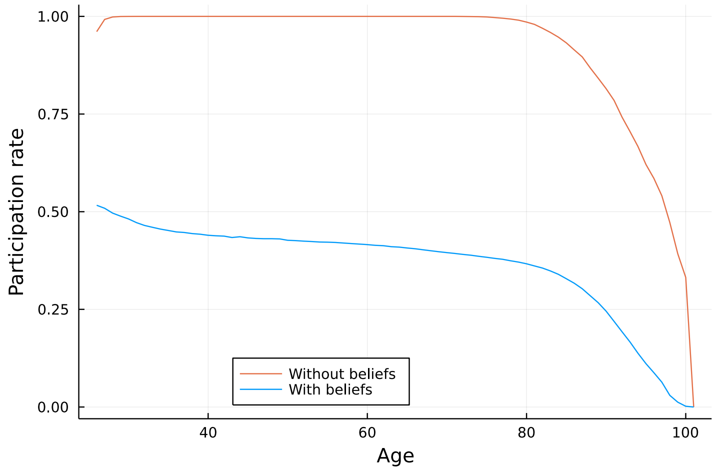
Notes. This figure plots the distribution of the number of spells in the simulated population for the model without beliefs ($b_{it} = 1\ \forall i, t$) and under different levels of per-period participation costs. Entry costs are set to zero. The empirical distribution for the Norwegian population is also shown (see Figure 9).

FIGURE E.29: Model without beliefs: hazard rate for reentry for different per-period costs



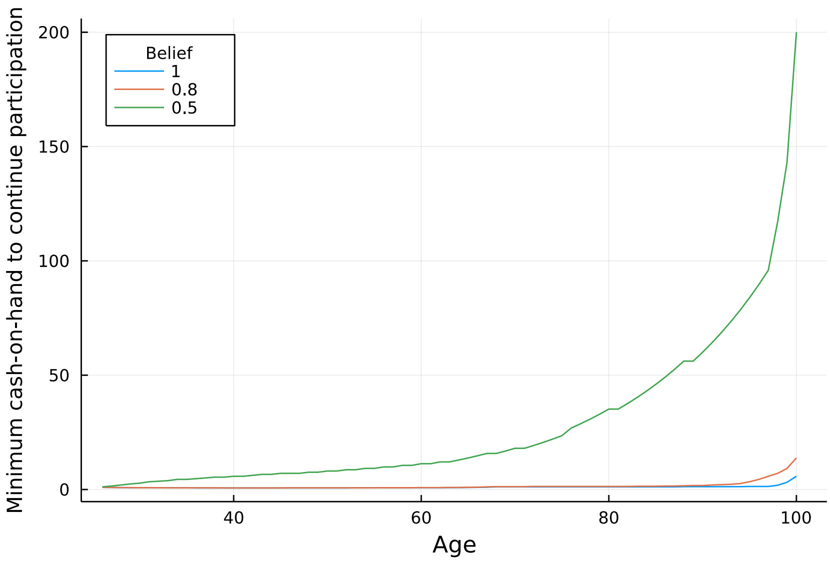
Notes. This figure plots the hazard rate for reentry in the model without beliefs ($b_{it} = 1\ \forall i, t$) for different levels of per-period participation costs $\bar{F}^1$. Entry costs are set to zero. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after exit to 1 to facilitate comparison with the empirical hazard function, for which only the slope of the hazard function is identified. The empirical hazard function is also shown in panel (B).

FIGURE E.30: Model with beliefs: simulated participation rates



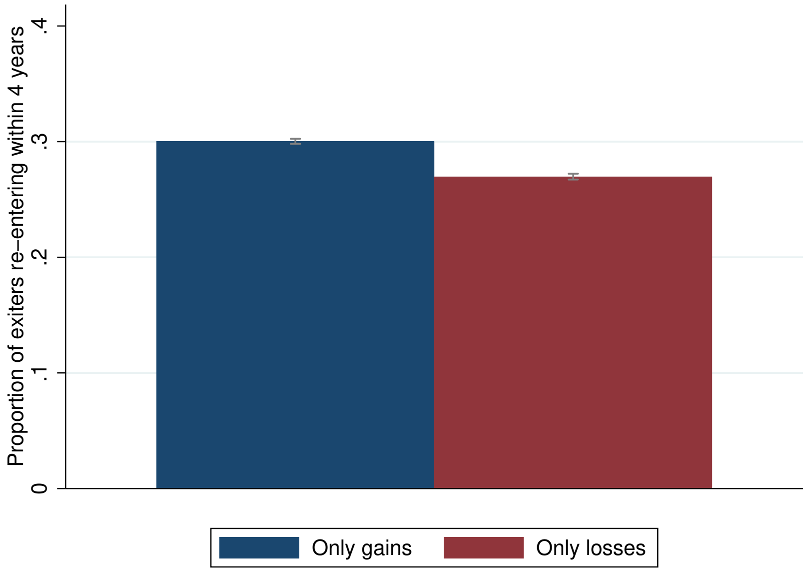
Notes. This figure plots the simulated participation rate over age in the models with and without beliefs. Entry and per-period costs are both set to 0.5% of permanent income in the two models.

FIGURE E.31: Minimum wealth needed to continue participation for different beliefs



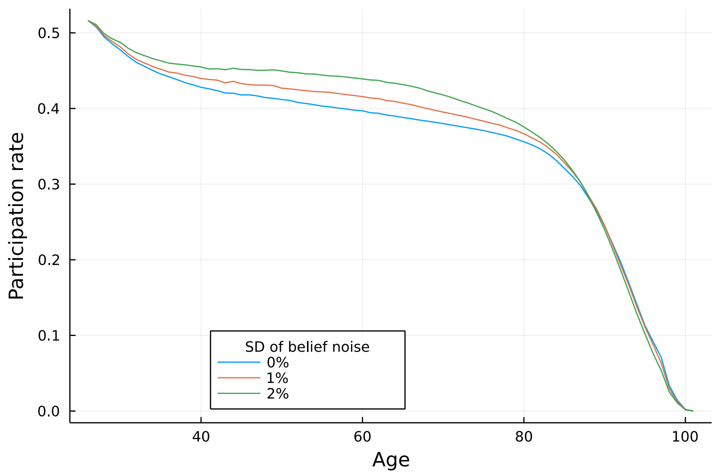
Notes. This figure plots the minimum wealth required to continue participating at different ages for three different values of beliefs $b_{it} \in \{0.5, 0.8, 1\}$.

FIGURE E.32: Proportion of exiters reentering within 4 years by prior performance



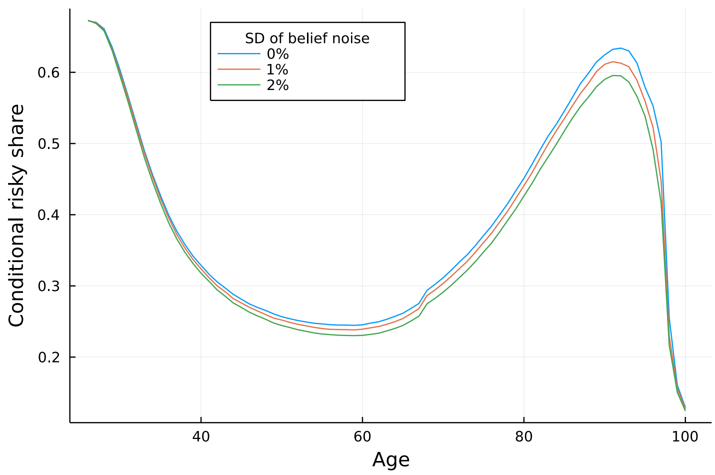
Notes. This figure plots the proportion of exiters who reenter into the stock market within the next 4 years based on their prior performance as measured by the report of taxable gains and tax-deductible losses. The left bar shows the proportion of exiters who only report taxable gains in their exit year who reenter in the next 4 years. The right bar shows the corresponding proportion for exiters reporting only losses. We use exiters who exit between 2006 and 2014 in these plots.

FIGURE E.33: Model with beliefs: simulated participation rates for different σ_ν



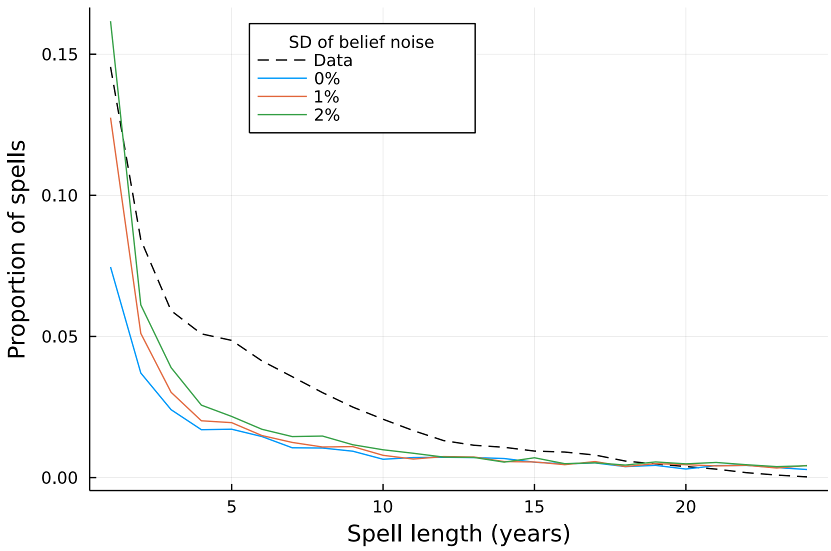
Notes. This figure plots the simulated participation rate over age in the model with beliefs for different values of the standard deviation of belief shocks σ_ν. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income.

FIGURE E.34: Model with beliefs: conditional risky asset share for different σ_ν



Notes. This figure plots the average conditional risky asset share over age in the model with beliefs for different values of the standard deviation of belief shocks σ_ν. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income.

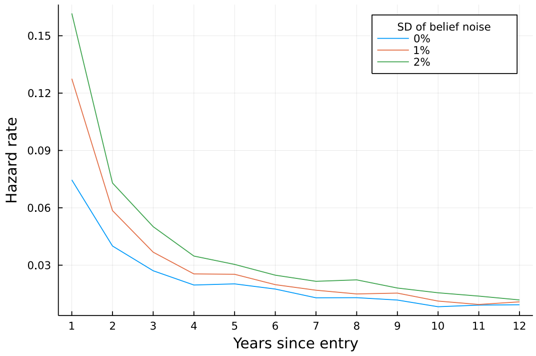
FIGURE E.35: Model with beliefs: spell length distribution for different σ_ν



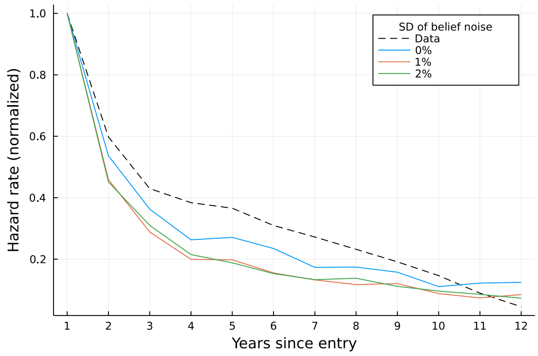
Notes. This figure plots the distribution of spell lengths in the model with beliefs for different values of the standard deviation of belief shocks σ_ν. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income.

FIGURE E.36: Model with beliefs: hazard rate for exit under different σ_v

(A) Levels

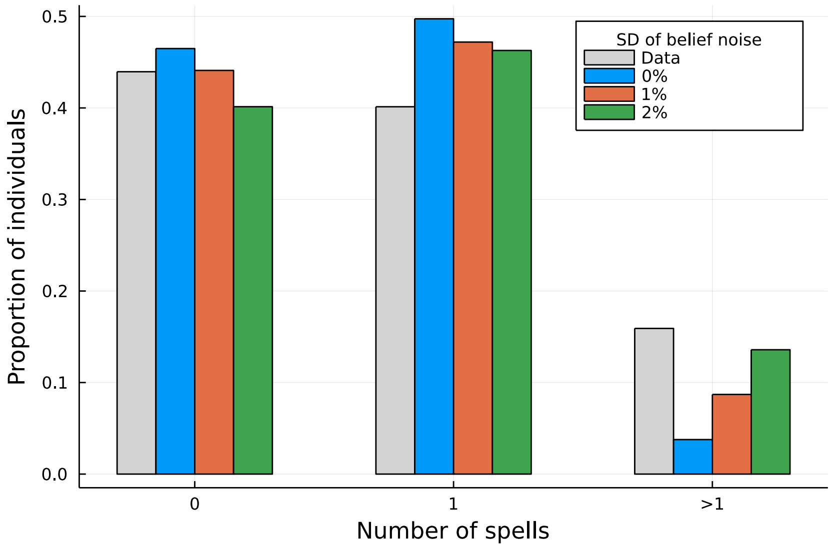


(B) Slope (normalized)



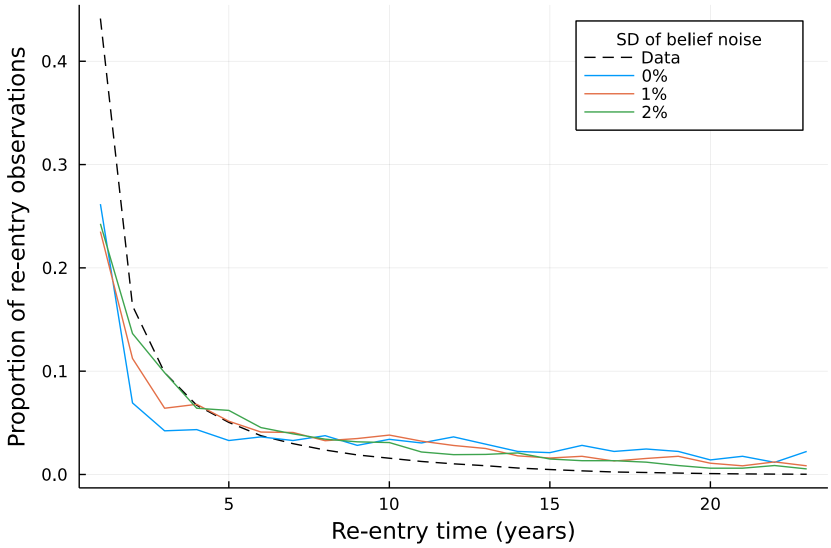
Notes. This figure plots the simulated hazard rate for exit in the model with beliefs for different values of the standard deviation of belief shocks σ_v. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after entry to 1, and shows the slope of the hazard function. The empirical hazard function is also shown in panel (B).

FIGURE E.37: Model with beliefs: number of spells under different σ_v



Notes. This figure plots the distribution of the number of spells in the model with beliefs for different values of the standard deviation of belief shocks σ_v. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income.

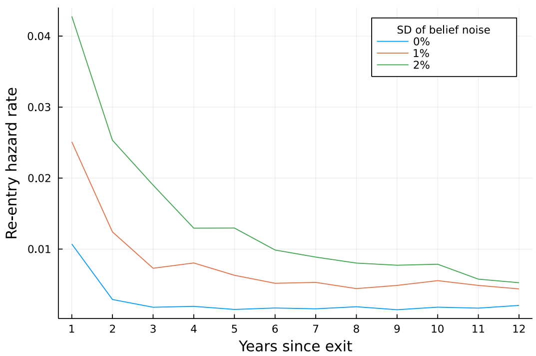
FIGURE E.38: Model with beliefs: reentry time distribution under different σ_ν



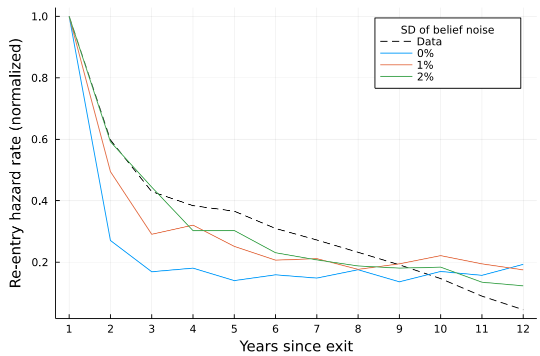
Notes. This figure plots the distribution of reentry times in the model with beliefs for different values of the standard deviation of belief shocks σ_ν. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income.

FIGURE E.39: Model with beliefs: hazard rate for reentry under different σ_ν

(A) Levels

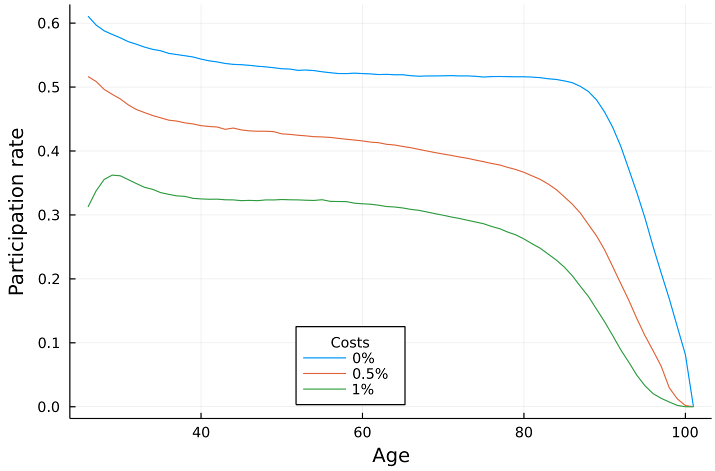


(B) Slope (normalized)



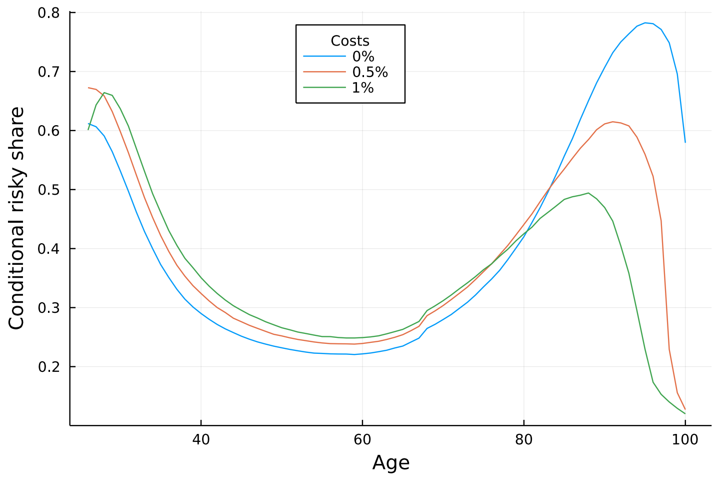
Notes. This figure plots the simulated hazard rate for reentry in the model with beliefs for different values of the standard deviation of belief shocks σ_ν. We consider 3 values: 0%, 1% (baseline), and 2%. Both entry and per-period costs are set at 0.5% of permanent income. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after exit to 1, and shows the slope of the hazard function. The empirical hazard function is also shown in panel (B).

FIGURE E.40: Model with beliefs: simulated participation rates under different participation costs



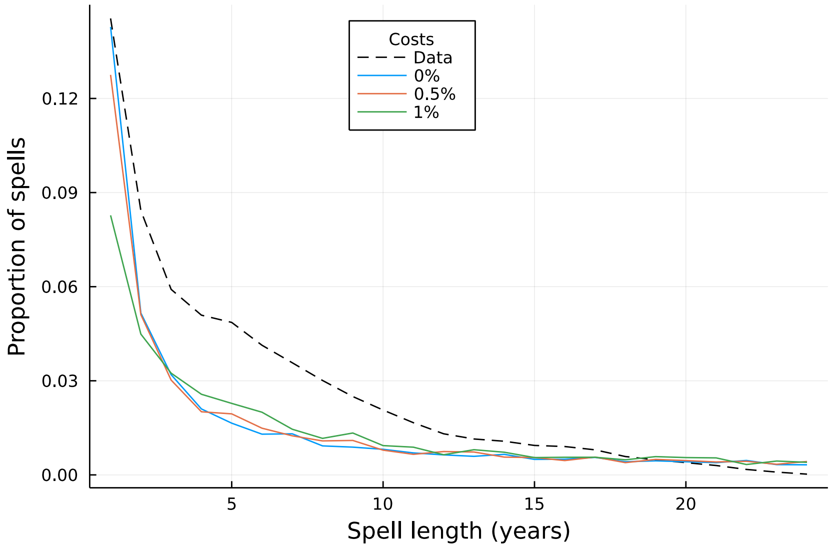
Notes. This figure plots the simulated participation rate over age in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs.

FIGURE E.41: Model with beliefs: conditional risky asset share under different participation costs



Notes. This figure plots the average conditional risky asset share over age in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs.

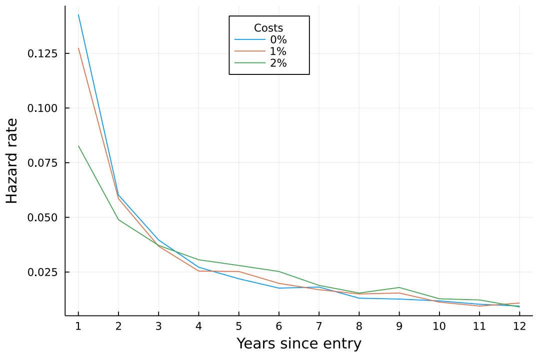
FIGURE E.42: Model with beliefs: spell length distribution under different participation costs



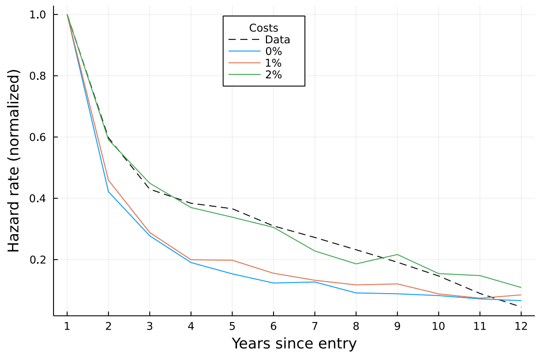
Notes. This figure plots the spell length distribution in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs.

FIGURE E.43: Model with beliefs: hazard rate for exit under different participation costs

(A) Levels

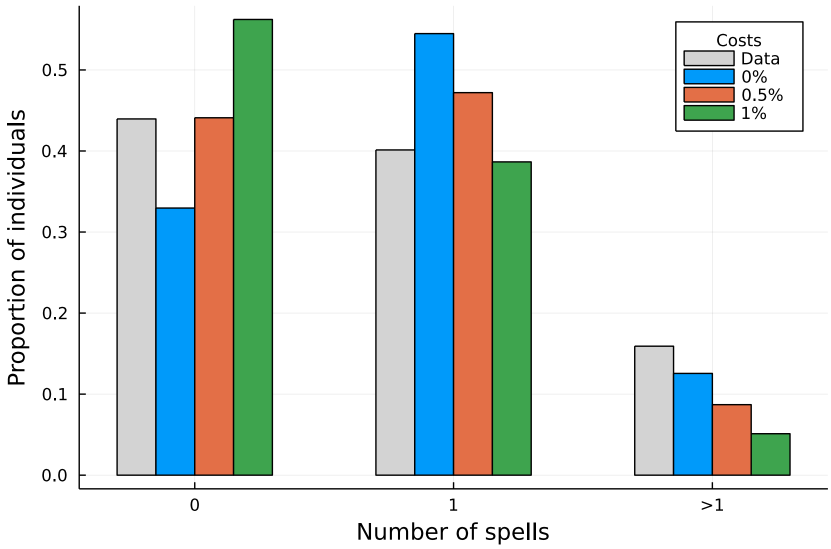


(B) Slope (normalized)



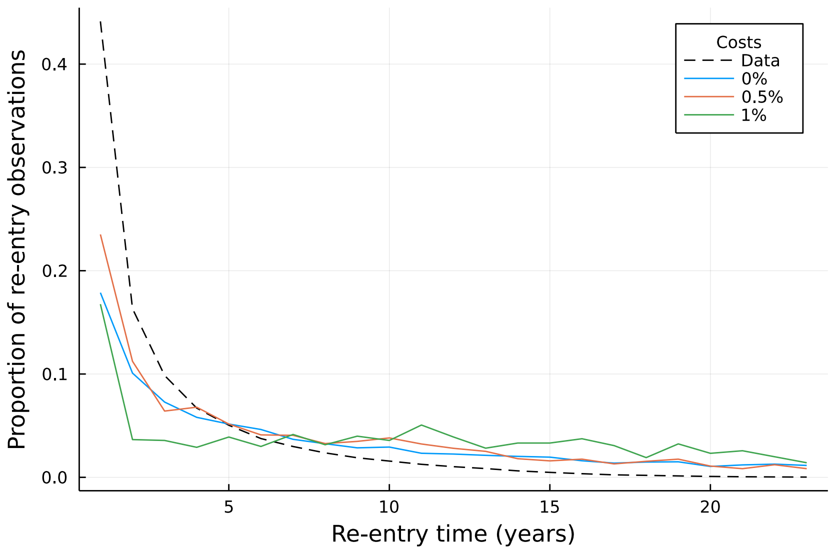
Notes. This figure plots the simulated hazard rate for exit in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after entry to 1, and shows the slope of the hazard function. The empirical hazard function is also shown in panel (B).

FIGURE E.44: Model with beliefs: number of spells under different participation costs



Notes. This figure plots the distribution of the number of spells in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs.

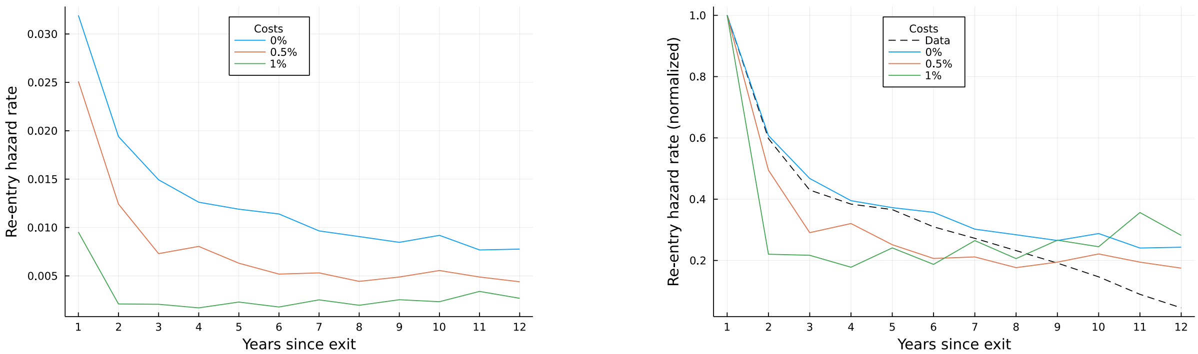
FIGURE E.45: Model with beliefs: reentry time distribution under different participation costs



Notes. This figure plots the distribution of reentry times in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs.

FIGURE E.46: Model with beliefs: hazard rate for reentry under different participation costs

(A) Levels (B) Slope (normalized)



Notes. This figure plots the simulated hazard rate for reentry in the model with beliefs under different values of participation costs. We consider 3 values: 0%, 0.5% (baseline), and 1%. We apply this value to both entry and per-period costs. Panel (A) gives the hazard rates in levels in each case. Panel (B) normalizes the hazard rate in the year after exit to 1, and shows the slope of the hazard function. The empirical hazard function is also shown in panel (B).