Household Portfolios and Retirement Saving over the Life Cycle*

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Abstract

This paper documents the share of investable wealth that middle-class U.S. investors hold in the stock market over their working lives. This share rises modestly early in life and falls significantly as people approach retirement. Prior to 2000, the average investor held less of their investable wealth in the stock market and did not adjust this share over their working life. These changes in portfolio allocation were accelerated by the Pension Protection Act (PPA) of 2006, which allowed employers to adopt target date funds (TDFs) as default options in retirement saving plans. Young retail investors who start at an employer shortly after it adopts TDFs have higher equity shares than those who start at that same employer shortly before the change in defaults. Older investors rebalance more to safe assets. We also study retirement contribution rates over the lifecycle and find that average retirement saving rates increase steadily over the working life. In contrast to what we find for investment in the stock market, contribution rates have been stable over time and across cohorts and were not increased by the PPA.
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The financial environment facing the typical American household has changed dramatically over the past four decades, as defined-contribution pension plans have spread, the costs of investing have declined, and regulations have evolved. In this paper, we use individual investors account-level data from 2006 and 2018 to characterize the life-cycle portfolio and saving behavior of American middle-class and upper-middle class investors with some retirement saving. We have three main sets of results.

First, we document that the share of wealth held in the stock market by typical American investors is hump-shaped over the working life, increasing until around age 50 and declining thereafter as investors approach retirement. Investors also hold a relatively high share of their wealth in equity on average, roughly 70%. These two findings represent a significant change in behavior. In the 1990's, equity shares documented in similar data were lower and rebalancing was largely unrelated to age (Ameriks and Zeldes, 2004). These two findings are not as visible in survey data (the Survey of Consumer Finances, SCF) partly due to mis-estimation of equity shares in hybrid funds.

Second, we find that these changes in retail investor behavior were accelerated by financial innovation and regulation, specifically by Target Date Funds (TDFs) and the Pension Protection Act of 2006 which allowed the use of TDFs as default investment options in employer-sponsored retirement plans. We use the quasi-exogenous variation between investors who enroll in a given retirement plan just before and just after it switches its default investment funds to TDFs. Consistent with the age-dependent asset allocations of TDFs, the change to a TDF default leads lower-income, younger investors to invest a greater share in the stock market and older workers to invest a lower share. Both effects decrease over time, as more investors adopt TDFs and TDF-like strategies.

Third, in contrast to portfolio allocations, retirement saving rates have a monotone increasing lifecycle pattern that is relatively stable over time and across cohorts. In our sample of investors with some retirement wealth, saving rates increase steadily with age, almost doubling between age 25 and 65. Their stability over time suggests at most minor effects of retirement saving products and changes in regulations designed to increase retirement saving over the past two decades.

As nicely elucidated in Campbell (2016), the institutions and laws surrounding household finance can be structured to improve the financial decision making of market participants. Our findings suggest that the fund design and regulation of TDFs has moved the average portfolios of retail investors towards the age pattern recommended by most prescriptive models of portfolio choice. Over the same time period, changes in retirement plan regulation and structure, most notably default contribution rates and automatic re-enrollment, have seemingly had little effect on retirement saving rates, which are remain lower that those recommended by most prescriptive models of saving and wealth accumulation (e.g. Poterba, 2014; Gomes et al., 2018; Duarte et al., 2021).

Our findings are based on an analysis of anonymized, account-level data from a large financial services company. The data contain the portfolios, individual trades, and detailed characteristics of millions of investors covering more than a trillion dollars in investable wealth. The size of our data set allows us to identify a sub-sample that is reasonably representative of the "typical" American retail investor with some retirement savings: investors with retirement savings accounts in the middle 80% of the age-adjusted distribution of retirement wealth, who we call *retirement investors* (RIs). Our analysis focuses on *investable wealth*, defined as stocks, bonds, and investment funds in retirement accounts and non-retirement brokerage accounts, and excluding bank accounts, durable goods, and housing, and on *saving rates* defined primarily as (realized) retirement contribution rates (the vast majority of inflows into financial wealth among our retirement investors).

We first document that during the last two decades this sample of US middle-class and upper-middle class investors on average held 70% of their investable wealth in the stock market, a share that is significantly higher than in prior decades. Second, across age, controlling for birth cohorts, the lifecycle pattern in equity allocations is hump-shaped. A cohort's average equity share increases by 7% as people age from 25 to 50 (and moves through calendar time), and then falls by the same amount from age from 50 to 65, as people reallocate financial wealth into safer assets, such as fixed income or cash-like securities.

These behaviors are markedly different from earlier time periods. Using similar administrative data on retirement savings prior to 2000, Ameriks and Zeldes (2004) reports an average equity share of only 58% and no re-balancing out of equities as people aged. These results are also different from leading survey evidence. The 2016 SCF shows an average share of only 54% of investable wealth allocated to equities in a comparable sample. Similarly, the SCF shows a reduction in equity shares with age that is only a third as large. We present several pieces of evidence that this difference is partly driven by a combination of mis-reporting and SCF data processing assumptions. In particular, both appear to underestimate the average equity share and its age-dependence in hybrid funds such as TDFs. While these findings highlight the benefits of administrative data, particular for products designed for less sophisticated investors, some residual differences remain and may reflect the policies of our data provider.

We also observe significant changes in behavior across ten-year birth cohorts. Each younger cohort has a higher equity shares than the prior cohort did at the same age. For example, cohorts born after 1970 have higher equity shares *at every (overlapping) age* than the previous, older cohorts. We also find that younger cohorts rebalance more as they age than older cohorts. This pattern is similar across terciles of ex-ante income, and while log income differences explain about half of the *level* differences in equity shares across people, the lifecycle pattern of income does not change the life-cycle pattern in equity shares.

Why has investor behavior changed from the 1990s? We show that the increased allocation to equity and the rebalancing over the life-cycle into safe assets was significantly accelerated by the growth of TDFs facilitated by changes in pension law. TDFs are mutual funds that automatically rebalance portfolio shares across different asset classes as people age. For investors more than 25 years before their target retirement date, a typical TDF maintains 80% to 90% of its assets in diversified stock funds and the remainder in bond funds. About 20 years before the retirement date, a TDF typically starts re-balancing the portfolio towards safe assets so as to reach a roughly even allocation between stocks and bonds by retirement.

TDFs grew rapidly following the Pension Protection Act (PPA) of 2006 which sanctioned the use of TDFs as "Qualified Default Investment Alternatives" (QDIA) in employer-sponsored retirement plans.[1] Prior to the PPA, most QDIAs were money market funds (which do not invest in stocks). Following the PPA and the employer adopting a TDF

[1] As discussed for example in Parker et al. (2020), investments in TDFs increased dramatically after the PPA of 2006, reaching $2.3 trillion in 2019 (Investment Company Institute, 2020).

as the default fund, new employees who did not choose allocations were defaulted into TDFs, which would hold 80-90% of its wealth in stocks for a younger worker. Additionally, new hires who did make active decisions may have been influenced by the default option. Initially, existing plan participants (existing employees) were unaffected by the change in the default option.[2]

We estimate the effect of having a TDF as the QDIA by comparing the portfolios of people who enroll in a retirement plan in the two years before the PPA to the portfolios of those who first enroll in the same plan in the two years after, holding constant the employer. Because the PPA permitted but did not require employers to change the default allocation, we focus on firms that adopted TDFs as defaults in 2007 or 2008.[3] The main identifying assumption is that the change in default options does not cause employers to choose workers with different portfolio preferences or workers to choose different employers. Both of these possibilities are unlikely given what we know about labor market participation.

The adoption of a TDF as the QDIA leads younger new enrollees to invest more of their financial wealth in the stock market compared to those starting prior to the switch at the same employer. The youngest cohort (people 25-35 years old at job start) increase the share of their portfolios invested in stocks by more than 5%. Consistent with the glide path of TDFs, the adoption of a TDF as the default fund reduces the share of older workers' portfolios invested in stocks.

These effects of default investments are persistent but decline over the five years following enrollment. For lower-income, younger workers, the increase in equity share halves over the five years following enrollment. For older workers, the relative reduction disappears entirely. This convergence is driven by the control group, those investors that were not defaulted into TDFs. Thus, investors who enrolled before the default changed still over time adopted TDFs or TDF-like strategies, perhaps in response to advertising, financial advice, or peer effects from their co-workers. We conjecture that the sanctioning of TDFs and their implied lifecycle glide paths by the PPA, as well as their subsequent adoption

[2]Over time, many plans have adopted regular automatic re-enrollment, in which existing employees are re-enrolled and must either make active choices or be defaulted into their plan's defaults.

[3]We also repeat the analysis for all employers independent of their default option, though these estimates are much noisier since many employers took many years to change their default options.

by retirement plan sponsors and administrators, led to the more widespread adoption of TDFs and TDF-type strategies through many channels besides default investment funds.

In the third and last part of our paper, we show that, unlike in the case of portfolio allocations, there has been little change in retirement savings behavior across cohorts over time. Measuring a person's retirement savings rate as their annual contribution to their retirement saving plans as a share of their income, average retirement saving rates across all birth cohorts are 4.5% at age 25 and 8.5% at 65 years of age.[4] Tracking birth cohorts or even individuals over time, we find that between the age of 25 and 65 the average person increases their contribution rate by about 4.5%. This pattern does not change much across cohorts. The oldest cohort, those born between 1943 and 1953, have contribution rates that are about 0.5% higher in levels than the other cohorts. However, younger cohorts see slightly higher within-person changes as they age. Thus average changes in savings rates across cohorts are negligible.

In contrast, there is significant heterogeneity in the level of contribution rates across income terciles, Across all ages, the bottom tercile of the income distribution has an almost 2% lower contribution rate than the top tercile: 3.9% compared to 5.7% at age 25, and 7.3% compared to 9.2% at age 65. This pattern again stayed constant across birth cohorts.

Finally, comparing people enrolling before and after the PPA — which included a number of provisions intended to increase savings (Choi et al., 2004) — we find that people enrolling after the Act had similar contribution rates to those enrolling before the Act. In sum, despite large changes over time in plan design and regulation as well as in portfolio holdings, contribution rates to retirement saving plans among our sample of retirement investors have remained remarkably stable.

Related Literature Our paper is most closely related to papers that use administrative data to measure household portfolio allocations over the lifecycle, in particular Ameriks and Zeldes (2004). Poterba and Samwick (2001) also finds significant cohort effects in portfolio allocations over the life cycle. Administrative data from Norway shows that

[4] This measure includes automatic payroll deductions or auto escalation programs, but excludes any re-balancing flows or portfolio appreciation. We also check that our main conclusions are not related to people hitting the legal limit on tax advantaged contributions in a year, which occurs for 6-9% of our sample.

Norwegian investors have a hump-shaped equity allocation (Fagereng et al., 2017). There are substantial differences in portfolios across countries, see (Guiso et al., 2003b,a), and for example Christelis et al. (2013) shows that U.S. households have higher levels of stock ownership and stock market participation than most European households (49.7% versus 26%). Gomes and Smirnova (2021) estimates a lifecycle model for U.S. households and also finds a hump-shaped pattern in age.

We also contribute to a growing literature on the institutional causes of portfolio behavior. McDonald et al. (2019) studies changes in fund selection by new participants following changes in default investment funds in retirement plans in 2012. Mitchell and Utkus (2020), using Vanguard data, looks at the effect of TDFs on existing employees and new entrants under both voluntary choice and automatic enrollment plans. That paper shows that in voluntary enrollment plans, 28.4% of new entrants adopted a TDF in their 401(k) portfolios, compared to only 10.2% of existing employees. But in plans with automatic enrollment, 79% of new entrants chose a TDF. Similar to our findings, TDF investors held substantially more in equity: 81% for TDF investors compared to 63% for those without TDFs. Gomes et al. (2020) shows that TDFs improve investment performances due to a reduction in risk-taking in anticipation of lower expected returns.

Our paper also informs models of optimal portfolio choice (see the surveys Curcuru et al., 2010; Wachter, 2010). Merton (1969) and Samuelson (1969) provide canonical models in which portfolio allocations are constant over the life cycle and scale-invariant. A large body of research derives optimal portfolio choice in more complex models, the most pertinent example of which is the case where investors receive realistic stochastic, non-tradable "endowment" income over their working lives, which generally implies that investors should reduce holdings of risky assets over their life cycle, see Viceira (2001), Heaton and Lucas (2000), Campbell and Viceira (2002), Benzoni et al. (2007), Gomes et al. (2020), and Storesletten et al. (2007). Other examples include non-standard utility functions, differences in risk aversion, and differences in beliefs.[5]

For the lifecycle pattern of savings rate, we relate to a large prescriptive literature

[5]For utility functions see Carroll (2000), Wachter and Yogo (2010), and Meeuwis (2019); for risk aversion see Ameriks et al. (2015) and Ameriks et al. (2019), and for beliefs see Meeuwis et al. (2018) and Giglio et al. (2021).

concerned with what amount of saving households should be doing (e.g. Lusardi and Mitchell, 2007; Scholz et al., 2006), and a large positive literature estimating models from saving profiles assuming optimal behavior (e.g. Gourinchas and Parker, 2002). When looking at contribution rates, Gomes et al. (2018) suggests that more than 75% of US retirement savers display a significant shortfall in their contributions relative to an optimal consumption model. Poterba et al. (2011) similarly shows that households have inadequate financial wealth to support retirement, and for more than 70% of households, social security is their major asset.

Finally, our findings contribute to a growing literature evaluating the overall impact of defaulting people into savings allocations. Madrian and Shea (2001) and Choi et al. (2004) find very large effects of default enrollment for participation and savings rates in DC plans early in the introduction of these automatic enrollment options. More recently a couple of papers have found that these allocations might be partially undone by other choices people make.

1 Data

This section describes the account-level data set and then how we create a subsample that is representative of typical American retirement investors over their working lives.[6]

1.1 Account-level data

Our main data set contains anonymized, account-level data on financial holdings from a large US financial institution. For each investor, the data contain information on all their accounts held at the firm. For these accounts, we observe end-of-month account balances and holdings, and all inflows, outflows, and transfers at a daily frequency. We observe assets at the CUSIP level for 87% of wealth. For the remaining 13% we observe the characteristics of the fund the wealth is invested in. We aggregate accounts at the (de-identified) individual level and track each individual's portfolio. The data cover millions of

[6] In a method closely related to Meeuwis et al. (2018)

investors and trillions in financial wealth. Our sample uses information from December 31, 2006 to December 31, 2018. We use the data at an annual frequency. We measure balances and holdings at the end of each calendar year by aggregating all observed flows within each calendar year. When we observe joint accounts for married couples, we allocate the funds to the spouse who has more total individual assets.

We focus on *investable wealth* defined as money market funds, non-money market funds, individual stocks and bonds, certificates of deposit, quasi-liquid retirement wealth, and other managed accounts.[7] We classify fund and security holdings into equity, long-term bonds, short-term bonds, and alternative assets (e.g. real estate and precious metals). Multi-class funds, also known as Target Date Funds (TDFs) or hybrid funds, are split between equity and fixed income in proportion to the observed equity share of the fund. Table I provides detailed variable definitions.

In addition to account-level portfolio information, we observe each investor's age, gender, zip code, and marital status (and an (imperfect) link to the partner if they also have accounts at the firm). For a subsample of the data, we also observe an anonymized employer indicator, 3-digit NAICS code of the employer's industry, employment tenure, and, for a further subsample, gross annual wage income. We annualize all income observations by scaling up part-year incomes to a full-year equivalent.

1.2 Retirement investor subsample

While these data provide a detailed view of portfolio allocations for a large number of US investors, there are two potential limitations of our data. First, while we observe a significant share of US investors, this is obviously not a randomly selected sample. In particular, most of the wealth we observe is held in retirement savings accounts and few investors have a very high net worth (as we document subsequently). We would like to understand the relationship between our sample and a similar subsample of the US population. The second potential limitation is that we do not necessarily observe all of

[7] Excluded categories of financial wealth are checking and savings accounts, saving bonds, cash value of life insurance, and other financial assets.

people's investable wealth because we do not observe wealth at other institutions.[8]

In order to both minimize and evaluate the importance of these two concerns, we define a sub-sample of people that are well-represented in our data and we can confirm are broadly similar to the same sub-sample in the US population. Our firm's data mainly includes typical working Americans with retirement saving during their working lives. This allows us to define a sample of *retirement investors* (RIs) that we can compare to a similarly-defined sample in the Survey of Consumer Finances (SCF).

First, we restrict our retirement investors sample to investors that are between 25 and 65 years of age. We exclude the youngest members of the sample because they typically have very low levels of investable wealth. By selecting 65 as the upper-bound, we avoid the issue that there is significant attrition among older investors in our data. Thus, our analysis focuses on working-age investors and so mostly on investors with labor income. Second, we drop investors with extremely high or low levels of retirement wealth, where *retirement wealth* consists of all investable wealth in retirement saving accounts of all types (excluding defined benefit plans and Social Security). We drop low wealth investors because they may simply have wealth at other institutions. We drop high wealth individuals because they are under-represented in our data. We choose our sample based on retirement wealth rather than total investable wealth because our data has incomplete coverage of non-retirement wealth (as we discuss below).

To construct our sample of RIs, we use data from the 2016 SCF to define a consistent sample of households based on retirement wealth holding. To correspond to our data, we treat couples in the SCF as two individuals. The SCF data allows us to measure retirement wealth, wage income, and age at the individual level, but non-retirement wealth is only measured at the household level, an issue we address in the following subsection. Using individuals aged 25-85 with some retirement wealth, we run quantile regressions of the log of individuals' retirement wealth (comparable to the measures in our institution's data) on a third order polynomial in age. We then drop individuals with retirement wealth below the estimated 10th percentile or above the 90th by age.[9]

[8]The only concern is missing *investable* wealth. In both our data and the SCF, we exclude wealth in savings and checking accounts, as well as net housing wealth, defined benefit pension plans, etc.

[9]For age 30, in the SCF data, the lower bound is $1,328 and the upper bound is $66,370. For age 60, the

Individual retirement investors make up 28% of the population of US households and 38% of the population of households aged 25-65 according to the (representative) SCF. They hold 33% (39%) of all household investable (retirement) wealth and 52% (54%) of investable (retirement) wealth among households age 25-65. Approximately 33% of both retirement wealth and investable wealth is held by the top 10%. Approximately 30% of retirement wealth and investable wealth is held by those aged 66-85.

In our data, retirement investors – individuals between 25 and 65 and in the middle 80% of the distribution of retirement wealth at each age – make up 73% of accounts that we observe and hold 75% of all retirement wealth. Our sample of retirement investors contains millions of individual investors and well more than a trillion in investable wealth.

1.3 Descriptive statistics and comparison to SCF

The top panel of Table II shows summary statistics for our sample of retirement investors in 2016.[10] In our RI sample, the average age is 45 years old, and the average (median) wage income is $101,384 ($74,230). About 55% of the sample are male and 70% are married. The average portfolio beta is 0.75, and nearly half of investable wealth, on average, is allocated to target date funds. The average retirement wealth is $96,000. The bottom panel of Table II shows analogous statistics for the population of US retirement investors as estimated from the 2016 SCF. The average age is 47, the average (median) wage income is a lower $66,459 ($50,000), about half are male, and a slightly higher 78% of investors are married.[11] In terms of wealth, the average investor in the SCF RI sample lives in a household with approximately $273,000 of investable wealth and has $98,000 in retirement wealth themselves (bottom panel of Table II), comparable to the average in our sample.[12]

Figure 1 shows that the retirement wealth distribution of our RI sample lines up well

lower bound is $6,774 and the upper bound is $744,000. See Appendix Figure A.1

[10]Appendix Table A.1 shows the same statistics for our entire sample period, 2006-2018.

[11]Because of the way heads of households are assigned in the SCF, about 78% of respondents are male in the SCF. When including partners, the sample is evenly split between males and females.

[12]The statistics in Table II are representative of our retirement sample of middle class Americans with retirement wealth. They are not representative of the assets under management for a typical firm, since we are explicitly dropping the highest wealth households whose wealth mostly lies outside of retirement accounts.

with individual respondents measured by the SCF. The SCF captures a somewhat higher mass of high wealth individuals, but overall the distributions are similar, suggesting that we are missing little retirement wealth at other financial institutions. Because RIs in our sample typically have most or all of their investable wealth in retirement accounts, we conclude that our sample of RIs provides a good overview of how the investable wealth of typical U.S. retail investors is allocated.

However, Table II also shows that RIs in our data have significantly less non-retirement wealth than RIs in the SCF. Is this because we miss wealth held at other institutions or because our data measure *individual* wealth and so we miss some of the assets that are common to both spouses for partnered investors? Figure 2a shows the total investable wealth distribution for individuals in our sample compared to households in the SCF (as in Table II) and confirms that we miss non-retirement wealth for wealthier individuals/households relative to the SCF.

However, the difference in wealth observed in the SCF and in our data is mainly due to the fact that the SCF measures household wealth rather than individual wealth. That is, little of the difference is due to our missing wealth held with other institutions. In our data, the sample of married households for which we observe both spouses has on average fifty percent more investable wealth. Figure 2b shows that the distributions of total household investable wealth are much more similar for this married subset of our sample and the sample of married investors in the SCF. For couples, our data matches the SCF more closely, though our sample has a slightly higher median and mean wealth than the SCF. Appendix Tables A.2 to A.3 confirm this rough similarity both for married couples and separately for single individuals. We conclude that the difference in the distribution of wealth between our RI sample and that of the SCF is primarily driven by the unit of observation – individual investor as opposed to households.

Table II also summarizes the retirement saving behavior of our sample. The average RI designates a contribution rate of 8.1% of their income. However, because many people choose high rates that exceed the legal maximum contribution limit, the average ex-post rate is 6.4% of income. The SCF does not measure or allow us to infer portfolio betas, employment tenure, or retirement plan contribution rates.

2 The equity shares of portfolios

2.1 The average equity share

Our first main result is that in our RI sample, middle-class American investors hold a large share of their portfolio in equity. The average equity share of investable wealth is 71.0% in 2016 (Table III) and the median is 77.3%. For retirement wealth, the average is 71.1% and the median is 77.7%. Figure 3a plots the average equity share by year and while it is higher when the stock market has done well and lower when the stock market has done poorly, the average equity share is reasonably stable over time.[13]

Table III shows that the equity shares calculated for RI's in the 2016 SCF are substantially lower, 54.5% of household investable wealth and 52% of individual retirement wealth.[14]

We hypothesize that the difference between the equity shares arises largely because our data allow us to measure equity share exactly. Specifically, the SCF data are based on a survey in which people under-report the share of their wealth invested in equity because they are unaware that TDFs are allocated nearly entirely to equity for at least the first half of peoples' working lives. The main alternative hypotheses are that our sample under-represents investors with low equity shares and that the investments at other financial institutions that we do not observe have lower equity shares. Five pieces of evidence support our hypothesis.

First, consistent with people not being aware of the high equity content of TDFs, the respondents in the SCF who have some of their retirement assets in "mixed" funds report having lower than average equity shares, as shown by comparing columns (2) and (4) of Table III.[15] In the SCF, the subset of retirement investors who report having some assets in

[13]Table A.4 shows the comparison of the 2016 SCF with our full sample from 2006-2018. The magnitudes change slightly, but the arguments that follow still hold.

[14]These figures are somewhat lower than commonly reported in the SCF because we are calculating the average equity share rather than taking the ratio of averages. Because equity shares increase with wealth, equity shares calculated as aggregate equity over aggregate wealth are larger (e.g. Bricker et al. (2016)).

[15]The SCF phrases this question as "How is it invested? Is it all in stocks, all in interest-earning assets, is it split between these, or something else?" and then offers a variety of choices. We infer that the participant has something in a target date fund if they report having a mixed allocation of assets or if they have assets in a mutual fund or ETF. Thus, the same way survey responses may misreport equity share, they may also misreport (or we may mischaracterize) investments as hybrid funds.

a mixed fund report an equity share of only 47%, versus 54% for all retirement investors in the SCF. We observe the exact opposite in our data: the subset of investors with TDFs has a somewhat higher equity share (77% versus 71%) consistent with the under-reporting of the equity share by SCF respondents.

Second, SCF respondents also appear to under-report the decline in equity shares with age, and in a way that is correlated with TDF ownership. Households in the SCF report little rebalancing out of equity as they approach retirement relative to households in our data. What decline there is is primarily among those households not holding TDFs – those holding TDFs report quite flat equity shares despite significant automatic rebalancing. As a result, the difference between equity shares in our data and the SCF is the highest for young households who hold some TDFs. These patterns are what one would anticipate if misreporting were due to a lack of understanding of how much TDFs allocate to equity for younger investors.

Third, the difference between equity shares of investors holding TDFs and investors who do not occurs primarily in retirement wealth, where the vast majority of TDFs are held, and not in non-retirement accounts. Panel B of Table III shows that RIs in the SCF reported equity shares that are about 9% lower when they hold assets in a mixed fund, while RIs in our sample report an equity share that is approximately 5% higher when they hold assets in a TDF.

Fourth, it is notable that outside of retirement wealth, our investors hold significantly lower shares of their wealth in equity, both than they do in retirement accounts and than the SCF households report in non-retirement accounts, both of which further support our main hypothesis. Specifically, consider the argument that our sample overstates equity share because we omit non-retirement wealth that the SCF measures. This is possible because, as noted, the distribution of wealth in our sample does not perfectly match that in the SCF, mostly due to the SCF reporting a somewhat larger amount of wealth held in non-retirement accounts, 13% versus 4% (Figures 1 and 2a and Table II). But non-retirement assets in the SCF (Panel C of Table III), have an equity share of 73%, which is higher than in our sample (and than in SCF retirement accounts).[16] Because this wealth has a high equity

[16]This includes equity held in trusts and mutual funds or stocks held outside of retirement accounts as a

share, if we were able to observe and add such wealth to our data, it would raise, not lower, the average equity share in our data.

Finally, we compare the time series of the SCF, starting in 2007, with our sample in the same years and find that the discrepancy worsens over time. This is consistent with the rise of TDFs, both in our sample and in the United States in general (see Figure 5 and Parker et al. (2020)). Appendix Figures A.3 and A.4 show the time series of the equity share of retirement wealth and investable wealth, respectively in 2007, 2010, 2013, and 2016 (the years of the SCF that overlap with our data). While there is already a large difference between the average equity share reported in the SCF and our sample in 2007, the gap grows over time, which supports the notion that TDFs contribute to the difference. Moreover, the difference between those with and without TDFs in their portfolios grows over time in the SCF, further suggesting that the mismeasurement is worsened by the presence of TDFs in the portfolio.

Despite these five arguments, some of the difference in measured equity shares may come either from idiosyncrasies of our sample or the wealth held at the institution we observe. For example, we could in part be measuring a firm fixed effect that raises equity share. Another possibility is that our average equity share is affected by the gender composition of our sample or by the fact that our unit of analysis is individuals and the SCF measures households.

However, neither the unit of observation nor household composition appears to be responsible for our finding of high average equity shares. The above pieces of evidence that TDF equity shares are misreported in the SCF all appear in the subsample of only married investors (Appendix Table A.5). For these sub-samples — married investors in the SCF and investors in our data for which we observe both spouses — we are comparing groups of individuals with very similar gender compositions. We also find similar patterns in the sample of all single investors in the SCF and in our sample (Appendix Table A.6), although with the one exception. Single investors who hold TDFs in their retirement accounts have higher non-retirement equity shares than all single investors.[17] This fact suggests that the

fraction of all trusts, mutual funds, stocks, bonds, and CDs held outside of retirement.

[17] See columns (2) and (4) of Panel C of Table A.6.

non-retirement wealth of younger, single investors, that we do not observe in our data likely has a higher equity share than the retirement wealth we do observe. Lastly, the residuals from a regression of portfolio equity share on gender, wealth, and birth-year fixed effects shows the same patterns again in the residuals, further indicating that the results are not driven by differences in sample composition (Table A.7).

We conclude that, while the two samples do not match perfectly, the SCF likely significantly understates the average equity shares of our retirement investor sample. We now turn to the analysis of the lifecycle dynamics of equity shares and how this has changed relative to similar administrative data from the 1990's.

2.2 The cross-section of equity shares by age

In the cross-section, averaging across people and years in our sample, the age profile of equity shares is declining in age. Figure 3b shows that the average equity share is roughly constant across ages prior to age 50 and then declines rapidly with age after age 50.

To control for the effect of differences in labor earnings, we regress equity share on indicator variables for three-year age groups using the following specification:

$$y_{it} = \boldsymbol{\beta}_1' \boldsymbol{Age}_{it} + \beta_2 Inc_{it} + \epsilon_{it} \tag{1}$$

where y_{it} is portfolio equity share, Age_{it} is a vector of three-year age group indicators and Inc_{it} is the log deviation of the individual's income in each year from the sample mean income, which is only included in some specifications.

The first column of Table IV shows that equity shares actually decline monotonically with age, beginning at approximately 74% for 25-27 year-olds and decreasing to approximately 55% for 64-65 year-olds. But this decline is uneven. From age 26 to 48 the average equity share decreases by only 3% over 22 years, while after age 50 the equity share decreases by 2-3% per year.

The second column of Table IV shows that, comparing people with the same income across ages, the portfolio share of equity still declines monotonically with age but now more steadily, with a more significant decline before age 50. People with higher income tend to have higher equity shares. A two standard deviation change in income is associated with a nearly 8% higher equity share. This effect is identified from the primary source of variation which is the difference in income across individuals not age groups. Finally, comparing the last rows of Columns (1) and (2) shows that differences in income explain roughly as much variation in portfolios as age groups explain.

This cross-sectional age pattern holds widely across sub-groups of retirement investors. Columns (3)-(5) of Table IV show that the lifecycle patterns found in columns (1) and (2) are not driven by investor income: equity share decreases by approximately 25% over the lifecycle, regardless of one's initial income tercile.[18] Comparing columns (3)-(5), we see that the equity share is lower, by about 5%, in the lowest income group, but the decrease with age is similar in magnitude.

Finally, the lifecycle pattern does not appear to be driven by the passive appreciation of equity holdings. Appendix Table A.8 shows that the cross-sectional results are similar using price-constant equity shares. The price-constant equity share measures inflows and outflows to each asset, ignoring any change in price, making equity shares insensitive to asset returns.

2.3 The portfolio share of equity over the lifecycle

In contrast to the cross-sectional pattern, tracking the same individuals over time, equity shares are hump-shaped across the working life.

Table V shows analogous regressions to the specification in equation (1) but includes person fixed effects. Column (1) shows that young people tend to increase the equity share of their portfolios, but as they approach retirement they reduce their equity exposure. People increase their equity share by approximately 7% from age 25 to 50, then they decrease it by about the same amount from age 50 to 65. Changes in income do not drive this result. The same pattern holds in column (2) when controlling for income, with a

[18] Initial income is based up on the first (or second, if first is not available) year in which the individual enters our sample. The first tercile of initial income covers those with income below $46,000 per year, approximately. The second covers those with income $46,000-75,000. The third tercile is those with an initial income greater than roughly $75,000 per year.

slightly higher magnitude (10% instead of 7%).[19]

This lifecycle hump-shaped pattern holds across income groups. The last three columns of Table V show regression results for different levels of initial income. Each group increases its equity share by 5-7% from age 25-50, and then decreases it as they age. We observe more aggressive rebalancing away from equity in the higher income groups, with the richest decreasing their shares by about 7% relative to their position at age 25-27. Those in the lowest income group decrease their equity share by only about 2%. Of course, those with higher income also start out with higher equity shares, and thus have more room to decrease them.

2.4 Changes across cohorts

Third we document that equity shares are increasing across cohorts and the hump-shaped pattern of equity over the lifecycle is a relatively new phenomenon. We focus on cohorts of people born in 10-year periods. We have five such cohorts, from those born between 1943 and 1952, to those born between 1983 and 1992. Looking across ages and across cohorts reveals two patterns.

First, looking across years, Figure 4a shows that the three cohorts born more recently (those born around 1965, 1975, and 1985) have slightly higher equity shares to those born around 1945 and 1955 in the 2000's, but fifteen to twenty percent higher equity shares in 2018.[20] The oldest cohort start with roughly 10% less of their portfolio allocated to equity and ends the sample with 15% to 25% less than the youngest three cohorts.

Second, and more importantly, younger cohorts have higher equity shares than older cohorts at the same age. This fact can be seen at the ages for which cohorts overlap in Figure 4b, which shows equity share by age for different cohorts.[21] More precisely (based on Appendix Table A.9), at any age there is a monotone increase in average equity share as

[19]The coefficient on income measuring the effect of changes in income is also smaller than the coefficient on the level of income in Table IV measured in the cross-section, an effect examined in detail in Meeuwis (2019).

[20]Figure A.6a shows a similar pattern for portfolios betas. Moreover, portfolios betas within cohort are relatively stable over time.

[21]Figure A.6b shows that this pattern is also true for portfolio betas. In other words, more recent cohorts have higher-beta portfolios than older cohorts at the same age.

one looks at younger cohorts (excluding 'endpoints' for each cohort where age composition potentially plays a big role) at the same age.

These patterns imply that cohort-specific lifecycle profiles of equity shares have both risen and become more hump-shaped for younger cohorts. Table VI makes this point by tracking the same investor over time, broken out by birth year cohort.

First, the older cohorts allocate away from equity sooner and more quickly than younger cohorts. Comparing the results in column (1) to column (2), from ages 55-65, the 1943 cohort decreases its equity share (relative to their own shares at age 52-54) by 19%. Meanwhile, those in the 1953 cohort decreased their equity share (again, relative to their own shares at age 52-54) by only about 5%. Similarly large difference appears when comparing the 1953 cohorts (column 2) to the 1963 cohorts (column 3). Those born 1953-1962 decrease their equity shares, by about 8% from age 43-52, while those born 1963-1972 actually increase their equity share by nearly 2% over the same age range.[22]

Second, among the youngest cohorts, shown in Columns (4) and (5), those born more recently increase their equity shares more quickly in their earliest years of investing, by approximately 1% more from ages 25-36 than those born 10 years earlier.

What has driven these changes in portfolio behavior? The greater investment in the stock market by the young and the decline over the latter half of working life are both consistent with an increased adoption of TDFs. As shown in Figure 5, younger cohorts are much more heavily invested in TDFs. Columns (6)-(8) of Table VI shows the lifecycle pattern of stock market investment by initial allocation to TDFs. Investors who begin with a high allocation of their portfolio to TDFs (75-100%) start life with higher initial equity shares and exhibit much stronger rebalancing behavior than those who start life with less invested in TDFs. In contrast, those with initially low allocations to TDFs (0-25%) follow more of a hump-shaped pattern in their equity shares, starting with approximately 62% equity, increasing it to 70% by mid-life, and lowering it only modestly to 66% at age 65. We discuss the role of TDFs in more detail in the next section.

[22] Put differently, comparing the trend in column (2) from ages 43-57 we see that those born from 1953-1962 decrease equity shares at about 2-4% per year. On the other hand, column (3) shows that those born from 1963-1972, at the same age, hold their equity share almost constant until they reach age 52, when they start to decrease it by only 1-2% per year.

2.5 Relation to portfolios during the 1990s

In this subsection, we present a final piece of direct evidence that portfolio behavior has changed over time by comparing the lifecycle portfolio holdings in our data covering 2006-2018 to the portfolio holdings in very similar administrative from the 1990s. Specifically, we replicate the central analysis from Ameriks and Zeldes (2004) which is based on administrative data from a large financial institution, where both the type of data and institution are quite similar to ours. Figure 12 in Ameriks and Zeldes (2004) shows that investors held less of their wealth in stocks and did not reduce their equity shares with age.

Figure 6 replicates Figure 12 from Ameriks and Zeldes (2004) and visually summarizes three main points. First, the top panel of Figure 6 shows that equity shares in more recent years are high and decline with age across households, with a steeper slope after age 55. In contrast, in earlier data, equity shares decrease with age from age 25 to 35 and are roughly the same for all ages after 35 (Ameriks and Zeldes, 2004, Figure 12, top panel).

Second, the middle panel of Figure 6 shows that tracking cohorts as they age, equity shares are roughly independent of age during the first half of working life and then decrease with age during the second half of working life. In contrast, the middle panel of Figure 12 in Ameriks and Zeldes (2004) shows that each cohort's equity share was *upward sloping* in age in the 1990's.

Third, in the last panel of Figure 6, the solid, red line shows that equity shares are hump-shaped in age controlling for differences across cohorts. The analogous figure in Ameriks and Zeldes (2004) shows a linear upward sloping line. Controlling for differences across years, the dashed blue line shows that equity shares are decreasing, more rapidly later in life, as in a TDF glide path. The analogous figure in Ameriks and Zeldes (2004) shows a flat line.

Finally, to confirm that we are documenting a real change in behavior rather than something specific to administrative datasets or these two firms, we replicate the Ameriks and Zeldes (2004) analysis of portfolios in the SCF. We compare Figure 9 in Ameriks and Zeldes (2004) which is based on SCF data from 1989-1999 with our own version of Figure 9 based on SCF data from 2007-2016 (Figure A.5). We find the same changes as we show between the two administrative data sets, but of a smaller magnitude.[23] Specifically, equity shares have risen in the SCF and there is now a lifecycle pattern of rebalancing out of equity in the second-half of working life.

3 Pension regulation, TDFs, and portfolio allocations

This section provides evidence that the the rapid rise of TDFs following the Pension Protection Act (PPA) of 2006 contributed to both of the main new facts we document: that equity shares that are high earlier in life and decline linearly over the second half of investor's working lives.

The Pension Protection Act of 2006 permitted Target Date Funds to be "Qualified Default Investment Alternatives" (QDIA) in employer-sponsored, defined-contribution retirement plans. The act provided a "safe harbor provision" that clarified that the use of a TDFs as the default investment vehicles in a plan was consistent with the fiduciary responsibilities of the plan sponsor (the employer) and the plan administrator.[24] Prior to this provision, both employers and administrators faced potential legal liability for replacing existing default options — primarily safe money market funds — with TDFs. Following the PPA, plans increasingly adopted TDFs as defaults, which moved employees who passively accepted or chose the default investment out of very safe, low-return funds and into largely equity funds. Following the PPA, the availability, adoption, and use of TDFs accelerated rapidly in the U.S. (Figure 5 shows the rise in our data and Parker et al. (2020) documents the aggregate growth in assets under management).

3.1 Identification Strategy

To identify the effect of TDFs on investors' portfolio allocations, we compare the lifecycle investment behavior of workers hired by a given firm just before and after 2006 at firms

[23]This smaller magnitude is consistent with the SCF not correctly measuring equity shares in TDFs, as we discussed in relation to Table III's evidence that equity shares decline with age more in our data than in the SCF.

[24]https://www.dol.gov/agencies/ebsa/about-ebsa/our-activities/resource-center/fact-sheets/default-investment-alternatives-under-participant-directed-individual-account-plans

that switched their default investment at this time to a TDF. This analysis identifies the exogenous effect of the PPA on investors' portfolios assuming that people (or employees) did not endogenously change the jobs they take due to the introduction of the PPA or their (potential) employers response to it. This is a reasonable assumption since employees typically are not aware of these regulatory changes and base their employment decision on many other factors. Employees who joined their employers before 2006 almost exclusively entered into plans that did not have TDFs as a default option, since without the safe harbor provision of the PPA, employers found it very risky to use this option. After 2006, many employers adopted TDFs as defaults and the employees joining the firm after this change then saw a different default investment vehicle. We focus specifically on individuals who enrolled in plans in 2007 or 2008 that switched to having a TDF as a default following the PPA.

We first analyze the short term – two year – effect of the adoption of a TDF as the default investment fund. We take the sample of employees who start a new job between 2005 and 2008 at a firm that switched to having a TDF as the default option after 2006. The specification is:

$$y_{it} = \beta_1 \times D_{treated} + \beta_2 \times D_{treated} \times AgeEnrolled_i + \beta_3 \times AgeEnrolled_i + \lambda_f + \epsilon_{it} \quad (2)$$

where y_{it} is the portfolio equity share. $D_{treated}$ is an indicator variable equal to one if an investor is enrolled in a retirement plan that switched to having a TDF default immediately after the PPA, in 2007 or 2008. λ_f is an employer fixed effect, so we compare individuals enrolling before the Act (in 2005 or 2006) to those enrolling after (in 2007 or 2008) at the same employer. Since TDFs by definition change their target allocation for people of different ages, we also include categorical variables for 10-year age groups at enrollment and interactions of these age groups with the treatment variable. These regressions include only firm-level fixed effects and not individual-level fixed effects since we estimate the effect of the PPA by comparing across investors who enrolled just before and after 2006. Table VII shows the results of estimation of equation (2) restricting the sample to the two years after enrollment for each new employee.

Column (1) of Table VII shows that someone aged 25 - 35 who is enrolled into a plan with a TDF default in the two years after the act (compared to those enrolled in the two years prior to the act in the same firm) has a 5.5% higher equity share during the first two years of their employment (the coefficient on the *treated* indicator variable). The effect is statistically significant and economically large relative to the average increase and decrease of average equity over the lifecycle. The coefficients on the interaction terms show that the effect of a TDF default on older individuals is to decrease their equity shares. For example, while those aged 55-65 at enrollment have 13% lower equity shares than those aged 25-34 (row 4), those treated by the change in default have equity shares that are lower again by nearly 15% more (row 7). This age pattern in the treatment effect – from positive when young to negative when old – is consistent with the change in behavior that we document. Relative to the low and (roughly) age-invariant equity profiles of the 1990's, TDFs raise the allocation to stock for younger workers and lower it for older workers. Controlling for income (column (2)) the effect on young households declines only slightly and that the lifecycle pattern remains quite similar.

Across income groups, the effect of a TDF default is generally larger for young investors with lower incomes, and generally smaller for all investors with high income. In Columns (3)-(4) of Table VII, we repeat the analysis from Column (1) for the subsamples of people with the lowest and highest initial income. Column (3) shows that the initial impact on equity share at young ages is almost 6%, compare to 5.5% in the full sample. The effect on those in the bottom income tercile is similar for the older age groups as in the full sample. For the highest income tercile (column (4)), the treatment effects are significantly muted. For the youngest group (people 25-35 in age) the magnitude of treatment effect on equity shares is less than 2%. There are two possible reasons for this small effect. First, even in the control group, young higher-income households have high equity shares. Second, higher-income households make more active decisions make less use of TDFs. Consistent with the latter, the rebalancing effect of enrolling with a TDF default is much less pronounced for the highest income tercile.

These results are not driven by differences in investors' pre-existing portfolio allocations or their experience with assets or asset managers prior to enrolling with their new employer.

Columns (5)-(6) display the results of the same analysis as displayed in columns (1)-(2), but conducted only on those individuals who have no other retirement assets or rollover funds prior to enrollment at our institution. It turns out that this sample restriction drops very few households. As a result, the results are virtually unchanged from those in the first two columns, even for older new employees.

3.2 Medium-run impact and convergence

In order to analyze the impact of the PPA on the investment dynamics and persistence of portfolio allocation over the medium term, we now repeat the analysis above but track individuals for five years after enrollment in a retirement plan. We expand our specification to:

$$\begin{aligned} y_{it} = &\beta_1 \times D_{treated} + \beta_2 \times D_{treated} \times AgeEnrolled_i + \beta_3 \times AgeEnrolled_i \\ &+ \beta_4 \times D_{treated} \times \lambda_t + \beta_5 \times \lambda_t + \lambda_f + \epsilon_{it} \end{aligned} \tag{3}$$

where the notation is the same as in equation (2) and we have added year fixed effects λ_t and interactions of these year fixed effects with the treatment indicator to trace out the investment trend for both the control and treatment group over time, respectively. In this specification, to study differences by age, we run separate regressions using different age groups, rather than including the full set of age fixed effects and interactions.

Column (1) of Table VIII confirms that the effect of the PPA on equity shares is positive even averaged over the first five years after enrollment and based on the full sample enrolled in 2005-2008.[25] More interestingly, the dynamic analysis however reveals that the difference in portfolios declines over time. As before, the positive effect of the PPA is much larger for the low income group than the high income group (columns 2 and 3), however, this difference is not persistent, shrinking to nearly zero five years after treatment.

More importantly still, TDFs tend to raise equity shares for the young and lower equity shares for those near retirement. Column (4) shows that for those aged 25-34 at enrollment

[25] Appendix Table A.10 shows the results only using those who enrolled in their plan in 2007 as the control group. This minimizes possible spurious correlation due to the financial crisis.

the change to a TDF default increases equity share on average by 1.5% the year of the change and rises to almost 4% in the following two years. In the last two years we see some convergence between the treatment and control groups. But at the end of the five-year period, the treated individuals still have equity shares that are nearly 3% higher than those of the control group.

Table VIII further shows that for the older age groups, the effect is the opposite: the PPA decreases equity shares immediately following treatment, which is in line with the prescribed glide path of TDFs. As with the youngest group, this difference tends to decrease over time as the two groups converge. For those aged 55-65, the difference is persistent, with the treated group's equity shares still being 2% lower than the control group's five years after treatment.

The PPA also played a role in the convergence of portfolios allocations between income groups, particularly for those that were enrolled at a young age. Figure 7 plots the predicted equity shares of treatment and control groups broken out by age and income tercile.[26] Looking first at the youngest age group (25-34) in Figure 7a, the adoption of a TDF default significantly increased equity shares for the low income group. And again we see that the control group converges somewhat to the treatment group over time. In contrast, the effect on equity shares for the high income group is positive but much smaller.

Figure 7b shows the results for those enrolled from age 55-65 for high-income investors and for low-income investors. The PPA significantly decreased equity shares for both groups. Over time, the two treated groups become more similar when compared to the two untreated groups, implying a similar convergence effect of the changes in defaults facilitated by the PPA.

In conclusion, middle-class and upper-middle class working-age American investors with retirement wealth now hold a large share of their financial wealth in equity and reduce the share as they age, following a concave rather than a linear lifecycle pattern. This is relatively new behavior, not visible prior to 2000. This large change appears to be due to the combination of industry development and regulatory approval of target date funds as

[26]These are estimated in unreported regressions that repeat columns (4) and (7) from Table VIII on the income subsamples.

defaults in retirement saving plans. The new portfolio behavior follows the prescription embedded in TDFs investment strategies, to invest mostly in stocks when young and to decrease this share significantly in the second half of working life as retirement approaches.

4 Contribution Rates

This section presents an analysis of the average contribution rates that investors make to their retirement plans over their working lives. The analysis, which mirrors our analysis of portfolio composition, shows three main results. First, contribution rates increase linearly with age, increasing by 4-6% over the working life. Second, and more importantly, unlike portfolio behavior, this behavior has been relatively stable over time. Third, average contribution rates responded only minimally to the Pension Protection Act of 2006, and actually decreased slightly following the Act. Thus, contribution rates are less sensitive than equity shares to the changing regulatory environment or investment trends over time.

4.1 Realized Contribution Rates

We measure realized contribution rate as the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year.

Table IX presents the coefficients from estimation of equation (1) with realized contribution rates as the dependent variable. Column (1) shows that, in the cross-section, contribution rates increase monotonically with age, from about 4.6% at age 25 to 8.5% at age 65. Columns (2) - (5) show that contribution rates increase by a similar 4% over the working life when controlling for income in two different ways. In column (2), the coefficient on current log income deviation from the average implies that each 1% deviation in income from the average is associated with a nearly 2 basis point increase in reported contribution rate. Instead, looking across initial income groups, those in the highest income group (column (5)) save nearly 2% more, on average, than those in the lowest income group (column (3)) at every age. The increases over the lifecycle, however, are parallel:

each group increases its total saving rate by about 3.5% from age 25-65.

This relatively stable, increasing age pattern of saving is not only a feature of the cross-section, but characterizes the average behavior of investors as they age.[27] Table X shows the regression of realized contribution rate on age group indicators, including a person fixed effect which effectively include a cohort effects. In the baseline results in column (1), contribution rates increase by just over 5% over the lifecycle, the same increase as in the cross-sectional age pattern. In column (2), we also control for log income which does little to change the age effects nor the R-squared of the regression. This confirms that, when controlling for the person fixed effect, income is less important for determining contribution rates and that increasing savings rates with age are unlikely to be due to income profiles.

Splitting households by initial income, all income groups also show a similar lifecycle pattern, though those with higher incomes have higher contribution rates overall. Columns (3) and (5) show parallel increases of 4.6% and 5.1% over working life in average contribution rates for the bottom and top income groups. The average contribution rate of the middle initial income group increases by a slightly larger 6.2%. These differences in contribution rates across cohorts in part relate to contribution limits set by the IRS, as we analyze in the next subsection.

The within-person results broken out by cohort again show that each cohort increases its savings rate with age. Columns (1)-(5) of Table XI show that the younger cohorts increase their rate of contribution at a slightly faster pace. For example, comparing column (4) to column (5), we see that 28-30 year-olds born from 1983-1992 increase their contribution rate by 0.81%, relative to at age 25-27, while 28-30 year-olds born from 1973-1982 increase it by 0.52%. A similar pattern holds when differencing across rows for the other age groups that are common to multiple cohorts. In summary, although older cohorts start at a higher savings rate, the younger cohorts increase their rate slightly faster as they age, even when controlling for income.

Finally, the stable pattern of saving behavior holds regardless of the share of TDFs

[27] We find analogous results to those in this subsection controlling for cohort effects rather than individual effects (see Appendix Table A.11).

initially held by the investor, although investors with large initial investments in TDFs increases their savings rates by more than other investors. Columns (6)-(8) of Table XI break out the within-person results by initial TDF share. Investors with intermediate investments in TDFs (column (7)) have the highest level contribution rates. Investors with TDF shares below of 25% increase their contribution rates over their working lives by a large amount, 6.6%, or about 1.5 to 2% more than the 4.9% to 4.6% increase of the two other groups that start with a larger allocation to TDFs.

4.2 Realized versus Reported Contribution Rates

Thus far, we have limited our discussion of contribution rates to *realized* contribution rates: the percentage of income that is actually saved for retirement, ex-post (on a year-by-year basis). However, there is a distinction between the realized rate of savings and the designated or *reported* rate of savings that investors decide upon ex-ante. The difference between reported and realized contribution rates is the result of retirement contribution limits, set by the IRS. [28] Depending on their income and reported contribution rate, some people will hit their maximum contribution before the end of the year, and thus their actual *realized* contribution will be less than what they designated at the beginning of the year. This may occur if someone has a very high income, or if someone sets a very high contribution rate. We address this discrepancy in two ways, both of which confirm the results of the previous subsection.

First, we condition our analysis on an indicator variable equal to one if an individual hits their contribution limit in the given year. We set this indicator to one if the investor's *reported* contribution rate times their income is larger than the allowed amount by the IRS in that year.[29] We find that 6-9% of our sample with available income data max out on their contribution in a given year. We then conduct our analysis again using a specification that

[28]https://www.irs.gov/newsroom/401k-contribution-limit-increases-to-19500-for-2020-catch-up-limit-rises-to-6500

[29]Base contribution limits increased from $15,000 in 2006 to $18,000 in 2017. In addition, contribution limits for individuals older than 50 are higher by a "catch-up" contribution amount that rose from $5,000 in 2006 to $6,000 in 2017. We use the age- specific limit in the corresponding year to calculate the limit for each investor.

controls for hitting the contribution limit:

$$y_{it} = \beta_1 \times D_{maxout} + \beta_2 \times D_{maxout} \times Age_{it} + \beta_3 \times Age_{it} + \epsilon_{it} \quad (4)$$

where y_{it} is the realized contribution rate. D_{maxout} is an indicator equal to one if the individual investor, i, maxes out on their retirement contribution, as described above, in a given year. Age_{it} are indicators for ten-year age groups. In some specifications, we also include a control for the deviation of the investor's current income from the average.

In the cross-section, retirement contribution rates increase by under 3% over the working life when controlling for hitting the contribution limit and whether controlling for income or not (Table XII). Note that the coefficient on maximizing retirement contributions is positive implying that on average investors that contribute a larger share of their incomes are more likely to be hitting the legal limits. The coefficients on the interaction terms between hitting the cap and age show that the cap on contributions lowers realized contributions most strongly for those at prime earning age (age 35-54, Columns (1) and (2)). Columns (3)-(4) show results replacing the indicator variable in equation with *max out ever*, an indicator equal to one if the individual maxes out on their contribution during any year that we observe them in the sample (before or after the current year). The cross-sectional patterns lie between those without any control for maximizing retirement contributions and those withe contemporaneous control in Columns (1) and (2).

Our second method of addressing the discrepancy between realized and reported contribution rates is by repeating our analysis on the *reported* contribution rate rather than the realized rate. The reported contribution rate is the percentage of income that the individual designates to their retirement account at the beginning of each year.

Using designated rather than realized contribution rate largely confirm our results using realized rates.[30] In the cross-section, designated savings increases monotonically with age from about 6% to 10% over the lifecycle (Table A.12). Hence, reported contribution rates are about 1% higher than the realized rates observed in Table IX, confirming that some individuals set a rate that is too high and hence save at a rate lower than anticipated.

[30]Tables in the Appendix.

Column (2) of Table A.12 shows the same age pattern controlling for log income. As before, the coefficient on income implies that each 1% deviation of income from the average is associated with a nearly 5% increase in reported contribution rate. Note that income has significantly more explanatory power for designated contribution rates (adding income doubles the R-squared) than for realized rates, consistent with the contribution cap distorting an otherwise relatively stable desired contribution rate over the income distribution. We also find cross-sectional patterns in designated contribution rates across different cohorts and different TDF allocations that are similar to those for realized contribution rates (Appendix Table A.13).

Finally, and most importantly, the baseline results including a person fixed effect, shown in Table A.14 confirm that individuals increase their contribution with age at a magnitude that explains nearly all of the aggregate variation. Similar to realized contribution rates, higher reported contribution rates are not driven by people earning higher incomes as they age (column (2)). Each cohort behaves similarly, but younger cohorts increase their contributions at a slightly quicker pace (Table A.15, columns (1)-(5)). Additionally, those with the lowest allocation to TDFs (column (8)) increase their contribution rate by more than those with higher allocations to TDFs at every age. All these results are consistent with conclusions in the previous subsection where we use realized contribution rates to conduct analogous analysis.

4.3 The Effect of the Pension Protection Act of 2006

Our results so far suggest that the Pension Protection Act of 2006, which included several provisions designed to encourage savings in retirement funds (Beshears et al., 2010), had little to no impact on actual retirement saving rates by age or across cohorts of savers. In this subsection, we present evidence that the immediate effects of the PPA on retirement saving rates were, if anything, negative.

We replicate the difference-in-difference analysis of subsection **??** but comparing the retirement saving rates of new enrollees at the same employer in the two years before and after the PPA of 2006. Unlike in our analysis of portfolios, we designate anyone enrolled during 2007-2008 as a treated investor, regardless of whether or not their plan's default investment allocation changed and estimate equations (2) and (3) with reported contribution rate as the dependent variable.[31]

First, as shown in column (1) of Table XIII, those enrolling at an employer after PPA 2006 have lower contribution rates in the two years following enrolment. The effect starts at a large -0.43% of income for those age 25-35, and becomes increasingly negative with age, reaching -1.2% for those age 55-65. The negative sign, magnitude, and pattern are similar when controlling for income (column (2)) and across income groups (Columns (3)-(4)). Finally, this decrease in saving is similar for those with no other retirement assets at the institution prior to enrollment, as shown in columns (5)-(6). This result implies that the finding is not driven by those who have some wealth at the institution prior to enrolling in a new plan.

Tracing out the effect over the five years following enrollment, the PPA had only a transitory negative effect on average contribution rates and it is largest for the oldest investors. We repeat our analysis tracking investors for five years after they enroll and including interactions of individual indicator variables for each year after treatment with an indicator for being treated by the PPA (enrolled in 2007 or 2008, versus 2005 or 2006). As shown in Table XIV, Column (1), the PPA has a negative initial effect on contribution rates, but the magnitude decreases over time and is essentially zero five years after treatment. Column (3) shows that the decrease in retirement contribution rates is slightly more persistent for households with higher (initial) income. Splitting the result by age group, columns (4)-(7) shows that the effect is negative for each age group, and largest in magnitude and most persistent for the older age groups. For example, those aged 55-65 when enrolling after PPA have contribution rates that are 1.3% lower than those enrolling before during the year they enroll, a difference that declines to 0.5% after five years. In contrast, those in the

[31] In our analysis of portfolios equity shares, only those who were enrolled in a plan that changed its default investment to a TDF after the PPA are considered treated. In that case, we measured the effect of TDF default allocation, induced by the PPA on portfolio allocation. In the case of contribution rates, we want to measure the impact of the PPA overall. The PPA had a significant number of provisions intended to increase savings rates, but we are not able to isolate those plan features in our regressions, due to data limitations. Hence, we simply designate anyone enrolled in a plan from 2007-2008 as a treated investor, regardless of which plan features changed following the PPA.

age group 25-34 enrolling after PPA contributed only -0.7% less of their income the year of enrollment and -0.1% five years after enrollment relative to those that enrolled just before PPA.

It is possible that the interaction terms are picking up some of the differences in year fixed effects and that saving rates are lower for the treatment group due to the timing of the financial crisis. However, Appendix Table A.16 shows that the results are similar if we include only those enrolled in 2007, rather than 2007-2008. This eliminates any possible spurious effects on saving rates due to the financial crisis. Moreover, the income control in column (1) indicates that the results hold even for those who did not experience significant changes in income due to the financial crisis.

Figure 10 shows the predicted contribution rates for those in the youngest and oldest age group, split out by those in the lowest and highest income tercile.[32] Looking first at those aged 25-34 in Figure 10a, the PPA significantly decreased contribution rates for both income groups, initially by about 0.7-0.9%.[33] However, the difference between the treated and control groups converges to zero over time.

For those enrolled when aged 55-65, investors with lower incomes are more affected by the PPA, as shown in Figure 10b. The treated group with high incomes decreases their contribution rate by about 0.7% following treatment. For the lower income group, the immediate effect is larger: 1.3%. For both income groups, the difference between treated and control after five years is nearly zero.

5 Conclusion

The results in this paper show that the portfolios of typical retirement investors in the U.S. have changed significantly over the last few decades. Investors hold more of their

[32]These are estimated in unreported regressions that repeat columns (4) and (7) from Table XIV on the income subsamples.

[33]The reason that both the treatment and control group decrease their contribution rate over the five-year time period following enrollment is that the five-year period that we analyze happens to take place during the Great Recession and its aftermath. This pattern is consistent with the fact that contribution rates increase with age (Table A.12 (cross-section) and A.14 (within-person)) and at the same time contribution rate decreased uniformly across birth cohorts from 2007-2009 (Figure 9).

investable wealth in the stock market than they did in the 1990s, and they reduce the share of their portfolio invested in the stock market as they age when they used to maintain a relatively constant share as they aged. These two changes are consistent with the rise of new retirement savings products, such as TDFs, and the advent of new regulations, such as the PPA of 2006. We show that the adoption of TDFs as default investments in employer-sponsored retirement plans has a causal effect on portfolios in the direction of the observed changes in portfolio holdings for younger workers, particularly those with lower incomes. But the causal effects are short-lived. We see that individuals in the control group who are not defaulted into TDF over the next five years start catching up to the treatment group.

Did the PPA and the rise of TDFs fundamentally change investor behavior, or, even without these changes, would investors have increased the share share of their portfolios invested in stocks when young stocks and decreased this share as they aged? On the one hand, greater dissemination of prescriptive, model-based portfolio advice and a recognition of the equity premium puzzle, might over time have led to this shift in investor behavior even absent the PPA. On the other hand, the PPA, by sanctioning TDFs as default investment options, may have been a critical catalyst in making higher equity allocations acceptable advice for retail investor portfolios. The timing is certainly consistent with this second interpretation, as is the observation that the PPA seems to have led the investment advice industry (many of whom, like retirement plan sponsors, have a fiduciary duty to their investors) to recommend TDF-like investment strategies more broadly. In either case, these changes in behavior may be part of the recent high valuation of stocks (high price to earnings ratios) as well as potentially leading to greater stability in asset class returns, as stuggested in Parker et al. (2020).

Finally, our result that the lifecycle pattern of retirement contribution rates has been relatively stable suggests that the many changes both in the design of retirement saving plans and in the regulatory environment have had little effect on retirement wealth accumulation other than through portfolio choices and resulting returns.

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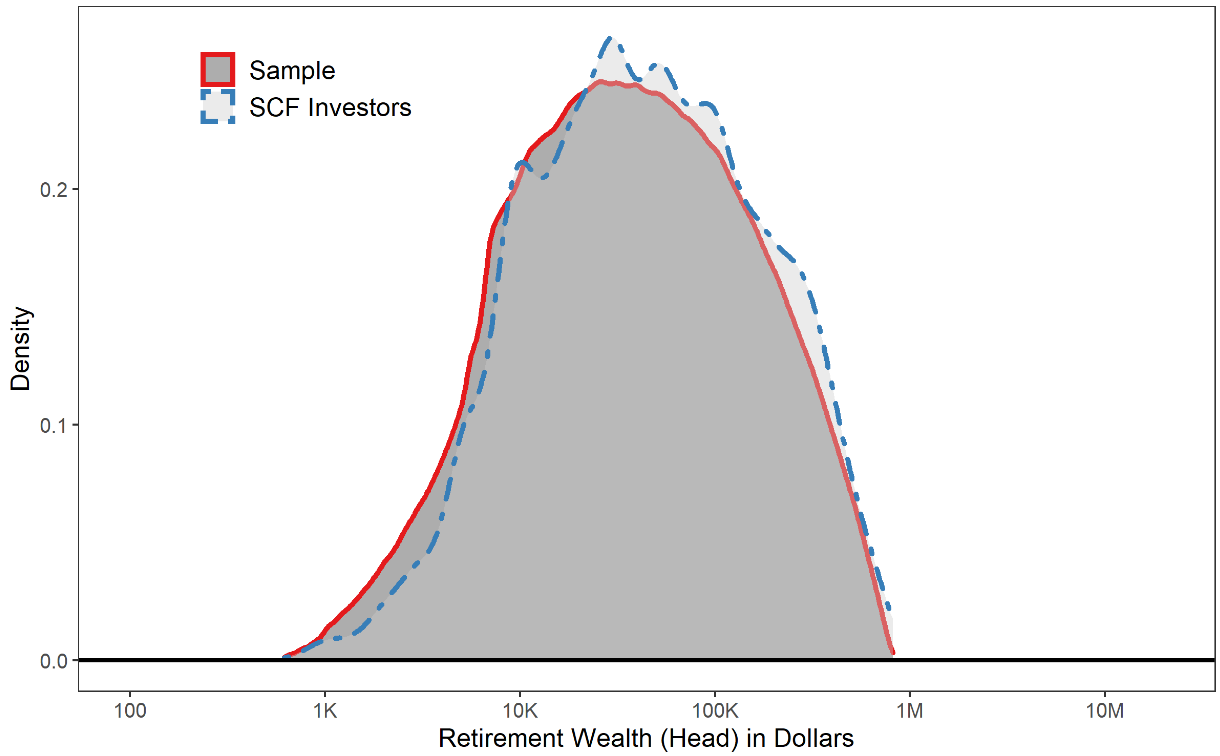
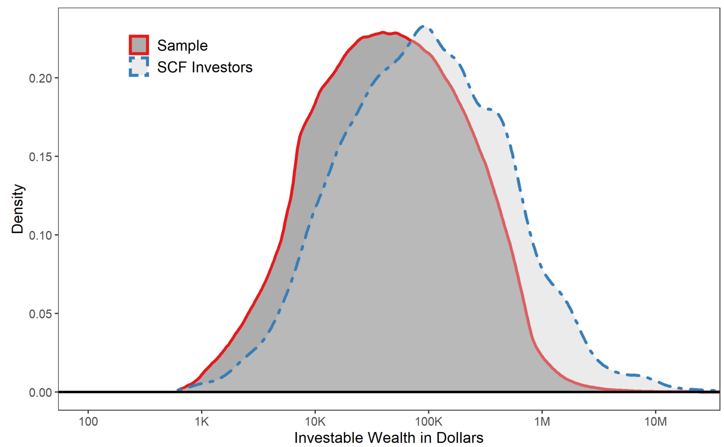
Figure 1: Individual Retirement Wealth Distribution in Firm Data and the SCF in 2016



Notes: This figure plots the distribution of retirement wealth in the sample of retirement investors (RIs) versus the distribution of retirement wealth for RIs in the SCF in 2016. Retirement wealth is defined as any wealth in retirement saving accounts of all types (excluding defined benefit plans and Social Security).

Figure 2: Investable Wealth Distribution in Firm Data and the SCF in 2016

(a) Investable wealth, individual versus household

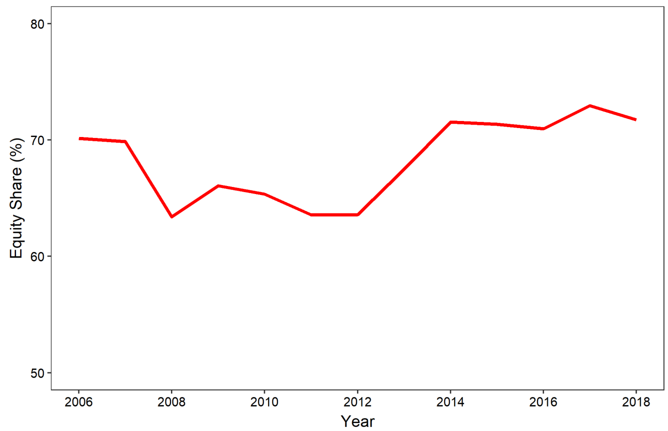


(b) Investable wealth, household versus household

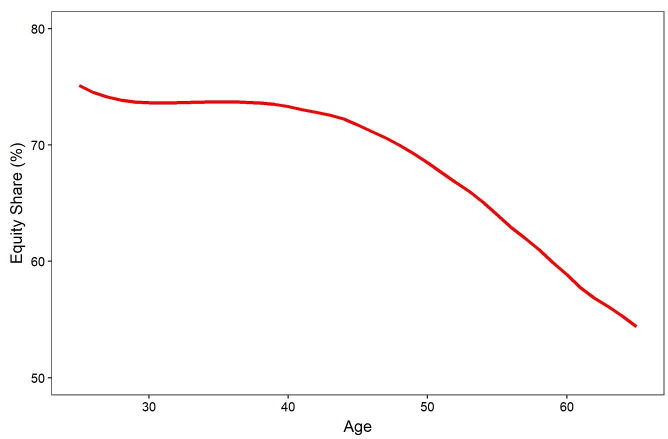
Notes: This figure plots the distribution of investable wealth of retirement investors (RIs) versus the distribution of investable wealth for RIs in the SCF in 2016. The top panel shows individual investable wealth in our sample versus household investable wealth in the SCF. The bottom panel shows household investable wealth in our sample for the subset of households in which we observe both spouses versus household wealth in the SCF for the subsample of investors who are married. Investable wealth is defined as money market funds, non-money market funds, individual stocks and bonds, certificates of deposit, quasi-liquid retirement wealth, and other managed accounts.

Figure 3: Portfolio Equity Share by Year and Age

(a) Equity Share by Year



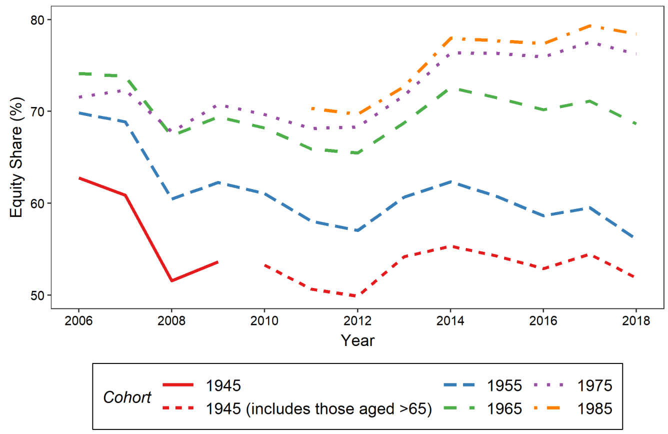
(b) Equity Share by Age



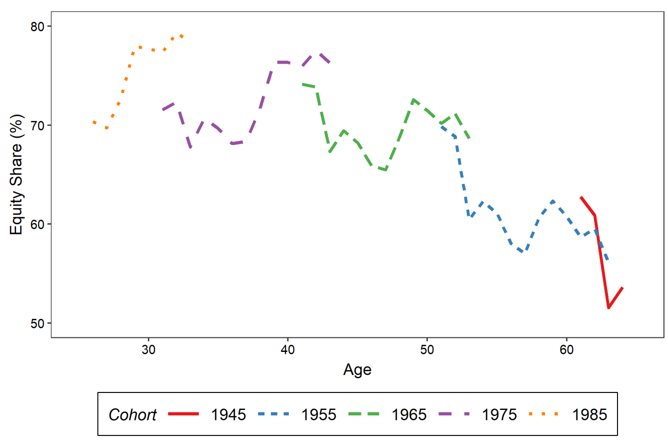
Notes: This figure shows the portfolio equity share in our sample. The top panel shows the equity share for the entire sample, averaged by year. The bottom panel shows the equity share averaged by age. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. The sample is our full set of retirement investors (RI).

Figure 4: Portfolio Equity Share by Birth Cohort

(a) Equity Share by Birth Cohort and Year



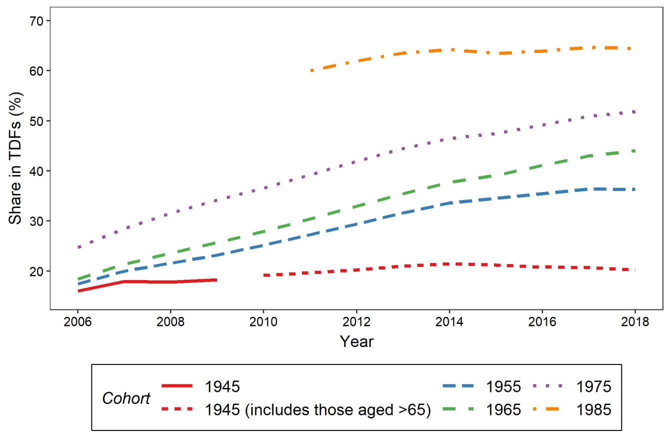
(b) Equity Share by Birth Cohort and Age



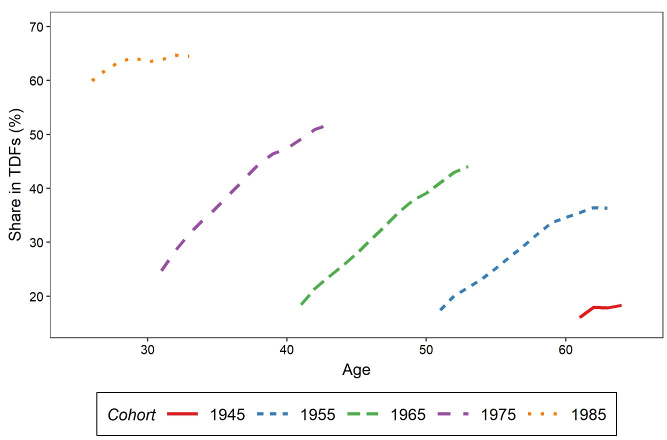
Notes: These figures show the portfolio equity share averaged by birth year cohorts. The top panel shows the averages by year over our sample period. We include only years during which each member of the cohort is aged 25-65, unless otherwise indicated. The bottom panel shows the averages by age, where age is the median age of the cohort. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. A cohort is defined as having been born in the three-year period centered around the year indicated. The sample is our full set of retirement investors (RI).

Figure 5: Target Date Fund Share by Birth Cohort

(a) TDF Share by Birth Cohort and Year

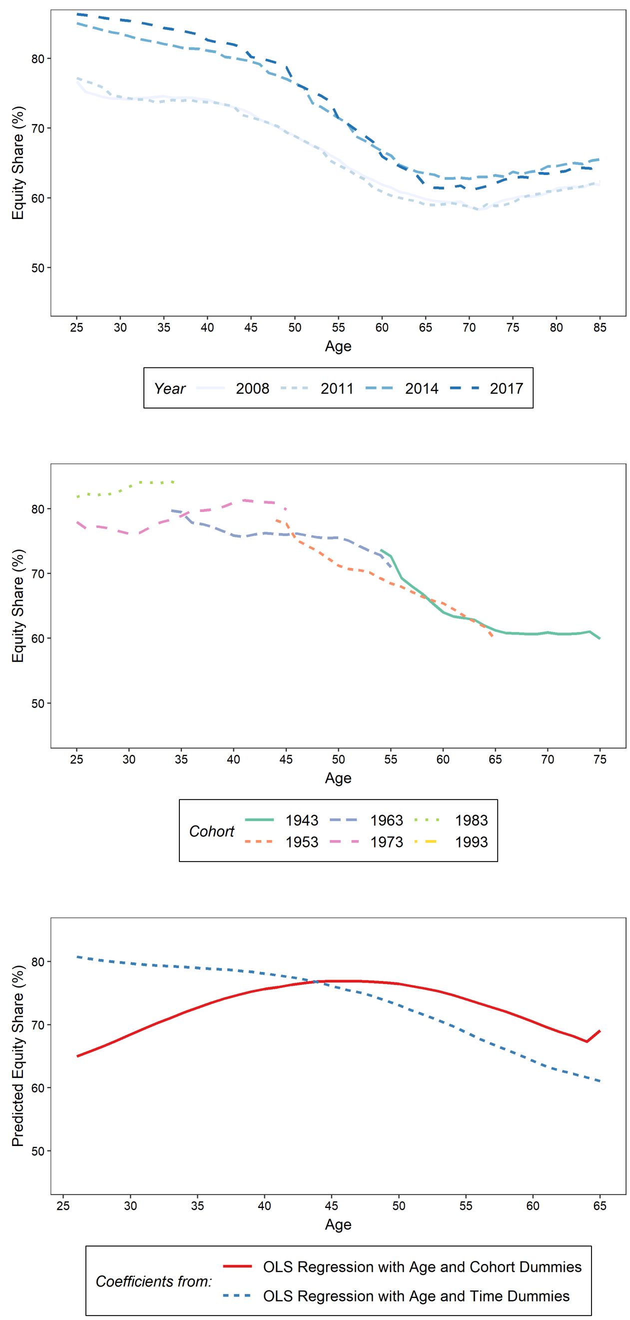


(b) TDF Share by Birth Cohort and Age



Notes: These figures show the share of the portfolios that is invested in Target Date Funds (TDF) averaged by birth year cohorts. The top panel shows the averages by year over our sample period. We include only years during which each member of the cohort is aged 25-65, unless otherwise indicated. The bottom panel shows the averages by age, where age is the median age of the cohort. TDFs are mutual funds that maintain a given portfolio share of assets invested in different asset classes, where the shares change with the number of years until 'target date,' the expected retirement date of the investor. A cohort is defined as having been born in the three-year period centered around the year indicated. The sample is our full set of retirement investors (RI).

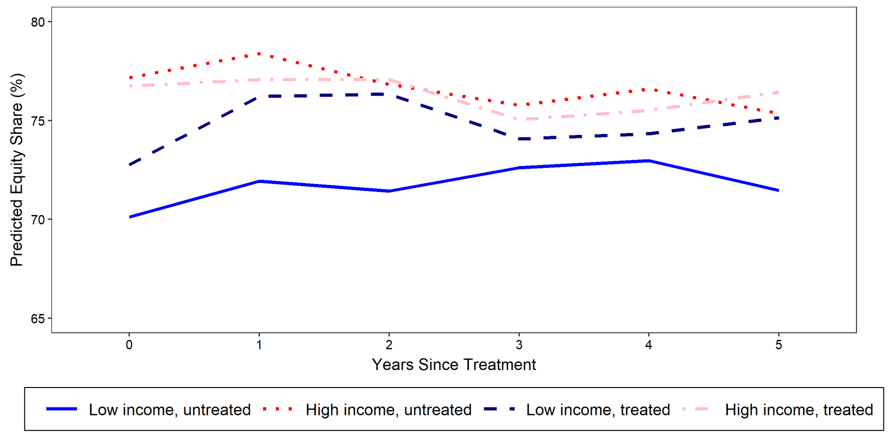
Figure 6: Equity Share Among Equity Owners



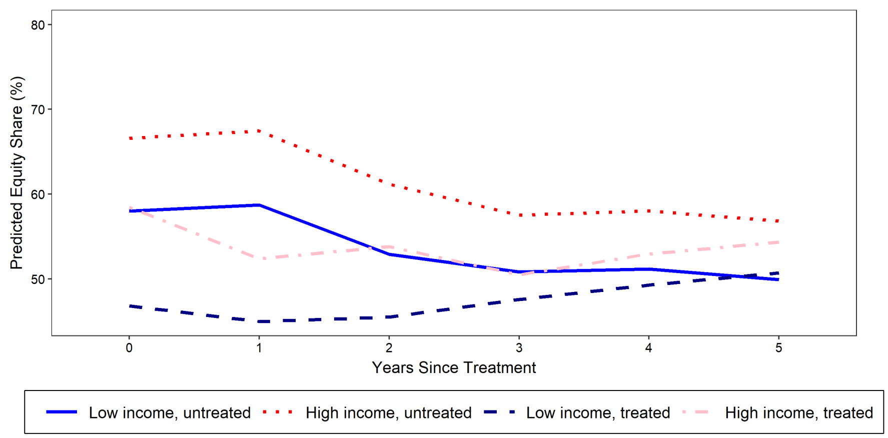
Notes: This figure replicates the results shown in Figure 12 of Ameriks and Zeldes (2004). The top figure shows the observed equity share by age in four different years of our sample. The middle figure shows the observed equity share by age in each cohort in our sample. A cohort is defined as having been born in the ten-year period beginning with the year indicated. The bottom figure shows the predicted values from a regression of equity share on indicator variables for age and either cohort or time. We obtain the predicted values by adding the median cohort or year coefficient, respectively, to each age coefficient. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. The sample is our set of retirement investors (RI) who own at least some equity.

Figure 7: Predicted Equity Share: Pension Protection Act

(a) Age Enrolled 25-34



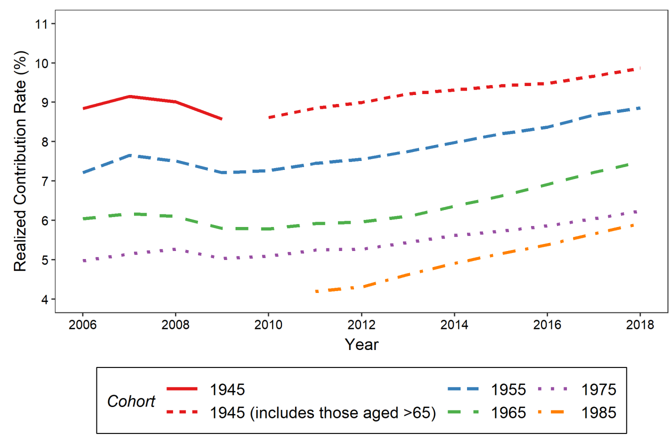
(b) Age Enrolled 55-65



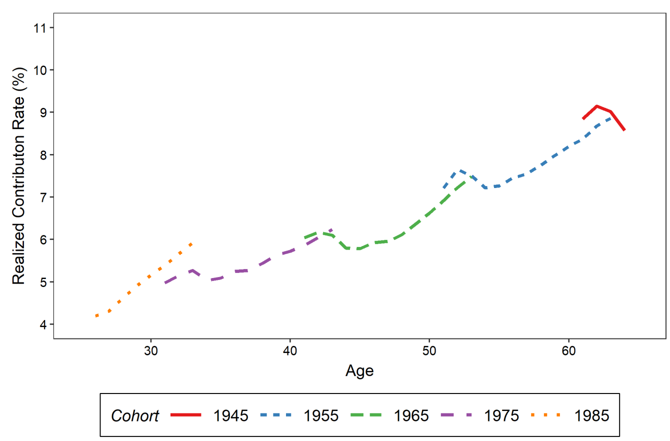
Notes: This figure shows the predicted equity share for those treated by the Pension Protection Act of 2006 and those not treated by the act, split out by age and income groups. The top panel shows the results for those aged 25-34 when enrolled. The bottom panel shows the results for those aged 55-65 when enrolled. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. The sample is our set of retirement investors (RI) who were enrolled between 2005-2008.

Figure 8: Realized Contribution Rate by Birth Cohort

(a) Realized Contribution Rate by Birth Cohort and Year



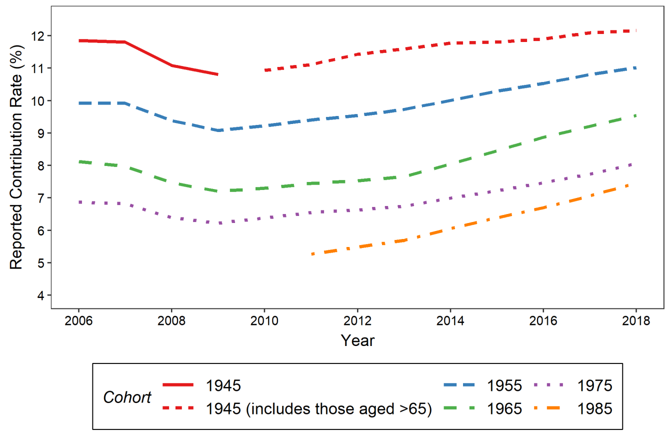
(b) Realized Contribution Rate by Birth Cohort and Age



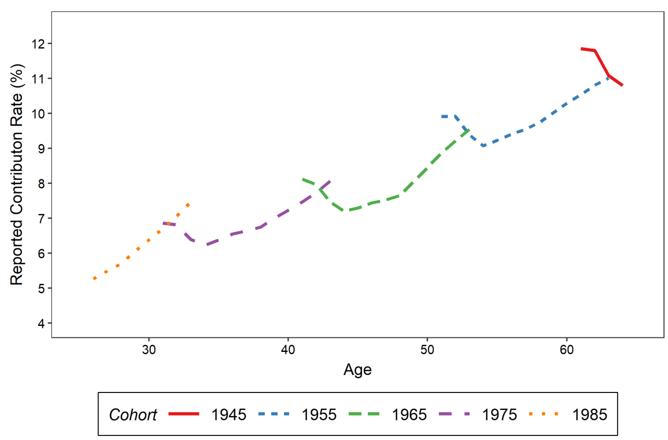
Notes: These figures show the realized contribution rate averaged by birth year cohorts. The top panel shows the averages by year over our sample period. We include only years during which each member of the cohort is aged 25-65, unless otherwise indicated. The bottom panel shows the averages by age, where age is the median age of the cohort. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. A cohort is defined as having been born in the three-year period centered around the year indicated. The sample is our full set of retirement investors (RI).

Figure 9: Reported Contribution Rate by Birth Cohort

(a) Reported Contribution Rate by Birth Cohort and Year



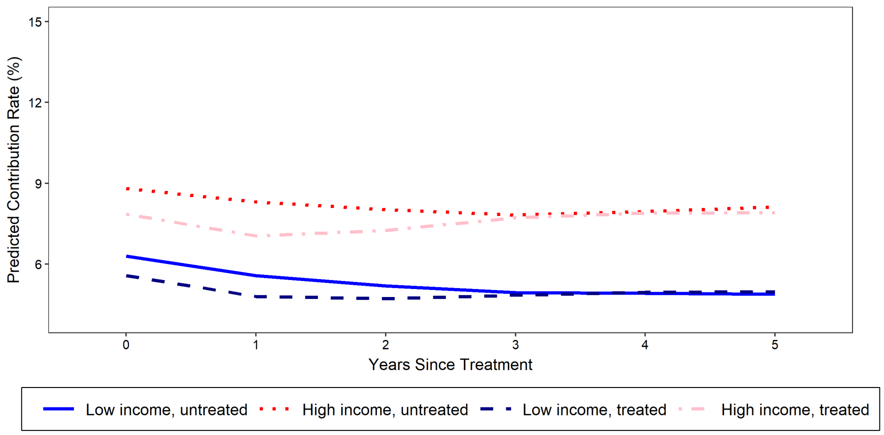
(b) Reported Contribution Rate by Birth Cohort and Age



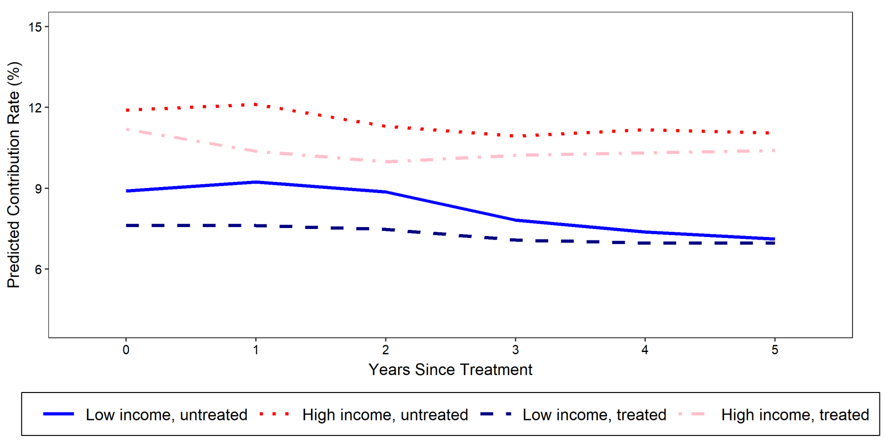
Notes: These figures show the reported contribution rate averaged by birth year cohorts. The top panel shows the averages by year over our sample period. We include only years during which each member of the cohort is aged 25-65, unless otherwise indicated. The bottom panel shows the averages by age, where age is the median age of the cohort. The reported contribution rate is the percentage of their income that an individual designates to be allocated into their retirement accounts at the beginning of each calendar year. A cohort is defined as having been born in the three-year period centered around the year indicated. The sample is our full set of retirement investors (RI).

Figure 10: Predicted Contribution Rate: Pension Protection Act

(a) Age Enrolled 25-34



(b) Age Enrolled 55-65



Notes: This figure shows the predicted contribution rate for those treated by the Pension Protection Act of 2006 and those not treated by the act, split out by age and income groups. The top panel shows the results for those aged 25-34 when enrolled. The bottom panel shows the results for those aged 55-65 when enrolled. The reported contribution rate is the percentage of their income that an individual designates to be allocated into their retirement accounts at the beginning of each calendar year. The sample is our set of retirement investors (RI) who were enrolled between 2005-2008.

Table I: Definitions of key variables

Variable	Definition
Investable wealth	The dollar value of the following assets, measured at the end of each calendar year and summed across retirement funds, individual brokerage accounts, and accounts managed by a financial advisor: money market mutual funds, non-money market funds (including mutual funds and ETFs), individual stocks and bonds, certificate of deposits, and trusts. The measure excludes bank accounts (checking and saving), savings bonds, cash value of life insurance, durable goods, and housing.
Retirement wealth	The dollar value of all wealth in retirement saving accounts of all types, measured at the end of each calendar year. This includes 401K and 403B plans, IRAs, and other Thrift plans. It excludes defined benefit plans and social security.
Non-retirement wealth	The dollar value of all investable wealth that is not retirement wealth, measured at the end of each calendar year. It includes individual stocks, bonds, money market mutual funds, and non-money market funds (including mutual funds and ETFs), certificates of deposit and trusts that are not held in retirement accounts.
Labor income	The dollar value of gross labor/wage income (pre-tax) earned by the head of household, annualized by scaling up part-year incomes to a full-year equivalent. In the SCF, the sum of wages from the head of household's first and second job and self-employment income. Both measures exclude rental income, dividends, royalties, and any income that is not payment for labor. When included in regressions, we normalize income by taking the log deviation of labor income from the RI sample average in the same year.
Retirement Share of Wealth	Total retirement wealth divided by total investable wealth at the end of each calendar year.
Target Date Funds (TDF)	Mutual funds that maintain a given portfolio share of assets invested in different asset classes, where the shares change with the number of years until 'target date,' the expected retirement date of the investor, sometimes referred to as "hybrid", "combination", "auto-rebalancing", or "mixed" funds.
TDF Share of Investable Wealth	Total dollar value of TDFs in the portfolio divided by total investable wealth at the end of each calendar year.
Employment Tenure	The number of years that an employee has been working for their current employer, available for a subset of our sample for which labor income is available.
Equity share of retirement wealth	The percentage share of the retirement wealth at the end of each calendar year that is invested in equities and equity-like securities such as individual stocks, equity mutual funds, and the equity component of blended funds (TDFs and auto-rebalancing funds).

Definitions of key variables, continued

Variable	**Definition**
Equity share of investable wealth	The percentage share of investable wealth at the end of the calendar year that is invested in equities and equity-like securities such as individual stocks, equity mutual funds, and the equity component of blended funds (TDFs and auto-rebalancing funds).
Equity share of non-retirement wealth	The percentage share of non-retirement wealth at the end of the calendar year that is invested in equities and equity-like securities such as individual stocks, equity mutual funds, and the equity component of blended funds (TDFs and auto-rebalancing funds).
Long-term bonds (fixed income)	Bond funds, long-term government and corporate bonds, and the portion of funds that invest across asset classes (TDFs and auto-rebalancing funds) that is not allocated to equity.
Short-term bonds (cash-like securities)	Money market mutual funds, short-term treasury bonds, and CDs.
Market betas	Using all available return data from 2006 to 2018, we estimate betas from monthly regressions of excess asset returns on excess market returns. We require at least 24 monthly return observations. We set the market beta of short-term bonds to zero. We use the estimated beta on a corresponding ETF as a proxy for individual betas on agency bonds (ticker: AGZ), municipal bonds (MUB), TIPS (TIP), gold (IAU), silver (SLV), and platinum (PPLT). For mixed-asset funds, we account for time variation in betas due to a changing equity share of the portfolio (especially for lifecycle funds) by assuming that the fund market beta is affine in the fund equity share with a fund-specific intercept and a common slope. We estimate the common slope in a pooled regression that includes all mixed-asset funds in an investor's portfolio.
Reported contribution rate	The elected retirement saving rate as a fraction of labor income in employment-based accounts, reported at a monthly frequency. We use the value reported in January for our annual data. This is available only for the subset of the sample for which labor income is observed.
Realized contribution rate	The sum of all flows into retirement accounts in a given year, as a fraction of annual realized labor income. This is calculated only for the subset of the sample for which labor income is observed.

Table II: Characteristics of Sample of Retirement Investors in 2016

Retirement Investors				
	Summary Statistics			
	Mean	Median	SD	Percentage of RI Sample with Observed Data
Age (Years)	45.38	46	11.28	100%
Female	0.46	0	0.50	94.0%
Married	0.72	1	0.45	89.5%
Labor Income ($)	101,384	74,230	195,060	41.0%
Investable Wealth ($)	116,938	38,394	367,156	100%
Retirement Wealth ($)	95,654	35,451	155,237	100%
Retirement Share of Wealth (%)	96.3	100	13.9	100%
Portfolio Beta	0.75	0.84	0.32	86.9%
TDF Share of Invest. Wealth (%)	47.9	37.3	44.7	99.6%
Employment Tenure (Years)	10.50	7.94	9.17	60.0%
Reported Contribution Rate (%)	8.1	6.0	7.3	53.2%
Realized Contribution Rate (%)	6.4	5.5	5.3	47.1%

Retirement Investors - Survey of Consumer Finance				
	Summary Statistics			
	Mean	Median	SD	Number of Observations
Age	46.78	47	10.63	3130
Female	0.50	0	0.50	3130
Married	0.78	1	0.39	3130
Labor Income (Individual, $)	66,459	50,000	1,129,486	3130
Labor Income (Household, $)	101,349	77,000	1,445,913	1889
Investable Wealth (Household, $)	273,282	72,000	17,019,097	1889
Retirement Wealth (Household, $)	193,568	76,830	659,727	1889
Retirement Wealth (Individual, $)	97,658	41,500	155,503	3130
Retirement Share of Investable Wealth (Individual, %)	65.32	76.19	38.43	3130
Retirement Share of Investable Wealth (Household, %)	87.81	100.00	31.33	1889

Notes: This table presents summary statistics on demographics, wealth, and portfolio allocations for our Retirement Investor (RI) sample in 2016 and a comparable sample of the 2016 Survey of Consumer Finance (SCF). Detailed definitions for retirement wealth and investable wealth are provided in Table I. The reported contribution rate is the percentage of their income that an individual designates to be allocated into their retirement accounts at the beginning of each calendar year. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. Market betas are obtained by regressing monthly fund or security excess returns on the value-weighted CRSP market excess return over the period 2007–2017 with at least 24 observations. Income is the labor income of the respondent in 2015. The sample is not representative of the assets under management of our financial service firm, since by design we drop the highest and lowest income groups.

Table III: Average Share of Equity in Portfolios Among Retirement Investors

	All Retirement Investors		Retirement Investors with Hybrid Fund (e.g. TDF) in Retirement Account	
Panel A: All Investable Wealth	Main Sample (Individuals)	SCF (Households)	Main Sample (Individuals)	SCF (Households)
All RIs	71.0	54.5	76.6	46.9
Age 25-34	77.6	59.1	84.8	49.6
Age 35-44	76.0	55.9	82.2	47.9
Age 45-54	71.2	53.8	74.7	45.5
Age 55-65	60.5	51.2	61.2	45.4
Respondents		54.3		47.0
Partners		54.8		46.9
Panel B: Retirement Wealth	Main Sample (Individuals)	SCF (Individuals)	Main Sample (Individuals)	SCF (Individuals)
All RIs	71.1	51.7	76.7	42.1
Age 25-34	77.7	56.2	85.0	44.2
Age 35-44	76.2	54.1	82.4	43.5
Age 45-54	71.4	50.5	74.8	40.2
Age 55-65	60.6	48.0	61.2	41.2
Respondents		52.1		43.3
Partners		50.8		39.8
Panel C: Non-Retirement Wealth	Main Sample (Individuals)	SCF (Households)	Main Sample (Individuals)	SCF (Households)
All RIs	51.1	73.4	53.2	73.2
Age 25-34	52.0	87.5	53.0	86.9
Age 35-44	53.5	68.9	55.5	68.3
Age 45-54	51.1	74.5	52.9	73.6
Age 55-65	48.8	69.6	50.8	69.6
Respondents		73.9		74.4
Partners		72.7		71.2

Notes: This table presents the share of equity in the portfolio allocations for various samples of our Retirement Investors (RI) sample in 2016 and the comparable RI sample of the 2016 Survey of Consumer Finance (SCF). Panel A shows equity shares of total investable wealth at the individual level in our sample and the household level in the SCF. Panel B shows equity shares of retirement wealth, at the individual level in both datasets. Panel C shows equity shares of non-retirement wealth at the individual level in our sample and the household level in the SCF. The figures in Panel C are conditional on owning some non-retirement wealth, which is approximately 40% of the SCF RI sample and 16% of our RI sample. The first two columns show the means for the full sample of RIs in each dataset. The last two columns show the means for the subsample of the RI sample that has some of their retirement assets in a target date fund (TDF). Investable wealth is defined as money market funds, non-money market funds, individual stocks and bonds, Retirement wealth is defined as any wealth in retirement saving accounts of all types (excluding defined benefit plans and Social Security). certificate of deposits, quasi-liquid retirement wealth, and other managed accounts. The equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets.

Table IV: Cross-Sectional Regressions of Equity Share, Full Sample and by Income Terciles

	Portfolio equity share				
	(1) All Observations	(2) All Observations	(3) First Tercile of Initial Income	(4) Second Tercile of Initial Income	(5) Third Tercile of Initial Income
Age 25-27	0.7366	0.8031	0.7489	0.7915	0.7943
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0005)
Age 28-30	0.7326	0.7964	0.7321	0.7797	0.7865
	(0.0001)	(0.0002)	(0.0003)	(0.0002)	(0.0004)
Age 31-33	0.7331	0.7888	0.7272	0.7724	0.7790
	(0.0001)	(0.0001)	(0.0003)	(0.0002)	(0.0003)
Age 34-36	0.7348	0.7816	0.7253	0.7674	0.7730
	(0.0001)	(0.0001)	(0.0003)	(0.0002)	(0.0003)
Age 37-39	0.7344	0.7731	0.7208	0.7614	0.7681
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Age 40-42	0.7296	0.7615	0.7118	0.7515	0.7607
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Age 43-45	0.7209	0.7479	0.6990	0.7383	0.7509
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Age 46-48	0.7053	0.7280	0.6787	0.7172	0.7341
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Age 49-51	0.6844	0.7022	0.6542	0.6903	0.7102
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Age 52-54	0.6598	0.6738	0.6263	0.6602	0.6818
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)
Age 55-57	0.6304	0.6402	0.5923	0.6244	0.6482
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0003)
Age 58-60	0.6002	0.6063	0.5593	0.5869	0.6121
	(0.0001)	(0.0002)	(0.0004)	(0.0003)	(0.0003)
Age 61-63	0.5702	0.5730	0.5250	0.5486	0.5765
	(0.0002)	(0.0002)	(0.0004)	(0.0004)	(0.0004)
Age 64-65	0.5496	0.5482	0.4969	0.5173	0.5485
	(0.0002)	(0.0003)	(0.0005)	(0.0005)	(0.0005)
Log income		0.0761			
		(0.0003)			
Person fixed effect?	N	N	N	N	N
% of RI Sample	93.4	40.9	15.8	16.7	16.2
R-squared	0.0379	0.0751	0.0553	0.0744	0.0609

Notes: This table presents regression coefficients of annual individual portfolio equity shares on a set of demographic controls. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. The baseline specification in column (1) shows the coefficients for the regression of equity share on age group dummies. In the second column, we add a control for the log of income in the current year, measured as the individual's log deviation from the average income in the RI sample. Columns (3)-(5) show the results of the baseline specification for the first (lowest) through the third tercile of initial income, respectively. Initial income is based upon the income observed in the first (or second, if first is not available) year that we observe the individual. The sample is our full set of retirement investors (RI) from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table V: Within-Person Regressions of Equity Share, Full Sample and by Income Terciles

	Portfolio equity share				
	(1) All Observations	(2) All Observations	(3) First Tercile of Initial Income	(4) Second Tercile of Initial Income	(5) Third Tercile of Initial Income
Age 25-27	0.6758	0.6624	0.6336	0.6777	0.6784
	(0.0004)	(0.0006)	(0.0009)	(0.0009)	(0.0010)
Age 28-30	0.6854	0.6775	0.6273	0.6862	0.6945
	(0.0004)	(0.0005)	(0.0009)	(0.0008)	(0.0009)
Age 31-33	0.7042	0.7003	0.6395	0.7006	0.7099
	(0.0003)	(0.0005)	(0.0009)	(0.0008)	(0.0008)
Age 34-36	0.7227	0.7219	0.6572	0.7149	0.7213
	(0.0003)	(0.0005)	(0.0009)	(0.0008)	(0.0007)
Age 37-39	0.7370	0.7394	0.6735	0.7267	0.7302
	(0.0003)	(0.0005)	(0.0008)	(0.0008)	(0.0007)
Age 40-42	0.7460	0.7519	0.6864	0.7344	0.7348
	(0.0003)	(0.0005)	(0.0008)	(0.0007)	(0.0007)
Age 43-45	0.7517	0.7613	0.6968	0.7397	0.7364
	(0.0003)	(0.0004)	(0.0008)	(0.0007)	(0.0006)
Age 46-48	0.7519	0.7647	0.7011	0.7391	0.7325
	(0.0003)	(0.0004)	(0.0007)	(0.0007)	(0.0006)
Age 49-51	0.7486	0.7637	0.7026	0.7344	0.7242
	(0.0002)	(0.0004)	(0.0007)	(0.0006)	(0.0006)
Age 52-54	0.7397	0.7559	0.6964	0.7227	0.7102
	(0.0002)	(0.0004)	(0.0006)	(0.0006)	(0.0005)
Age 55-57	0.7253	0.7412	0.6833	0.7029	0.6907
	(0.0002)	(0.0004)	(0.0006)	(0.0006)	(0.0005)
Age 58-60	0.7071	0.7220	0.6661	0.6771	0.6664
	(0.0002)	(0.0003)	(0.0005)	(0.0005)	(0.0005)
Age 61-63	0.6845	0.6987	0.6420	0.6465	0.6389
	(0.0001)	(0.0002)	(0.0004)	(0.0004)	(0.0004)
Age 64-65	0.6635	0.6752	0.6159	0.6168	0.6132
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log income		0.0365			
		(0.0003)			
Person fixed effect?	Y	Y	Y	Y	Y
% of RI Sample	93.4	40.9	15.8	16.7	0.162
R-squared	0.7561	0.7742	0.7742	0.7372	0.6876

Notes: This table presents regression coefficients of annual individual portfolio equity shares on a set of demographic controls. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. The baseline specification in column (1) shows the coefficients for the regression of equity share on age group dummies. In the second column, we add a control for the log of income in the current year, measured as the individual's log deviation from the average income in the RI sample. Columns (3)-(5) show the results of the baseline specification for the first (lowest) through the third tercile of initial income, respectively. Initial income is based upon the income observed in the first (or second, if first is not available) year that we observe the individual. All regressions include a person fixed effect. The age group coefficients are normalized by adding the average fixed effect back to the estimated coefficients. The excluded age group is those aged 64-65. The sample is our full set of retirement investors (RI) from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table VI: Within-Person Regressions of Equity Share on Age Groups by Cohort and TDF Share

	Portfolio equity share							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	1943 Cohort	1953 Cohort	1963 Cohort	1973 Cohort	1983 Cohort	Initial TDF Share 75-100 %	Initial TDF Share 25-75 %	Initial TDF Share 0-25 %
Age 25-27				0.7153	0.7953	0.6582	0.5457	0.6264
				(0.0006)	(0.0004)	(0.0007)	(0.0011)	(0.0009)
Age 28-30				0.7208	0.8122	0.6765	0.5607	0.6276
				(0.0004)	(0.0004)	(0.0006)	(0.0010)	(0.0008)
Age 31-33				0.7379	0.8420	0.6930	0.5769	0.6378
				(0.0004)	(0.0003)	(0.0005)	(0.0009)	(0.0008)
Age 34-36			0.7268	0.7594	0.8629	0.7085	0.5956	0.6553
			(0.0005)	(0.0004)	(0.0001)	(0.0005)	(0.0008)	(0.0008)
Age 37-39			0.7142	0.7802		0.7169	0.6106	0.6717
			(0.0004)	(0.0003)		(0.0004)	(0.0008)	(0.0007)
Age 40-42			0.7101	0.8094		0.7193	0.6222	0.6851
			(0.0003)	(0.0002)		(0.0004)	(0.0007)	(0.0007)
Age 43-45		0.7859	0.7215	0.8176		0.7185	0.6316	0.6963
		(0.0008)	(0.0003)	(0.0001)		(0.0004)	(0.0007)	(0.0007)
Age 46-48		0.7449	0.7269			0.7128	0.6356	0.7011
		(0.0006)	(0.0003)			(0.0003)	(0.0007)	(0.0006)
Age 49-51		0.7182	0.7415			0.7030	0.6358	0.7041
		(0.0006)	(0.0002)			(0.0003)	(0.0006)	(0.0006)
Age 52-54	0.7366	0.7116	0.7377			0.6886	0.6304	0.7015
	(0.0010)	(0.0006)	(0.0001)			(0.0003)	(0.0006)	(0.0006)
Age 55-57	0.6802	0.6974				0.6690	0.6184	0.6927
	(0.0006)	(0.0006)				(0.0003)	(0.0006)	(0.0005)
Age 58-60	0.6192	0.6876				0.6448	0.6015	0.6831
	(0.0004)	(0.0005)				(0.0002)	(0.0005)	(0.0005)
Age 61-63	0.5880	0.6749				0.6153	0.5770	0.6701
	(0.0003)	(0.0005)				(0.0002)	(0.0004)	(0.0004)
Age 64-65	0.5505	0.6615				0.5887	0.5518	0.6557
	(0.0000)	(0.0000)				(0.0001)	(0.0001)	(0.0001)
Log income	0.0274	0.0226	0.0256	0.0407	0.0662			
	(0.0012)	(0.0006)	(0.0006)	(0.0006)	(0.0008)			
Person fixed effect?	Y	Y	Y	Y	Y	Y	Y	Y
% of RI Sample	3.1	10.9	11.5	10.3	5.0	39.5	7.9	10.1
R-squared	0.7948	0.7627	0.7537	0.7420	0.7343	0.7457	0.6769	0.6892

Notes: This table presents regression coefficients of annual individual portfolio equity shares on a set of demographic controls. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. Columns (1)-(5) show the results including age-group controls and a control for log income, broken out by birth cohort groups. Log income is measured as the log deviation of the individual's income from the average income of the RI sample. A cohort is defined as having been born in the ten year period beginning with the year indicated. Columns (6)-(8) show the results for different groups based on the initial share of their portfolio that is invested in target date funds (TDFs). All regressions include a person fixed effect. The age group coefficients are normalized by adding the average fixed effect back to the estimated coefficients. The excluded age group is those aged 64-65. The sample is our full RI sample from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table VII: Regressions of Equity Share on Automated Investment Allocation: Average Effect Two Years After Entering Sample

	Portfolio equity share					
	(1) All	(2) All	(3) Bottom Income Tercile	(4) Top Income Tercile	(5) No prior non-retirement wealth + no rollover assets	(6) No prior non-retirement wealth + no rollover assets
Treated	0.0552 (0.0007)	0.0533 (0.0008)	0.0599 (0.0011)	0.0186 (0.0024)	0.0578 (0.0007)	0.0555 (0.0008)
Age 35-44	-0.0134 (0.0006)	-0.0271 (0.0007)	-0.0339 (0.0013)	-0.0112 (0.0012)	-0.0140 (0.0006)	-0.0272 (0.0007)
Age 45-54	-0.0700 (0.0007)	-0.0875 (0.0008)	-0.1011 (0.0015)	-0.0627 (0.0014)	-0.0720 (0.0007)	-0.0887 (0.0009)
Age 55-65	-0.1325 (0.0012)	-0.1502 (0.0014)	-0.1658 (0.0026)	-0.1254 (0.0023)	-0.1352 (0.0013)	-0.1520 (0.0015)
Age 35-44 x Treatment	-0.0581 (0.0014)	-0.0542 (0.0016)	-0.0508 (0.0024)	-0.0366 (0.0041)	-0.0600 (0.0015)	-0.0549 (0.0017)
Age 45-54 x Treatment	-0.1029 (0.0018)	-0.0885 (0.0021)	-0.0717 (0.0030)	-0.0809 (0.0050)	-0.1042 (0.0018)	-0.0895 (0.0021)
Age 55-65 x Treatment	-0.1479 (0.0032)	-0.1314 (0.0038)	-0.1235 (0.0055)	-0.1173 (0.0091)	-0.1495 (0.0033)	-0.1322 (0.0038)
Log income		0.1031 (0.0012)				0.1072 (0.0013)
Constant	0.7352 (0.0003)	0.7476 (0.0004)	0.7180 (0.0006)	0.7353 (0.0003)	0.7335 (0.0003)	0.7468 (0.0004)
Firm Fixed Effect?	Y	Y	Y	Y	Y	Y
% of Total Sample	1.3	0.9	0.3	0.3	1.2	0.9
% of Sample Enrolled 2005-2008	18.1	12.8	5.0	3.9	17.0	12.2
R-squared	0.1543	0.1502	0.2266	0.1044	0.1620	0.1565

Notes: This table presents regression coefficients of annual household portfolio equity shares on a treatment dummy for being enrolled into a plan with a target date fund (TDF) as the default after the Pension Protection Act of 2006. We set this treatment dummy equal to one for those enrolled in their firm's retirement plan in 2007 or 2008 when that plan had a TDF as a default and zero for those enrolled in 2005 or 2006. Columns (1)-(2) show the results for the first two years of data after the individual enters our sample. Columns (3)-(4) repeat column (1) for those in the lowest and highest tercile of initial income, respectively. Columns (5)-(6) repeat columns (1)-(2) including only individuals who had no prior retirement wealth before enrollment and no rollover assets of any kind. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. Log income, when included, is the log deviation of the individual's current income from the average income of the RI sample. The sample is our set of retirement investors (RI) who enrolled in their plan from 2005-2008. Standard errors, in parentheses, are clustered at the household level.

Table VIII: Regressions of Equity Share on Automated Investment Allocation: Long-run Effect

	Portfolio equity share						
	(1) Full Sample	(2) Bottom Income Tercile	(3) Top Income Tercile	(4) Age Enrolled 25-34	(5) Age Enrolled 35-44	(6) Age Enrolled 45-54	(7) Age Enrolled 55-65
Year of x Treatment	0.0198	0.0463	0.0071	0.0161	-0.0263	-0.0584	-0.0618
	(0.0023)	(0.0036)	(0.0051)	(0.0022)	(0.0066)	(0.0092)	(0.0171)
1 Year After x Treatment	0.0430	0.0655	-0.0065	0.0295	-0.0154	-0.0750	-0.1321
	(0.0011)	(0.0015)	(0.0029)	(0.0011)	(0.0036)	(0.0068)	(0.0097)
2 Years After x Treatment	0.0683	0.0861	0.0287	0.0363	0.0186	-0.0181	-0.0515
	(0.0009)	(0.0013)	(0.0025)	(0.0011)	(0.0028)	(0.0050)	(0.0116)
3 Years After x Treatment	0.0032	0.0254	-0.0269	0.0005	-0.0261	-0.0268	-0.0524
	(0.0010)	(0.0015)	(0.0021)	(0.0013)	(0.0018)	(0.0025)	(0.0046)
4 Years After x Treatment	-0.0244	-0.0185	-0.0292	0.0003	-0.0173	-0.0274	-0.0410
	(0.0010)	(0.0015)	(0.0019)	(0.0013)	(0.0014)	(0.0020)	(0.0039)
5 Years After x Treatment	0.0036	0.0104	-0.0055	0.0257	0.0099	-0.0060	-0.0201
	(0.0010)	(0.0015)	(0.0023)	(0.0014)	(0.0016)	(0.0022)	(0.0043)
1 Year After	0.0087	0.0209	0.0126	0.0136	0.0133	0.0096	0.0088
	(0.0009)	(0.0018)	(0.0013)	(0.0012)	(0.0014)	(0.0016)	(0.0026)
2 Years After	-0.0194	0.0022	-0.0201	0.0067	-0.0207	-0.0445	-0.0564
	(0.0010)	(0.0019)	(0.0014)	(0.0012)	(0.0015)	(0.0017)	(0.0029)
3 Years After	-0.0272	0.0046	-0.0383	0.0142	-0.0282	-0.0675	-0.0876
	(0.0010)	(0.0019)	(0.0015)	(0.0013)	(0.0016)	(0.0018)	(0.0030)
4 Years After	-0.0221	0.0074	-0.0334	0.0243	-0.0209	-0.0629	-0.0810
	(0.0010)	(0.0019)	(0.0015)	(0.0013)	(0.0016)	(0.0018)	(0.0031)
5 Years After	-0.0348	-0.0091	-0.0459	0.0134	-0.0373	-0.0824	-0.0955
	(0.0011)	(0.0020)	(0.0016)	(0.0014)	(0.0017)	(0.0019)	(0.0034)
Log income	0.0487						
	(0.0012)						
Constant	0.7279	0.6751	0.7473	0.7255	0.7432	0.7059	0.6374
	(0.0010)	(0.0020)	(0.0014)	(0.0013)	(0.0015)	(0.0017)	(0.0028)
Firm Fixed Effect?	Y	Y	Y	Y	Y	Y	Y
% of RI Sample	1.6	0.5	0.5	0.8	0.6	0.4	0.1
% of Sample Enrolled 2005-2008	22.4	7.8	7.1	11.9	8.2	5.8	1.9
R-squared	0.0969	0.1727	0.0716	0.1537	0.1013	0.0942	0.1181

Notes: This table presents regression coefficients of annual household portfolio equity shares on being treated with the Pension Protection Act (PPA) of 2006. "Year of" means the year the individual enrolled in their retirement plan and "x years after" is x years after they enrolled in the plan. Each column includes year dummies for each year after enrollment, and interactions of these dummies with the treatment dummy. The treatment dummy is equal to one if the individual enrolled in 2007 or 2008 to a plan that switched to having a target date fund as the default following the PPA and zero if they enrolled in 2005 or 2006. The full sample is those enrolled from 2005-2008 who otherwise meet the RI sample criteria. The bottom (top) income tercile includes those whose initial income is in the lowest (highest) tercile. Columns (4)-(7) break out the result for all individuals enrolled from 2005-2008 by age at enrollment. The portfolio equity share is defined as the sum of equity securities, pure equity funds, and the equity portion of hybrid funds, relative to total portfolios assets. Log income, when included, is the log deviation of the individual's current income from the average income of the RI sample. Standard errors, in parentheses, are clustered at the household level.

Table IX: Cross-Sectional Regressions of Realized Contribution Rate, Full Sample and by Income Terciles

	Realized contribution rate				
	(1) All Observations	(2) All Observations	(3) First Tercile of Initial Income	(4) Second Tercile of Initial Income	(5) Third Tercile of Initial Income
Age 25-27	0.0456 (0.0000)	0.0512 (0.0000)	0.0393 (0.0000)	0.0520 (0.0000)	0.0569 (0.0001)
Age 28-30	0.0497 (0.0000)	0.0540 (0.0000)	0.0425 (0.0000)	0.0545 (0.0000)	0.0613 (0.0001)
Age 31-33	0.0526 (0.0000)	0.0558 (0.0000)	0.0445 (0.0000)	0.0555 (0.0000)	0.0629 (0.0001)
Age 34-36	0.0545 (0.0000)	0.0568 (0.0000)	0.0461 (0.0000)	0.0558 (0.0000)	0.0632 (0.0001)
Age 37-39	0.0560 (0.0000)	0.0578 (0.0000)	0.0474 (0.0000)	0.0564 (0.0000)	0.0634 (0.0000)
Age 40-42	0.0576 (0.0000)	0.0590 (0.0000)	0.0490 (0.0001)	0.0576 (0.0000)	0.0639 (0.0000)
Age 43-45	0.0596 (0.0000)	0.0608 (0.0000)	0.0514 (0.0001)	0.0596 (0.0001)	0.0650 (0.0000)
Age 46-48	0.0617 (0.0000)	0.0629 (0.0000)	0.0538 (0.0001)	0.0622 (0.0001)	0.0664 (0.0000)
Age 49-51	0.0662 (0.0000)	0.0674 (0.0000)	0.0569 (0.0001)	0.0662 (0.0001)	0.0719 (0.0000)
Age 52-54	0.0713 (0.0000)	0.0727 (0.0000)	0.0604 (0.0001)	0.0711 (0.0001)	0.0782 (0.0001)
Age 55-57	0.0752 (0.0000)	0.0768 (0.0000)	0.0637 (0.0001)	0.0756 (0.0001)	0.0822 (0.0001)
Age 58-60	0.0792 (0.0000)	0.0811 (0.0000)	0.0671 (0.0001)	0.0805 (0.0001)	0.0863 (0.0001)
Age 61-63	0.0833 (0.0001)	0.0855 (0.0001)	0.0712 (0.0001)	0.0857 (0.0001)	0.0902 (0.0001)
Age 64-65	0.0848 (0.0001)	0.0873 (0.0001)	0.0734 (0.0001)	0.0877 (0.0001)	0.0915 (0.0001)
Log income		0.0185 (0.0000)			
Person fixed effect?	N	N	N	N	N
% of RI Sample	41.4	41.1	12.0	13.3	12.6
R-squared	0.0472	0.0578	0.0446	0.0390	0.0385

Notes: This table presents regression coefficients of realized contribution rate on a set of demographic controls. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. The baseline specification in column (1) shows the coefficients for the regression of realized contribution rate on age group dummies. In the second column, we add a control for the log of income in the current year, measured as the individual's log deviation from the average income in the RI sample. Columns (3)-(5) show the results of the baseline specification for the first (lowest) through the third tercile of initial income, respectively. Initial income is based upon the income observed in the first (or second, if first is not available) year that we observe the individual. The sample is our full set of retirement investors (RI) from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table X: Within-Person Regressions of Realized Contribution Rate, Full Sample and by Income Terciles

	Realized contribution rate				
	(1) All Observations	(2) All Observations	(3) First Tercile of Initial Income	(4) Second Tercile of Initial Income	(5) Third Tercile of Initial Income
Age 25-27	0.0271	0.0142	0.0270	0.0282	0.0436
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Age 28-30	0.0344	0.0221	0.0331	0.0365	0.0534
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Age 31-33	0.0400	0.0283	0.0379	0.0427	0.0595
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Age 34-36	0.0439	0.0325	0.0416	0.0469	0.0626
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Age 37-39	0.0468	0.0357	0.0444	0.0504	0.0643
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)
Age 40-42	0.0493	0.0384	0.0470	0.0538	0.0653
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)
Age 43-45	0.0516	0.0409	0.0495	0.0570	0.0663
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)
Age 46-48	0.0541	0.0434	0.0520	0.0604	0.0675
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)
Age 49-51	0.0586	0.0480	0.0551	0.0650	0.0724
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Age 52-54	0.0640	0.0534	0.0588	0.0704	0.0782
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Age 55-57	0.0686	0.0581	0.0625	0.0757	0.0824
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Age 58-60	0.0736	0.0630	0.0664	0.0813	0.0870
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Age 61-63	0.0786	0.0681	0.0707	0.0870	0.0915
	(0.0000)	(0.0000)	(0.0001)	(0.0001)	(0.0001)
Age 64-65	0.0817	0.0711	0.0731	0.0900	0.0944
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Log income		-0.0108			
		(0.0001)			
Person fixed effect?	Y	Y	Y	Y	Y
% of RI Sample	41.4	41.1	12.0	13.3	12.6
R-squared	0.7684	0.7709	0.7755	0.7635	0.7355

Notes: This table presents regression coefficients of realized contribution rate on a set of demographic controls. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. The baseline specification in column (1) shows the coefficients for the regression of realized contribution rate on age group dummies. In the second column, we add a control for the log of income in the current year, measured as the individual's log deviation from the average income in the RI sample. Columns (3)-(5) show the results of the baseline specification for the first (lowest) through the third tercile of initial income, respectively. Initial income is based upon the income observed in the first (or second, if first is not available) year that we observe the individual. All regressions include a person fixed effect. The age group coefficients are normalized by adding the average fixed effect back to the estimated coefficients. The excluded age group is those aged 64-65. The sample is our full set of retirement investors (RI) from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table XI: Within-Person Regressions of Realized Contribution Rate on Age Groups by Cohort and TDF Share

	Realized contribution rate							
	(1) 1943 Cohort	(2) 1953 Cohort	(3) 1963 Cohort	(4) 1973 Cohort	(5) 1983 Cohort	(6) Initial TDF Share 75-100 %	(7) Initial TDF Share 25-75 %	(8) Initial TDF Share 0-25 %
Age 25-27				0.0376	0.0570	0.0448	0.0926	0.0583
				(0.0001)	(0.0001)	(0.0002)	(0.0003)	(0.0003)
Age 28-30				0.0428	0.0651	0.0510	0.1013	0.0682
				(0.0001)	(0.0001)	(0.0002)	(0.0003)	(0.0003)
Age 31-33				0.0474	0.0725	0.0550	0.1067	0.0756
				(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Age 34-36			0.0468	0.0513	0.0777	0.0577	0.1101	0.0809
			(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Age 37-39			0.0474	0.0549		0.0598	0.1124	0.0851
			(0.0001)	(0.0001)		(0.0001)	(0.0003)	(0.0003)
Age 40-42			0.0488	0.0588		0.0616	0.1145	0.0886
			(0.0001)	(0.0000)		(0.0001)	(0.0003)	(0.0003)
Age 43-45		0.0688	0.0510	0.0607		0.0633	0.1164	0.0919
		(0.0002)	(0.0001)	(0.0000)		(0.0001)	(0.0003)	(0.0003)
Age 46-48		0.0689	0.0538			0.0653	0.1183	0.0950
		(0.0001)	(0.0001)			(0.0001)	(0.0003)	(0.0003)
Age 49-51		0.0716	0.0594			0.0698	0.1223	0.0996
		(0.0001)	(0.0000)			(0.0001)	(0.0002)	(0.0003)
Age 52-54	0.0946	0.0764	0.0690			0.0751	0.1272	0.1051
	(0.0002)	(0.0001)	(0.0001)			(0.0001)	(0.0002)	(0.0003)
Age 55-57	0.0964	0.0811				0.0795	0.1314	0.1098
	(0.0001)	(0.0001)				(0.0001)	(0.0002)	(0.0002)
Age 58-60	0.0974	0.0868				0.0841	0.1356	0.1150
	(0.0001)	(0.0001)				(0.0001)	(0.0002)	(0.0002)
Age 61-63	0.1006	0.0936				0.0884	0.1397	0.1205
	(0.0001)	(0.0001)				(0.0001)	(0.0002)	(0.0002)
Age 64-65	0.1039	0.0941				0.0906	0.1414	0.1238
	(0.0001)	(0.0000)				(0.0001)	(0.0001)	(0.0000)
Log income	-0.0131	-0.0159	-0.0155	-0.0079	0.0039			
	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0002)			
Person fixed effect?	Y	Y	Y	Y	Y	Y	Y	Y
% of RI Sample	3.2	11.0	11.5	10.4	5.0	15.4	3.5	5.2
R-squared	0.8156	0.7798	0.7505	0.7139	0.7412	0.7511	0.7482	0.7396

Notes: This table presents regression coefficients of annual individual realized contribution rates on a set of demographic controls. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. Columns (1)-(5) show the results including age-group controls and a control for log income, broken out by birth cohort groups. Log income is measured as the log deviation of the individual's income from the average income of the RI sample. A cohort is defined as having been born in the ten year period beginning with the year indicated. Columns (6)-(8) show the results for different groups based on the initial share of their portfolio that is invested in target date funds (TDFs). All regressions include a person fixed effect. The age group coefficients are normalized by adding the average fixed effect back to the estimated coefficients. The excluded age group is those aged 64-65. The sample is our full RI sample from 2006-2018. Standard errors, in parentheses, are clustered at the individual level.

Table XII: Regressions of Realized Contribution Rate on Maxing Out on Contribution Limit

	Realized contribution rate			
	(1) All Observations	(2) All Observations	(3) All Observations	(4) All Observations
Max Out	0.0584 (0.0001)	0.0590 (0.0001)		
Max Out Ever			0.0403 (0.0001)	0.0475 (0.0001)
Age 25-34	0.0477 (0.0000)	0.0475 (0.0000)	0.0458 (0.0000)	0.0430 (0.0000)
Age 35-44	0.0528 (0.0000)	0.0528 (0.0000)	0.0495 (0.0000)	0.0479 (0.0000)
Age 45-54	0.0613 (0.0000)	0.0613 (0.0000)	0.0574 (0.0000)	0.0561 (0.0000)
Age 55-65	0.0735 (0.0000)	0.0735 (0.0000)	0.0696 (0.0000)	0.0681 (0.0000)
Log income		-0.0014 (0.0001)		-0.01235 (0.0001)
Age 35-44 x Max Out	-0.0173 (0.0001)	-0.0174 (0.0001)		
Age 45-54 x Max Out	-0.0184 (0.0001)	-0.0185 (0.0001)		
Age 55-65 x Max Out	-0.0056 (0.0001)	-0.0057 (0.0002)		
Age 35-44 x Max Out Ever			-0.0031 (0.0001)	-0.0027 (0.0001)
Age 45-54 x Max Out Ever			-0.0005 (0.0001)	0.0003 (0.0001)
Age 55-65 x Max Out Ever			0.0104 (0.0001)	0.0111 (0.0001)
Person fixed effect?	N	N	N	N
Percentage of Total Sample	44.9	41.3	44.9	41.3
R-squared	0.1118	0.1123	0.1473	0.1518

Notes: This table presents regression coefficients of annual realized contribution rates on measures of maxing out on retirement contributions. The realized contribution rate is the percentage of an individual's annual income that has been invested into a retirement account over the previous year, calculated at the end of each calendar year. Maxing out is defined as when an individual exceeds the dollar amount that is allowed for 401(k) contributions in a year, set by the IRS. Columns (1)-(2) contain a dummy for maxing out that it set to one if the individual maxes out their contribution in the current year. Columns (3)-(4) contain a dummy for maxing out that is set to one if the individual has *ever* maxed out their contribution while we observe them in our sample. Each specification also contains interactions of the corresponding max out measure with age group dummies. Log income is measured in the first (or second, if first is not available) year that we observe the individual. We then take the log deviation of the first year's income from the RI sample's average. The sample is our full RI sample from 2006-2017. Standard errors, in parentheses, are clustered at the household level.

Table XIII: Regressions of Reported Contribution Rate on the Pension Protection Act: Average Effect Two Years After Entering Sample

	Reported contribution rate					
	(1) All	(2) All	(3) Bottom Income Tercile	(4) Top Income Tercile	(5) No prior non-retirement wealth + no rollover assets	(6) No prior non-retirement wealth + no rollover assets
Treated	-0.0043	-0.0034	-0.0028	-0.0073	-0.0042	-0.0034
	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0001)	(0.0001)
Age 35-44	0.0117	0.0084	0.0103	0.0077	0.0112	0.0082
	(0.0001)	(0.0001)	(0.0002)	(0.0003)	(0.0001)	(0.0001)
Age 45-54	0.0239	0.0203	0.0204	0.0211	0.0229	0.0196
	(0.0001)	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
Age 55-65	0.0406	0.0367	0.0339	0.0406	0.0389	0.0354
	(0.0003)	(0.0003)	(0.0005)	(0.0005)	(0.0003)	(0.0003)
Age 35-44 x Treatment	-0.0023	-0.0026	-0.0015	-0.0002	-0.0021	-0.0024
	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0002)
Age 45-54 x Treatment	-0.0045	-0.0047	-0.0028	-0.0029	-0.0038	-0.0042
	(0.0002)	(0.0002)	(0.0004)	(0.0004)	(0.0002)	(0.0002)
Age 55-65 x Treatment	-0.0077	-0.0083	-0.0058	-0.0078	-0.0067	-0.0075
	(0.0004)	(0.0004)	(0.0007)	(0.0008)	(0.0004)	(0.0004)
Log income		0.0314				0.0307
		(0.0002)				(0.0002)
Constant	0.0619	0.0623	0.0508	0.0705	0.0613	0.0621
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm Fixed Effect?	Y	Y	Y	Y	Y	Y
% of Total Sample	1.9	1.4	0.6	0.4	1.8	1.3
% of Sample Enrolled 2005-2008	27.5	20.3	7.9	6.1	25.9	19.3
R-squared	0.1737	0.1915	0.1718	0.1242	0.1726	0.1888

Notes: This table presents regression coefficients of reported contribution rate on a treatment dummy for being enrolled into a plan following the Pension Protection Act (PPA) of 2006. We set this treatment dummy equal to one for those enrolled in their firm's retirement plan in 2007 or 2008 and zero for those enrolled in 2005 or 2006. Columns (1)-(2) show the results for the first two years that we observe the individual in our sample. Columns (3)-(4) repeat column (1) for those in the lowest and highest tercile of initial income, respectively. Columns (5)-(6) repeat columns (1)-(2) including only individuals who had no prior retirement wealth before enrollment and no rollover assets of any kind. The reported contribution rate is the percentage of their income that an individual designates to be allocated into their retirement accounts at the beginning of each calendar year. Log income, when included, is the log deviation of the individual's current income from the average income of the RI sample. The sample is our set of retirement investors (RI) who enrolled in their plan from 2005-2008. Standard errors, in parentheses, are clustered at the household level.

Table XIV: Regressions of Reported Contribution Rate on the Pension Protection Act: Long-run Effect

	Reported contribution rate						
	(1) Full Sample	(2) Bottom Income Tercile	(3) Top Income Tercile	(4) Age Enrolled 25-34	(5) Age Enrolled 35-44	(6) Age Enrolled 45-54	(7) Age Enrolled 55-65
Year of x Treatment	-0.0085	-0.0092	-0.0092	-0.0069	-0.0088	-0.0093	-0.0127
	(0.0002)	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.0005)	(0.0009)
1 Year After x Treatment	-0.0116	-0.0098	-0.0140	-0.0087	-0.0119	-0.0143	-0.0167
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0006)
2 Years After x Treatment	-0.0072	-0.0074	-0.0091	-0.0055	-0.0071	-0.0101	-0.0124
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0005)
3 Years After x Treatment	-0.0026	-0.0034	-0.0033	-0.0014	-0.0029	-0.0056	-0.0071
	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0005)
4 Years After x Treatment	-0.0012	-0.0016	-0.0026	-0.0007	-0.0025	-0.0054	-0.0072
	(0.0001)	(0.0002)	(0.0003)	(0.0001)	(0.0002)	(0.0003)	(0.0006)
5 Years After x Treatment	-0.0003	0.0001	-0.0028	-0.0009	-0.0023	-0.0042	-0.0051
	(0.0001)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0007)
1 Year After	-0.0041	-0.0064	-0.0036	-0.0062	-0.0034	0.0029	0.0017
	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0006)
2 Years After	-0.0092	-0.0093	-0.0093	-0.0094	-0.0114	-0.0050	-0.0075
	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0007)
3 Years After	-0.0126	-0.0125	-0.0123	-0.0116	-0.0156	-0.0104	-0.0142
	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0007)
4 Years After	-0.0130	-0.0135	-0.0117	-0.0112	-0.0163	-0.0113	-0.0149
	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0003)	(0.0004)	(0.0007)
5 Years After	-0.0133	-0.0145	-0.0111	-0.0113	-0.0170	-0.0127	-0.0171
	(0.0002)	(0.0003)	(0.0004)	(0.0002)	(0.0003)	(0.0004)	(0.0008)
Log income	0.0424						
	(0.0002)						
Constant	0.0806	0.0698	0.0982	0.0706	0.0826	0.0891	0.1047
	(0.0002)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0004)	(0.0003)
Firm Fixed Effect?	Y	Y	Y	Y	Y	Y	Y
% of RI Sample	2.5	0.9	0.8	1.3	0.9	0.6	0.2
% of Sample Enrolled 2005-2008	35.7	12.7	11.3	18.7	12.6	8.7	2.9
R-squared	0.1509	0.1169	0.0846	0.1367	0.1201	0.1096	0.1423

Notes: This table presents regression coefficients of reported contribution rate on being treated with the Pension Protection Act (PPA) of 2006. "Year of" means the year the individual enrolled in their retirement plan and "x years after" is x years after they enrolled in the plan. Each column includes year dummies for each year after enrollment, and interactions of these dummies with the treatment dummy. The treatment dummy is equal to one if the individual enrolled in 2007 or 2008, after the PPA, and zero if they enrolled in 2005 or 2006. The full sample is those enrolled from 2005-2008 who otherwise meet the RI sample criteria. The bottom (top) income tercile includes those whose initial income is in the lowest (highest) tercile. Columns (4)-(7) break out the result for all individuals enrolled from 2005-2008 by age at enrollment. The reported contribution rate is the percentage of their income that an individual designates to be allocated into their retirement accounts at the beginning of each calendar year. Log income, when included, is the log deviation of the individual's current income from the average income of the RI sample. Standard errors, in parentheses, are clustered at the household level.