How Do Household Portfolio Shares Vary With Age?

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Comments welcome.

Abstract

Using pooled cross-sectional data from the Surveys of Consumer Finances, and new panel data from TIAA-CREF, we examine the empirical relationship between age and portfolio choice, focusing on the observed relationship between age and the fraction of wealth held in the stock market. We illustrate and discuss the importance of the well-known identification problem that prevents unrestricted estimation of age, time and cohort effects in longitudinal data. We also document three important features of household portfolio behavior: significant non-stockownership, wide-ranging heterogeneity in allocation choices, and the infrequency of active portfolio allocation changes (almost half of the sample members made *no* active changes to their portfolio allocations over our nine-year sample period). When estimating portfolio share equations, we consider three separate exclusion restrictions: excluding time effects, cohort effects, and finally age effects. We find no evidence supporting a gradual reduction in portfolio shares with age. There is some tendency for older individuals to shift completely out of the stock market around the time of annuitizations and withdrawals.

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1 Introduction

How households allocate their financial portfolios has been an increasingly important issue to economists and policymakers alike. There has been a rapid increase in the fraction of U.S. households owning equities, from 33 percent in 1989 to 51 percent in 2001. Much of this has been due to the dramatic growth in individually-directed defined-contribution retirement plans, in which individuals choose how much of their retirement funds are allocated to different assets. Similar patterns of increased equity ownership and added individual control over retirement asset allocation have occurred in many nations around the world, suggesting that the quality of investment decisions made by households will be of increasing importance to their future living standards. As policymakers in the U.S. and elsewhere consider adding an individual-account component to social security systems, a key issue that arises is whether households will make appropriate investment allocation decisions. Poor choices could potentially leave households with unacceptably low retirement consumption.

One important aspect of the financial decisions made by households is how their portfolio allocation changes with age or horizon. Professional financial planners often advise that the fraction of wealth that people should hold in the stock market should decline with age. A typical rule of thumb is that the percentage of an investor's portfolio of financial assets that is held in equities should equal 100 minus her age, so that a 30-year-old would hold 70 percent of her financial wealth in stocks, while a 70-year-old would hold 30 percent in stocks.

The proliferation of this type of advice in the popular press has stimulated increased interest among academic economists in at least two questions regarding these professional prescriptions. First: Should individuals follow this advice and decrease investment in the stock market as they get older? And second: Do individuals follow this advice and actually decrease investment in the stock market as they get older? The goal of this paper is to contribute to the research on these two questions through a careful analysis of how household portfolio choices, and particularly investments in the stock market, actually vary with investor age. The results also have implications, for example, for understanding the effects of stock prices of the aging of the baby boom generation (Bakshi and Chen (1994)).

This is not a simple exercise for a variety of reasons. First, even with perfect data, it is difficult to disentangle empirically the effects that age has on portfolio shares (age effects) from effects related to a person's date of birth (cohort effects) or effects related to the date of observation (time effects). Second, the available data on household asset allocation are not perfect; the data are typically incomplete and may be subject to measurement error. Third, a majority of U.S. households do not hold any wealth in the stock market, either directly or indirectly through mutual funds or retirement-savings accounts (such as 401(k)s or IRAs). This suggests the need to model and examine at least two choices: the decision to own stock or not, and (conditional on an affirmative answer) the choice of how much stock to hold.

We use data from two sources in our analysis. The first is pooled, cross-sectional data from the 1962 Survey of Financial Characteristics of Consumers, and the 1983, 1989, 1992, 1995, and 1998 Surveys of Consumer Finances. These data have several desirable attributes. They contain detailed information on a wide variety of assets and liabilities owned by the sampled households and are carefully constructed and weighted so as to be representative of the entire population of U.S. households at the time of each survey. The 1989 through 1998 surveys have very similar formats, enabling relatively easy and legitimate comparisons of the survey results over time.

Our second data source is a unique panel data set constructed at TIAA-CREF (Teachers Insurance and Annuity Association-College Retirement Equities Fund). This data set tracks the quarterly account balances and contributions over a thirteen-year period (1987-1999) for approximately 16,000 randomly selected TIAA-CREF participants. This is the one of only a few data sets that we know of that tracks portfolio data for the same individuals over many years. It has the added advantage of containing actual account data rather than self-reported data, reducing measurement error dramatically.

The paper is structured as follows. In Section 2, we examine the advice provided by both economic theory and financial industry professionals regarding how portfolio shares should vary with age. We also examine the past empirical evidence on what households actually do. Section 3 describes the modeling and identification issues that must be addressed when performing the empirical work. Section 4 describes the data sets in more detail, and Section 5 presents the results of our analysis of the data. Section 6 concludes.

2 Economic theory, professional prescriptions, and previous evidence

There is a large and growing theoretical literature that addresses whether professional portfolio allocation advice regarding age and equity allocations is appropriate.[1] We begin by reviewing the economic theory and the professional prescriptions.

[1]See Jagannathan and Kocherlakota (1996) for an excellent review of the economic theory of age/horizon effects. Although they are not concerned with the age question, Canner, Mankiw, and Weil (1997) compare professional portfolio advice with the predictions of economic theory.

2.1 Economic theory

2.1.1 A benchmark model

In the late 1960s, economic theoreticians working on individual financial asset allocation decisions over time ("lifetime asset allocation") showed conditions under which optimal portfolio shares would constant over the life cycle, *i.e.,* independent of both age and wealth (Mossin 1968, Samuelson 1969, Merton 1969). This result is based on several assumptions, the most important of which are: (1) asset returns are independently and identically distributed over time, (2) agents have utility functions of the CRRA class that are time-invariant and additively separable over time, (3) agents have no labor income or nontradeable assets, and (4) markets are frictionless and complete. This is a useful benchmark because it forces us to recognize that one or more of these assumptions must be relaxed to generate optimal portfolio shares that vary with age.

In the subsequent subsections, we relax these assumptions. We note that once we do so, changes in age, as well as changes in variables that themselves change with age, can affect portfolio decisions.[2] For example, if utility is not CRRA, wealth may affect portfolio choices, and, because wealth may change in a pattern related to age, age may have an indirect effect on portfolio decisions. As we review the theoretical literature, it is important to be clear whether the age effect being examined is the *partial* derivative of the asset demand function with respect to age or the *total* derivative. In the benchmark model, both derivatives are zero. Once we depart from this framework, the two derivatives are no longer necessarily zero, nor are they necessarily the same.

2.1.2 Adding human capital and non-traded assets

If labor income is included in the portfolio choice model, it can cause individuals to optimally change their allocation of *financial* assets in a pattern related to the life-cycle. Consider first a class of models very close to the perfect markets model described above: assume that labor income is not directly traded, but that there exists a set of traded assets with payouts that are perfectly correlated with labor income (*i.e.*, there is spanning, so that labor income is effectively traded).

As a simple example, assume that labor income is certain, and that perfect markets exist for borrowing and lending. Assume also that there are only two financial assets: a risk-free asset and a risky asset (stocks). Define financial wealth (FW_t) as the sum of the dollar

[2]In many of the examples below, the relevant variable is the investment horizon rather than age per se. These variables are generally (but not always) closely related, and we do not attempt to distinguish between them in what follows.

amounts in the these two financial assets, and human wealth (HW_t) as the present value of future labor income (*i.e.*, human wealth is *not* included in measured financial wealth). Finally, define total wealth (TW_t) as financial wealth plus human wealth, and S_t as the amount of financial wealth held as stocks. Under these assumptions, the optimal allocation of total wealth between the risky and risk-free assets is constant over the lifetime, but the allocation of *financial* wealth is not: households will alter their holdings of the risk-free financial asset in order to maintain constant overall portfolio weights on risky and risk-free assets, *i.e.*, $S_t/TW_t = S_{t+1}/TW_{t+1}$. Households will tend to hold proportionately less of the risk-free financial asset, perhaps even selling short, when young (when the value of certain future labor income is very large), and tend to increase the proportion of financial wealth held in the risk-free financial asset as they age (as the value of future labor income declines).[3] While the goal of this activity is to ensure that the share of risky assets in the *overall* portfolio remains constant, the share of risky assets in the portfolio of *financial* assets tends to decline with age, up until the point at which there is no future labor income.[4]

Next consider the situation in which labor income is risky, but perfectly correlated with the payoffs of some portfolio of risky assets. As before, assume that human wealth is measured separately from financial wealth. A simple example of this scenario would be if labor income were perfectly correlated with the payoffs from holding the aggregate stock market.[5]

In this situation, households will keep constant the fraction of total wealth held in the risk-free asset (and thus the fraction of total wealth held in the sum of the risky asset and human wealth). But because the value of human wealth declines with age, the share of risky assets in the portfolio of financial assets tends to *rise* with age up until the point at which there is no future labor income.

Consider next the situation when labor income is not spanned by the payoffs on

[3] If there are borrowing constraints, then individuals desiring to borrow at the risk-free rate in order to invest more in risky assets while young may be prevented from doing so. If the borrowing constraint is not binding later in life, then an obvious life-cycle pattern in asset allocation may emerge.

[4] As Jagannathan and Kocherlakota (1996) point out, because the total value of financial assets is a random variable, such "increasing conservatism" is not inevitable. In fact, in periods in which there is a decline in the value of financial assets, it is possible that households may increase the percentage of financial portfolios held in stocks. To see this, note that holding overall asset shares constant, *i.e.*, $S_t/TW_t = S_{t+1}/TW_{t+1}$ implies $S_{t+1}/FW_{t+1} = (S_t/FW_t) \times [1 + (HW_{t+1}/FW_{t+1})]/[1 + (HW_t/FW_t)]$.

This means that the fraction of financial wealth held in stocks decreases whenever the ratio of human wealth to financial wealth decreases. This will *generally* occur as age increases, as human wealth decreases and financial wealth tends to increase with age. However, if in a given period, financial wealth happens to fall by a greater percentage than human wealth, the fraction of financial wealth optimally held in stocks will increase.

[5] With finite-lived individuals, it is not easy (and may not be possible) to construct a general equilibrium model in which this is true.

traded assets. First, we examine the case when labor income is uncorrelated with traded assets. Under certain additional conditions on the higher derivatives of the utility function (which are satisfied by CRRA utility), this risk impacts portfolio decisions.[6] In particular, the riskiness of an individual's financial portfolio will vary inversely with the level of his or her exposure to idiosyncratic "background" risks. Life-cycle portfolio effects will arise in the (otherwise) canonical framework under the additional condition that exposure to background risks varies over the life-cycle.

If changes in labor income are partially correlated with returns on traded assets, the results are likely to be in between those with spanning and those with no correlation. The pattern that obtains is determined by the direction and magnitude of the correlation of non-tradeable risks with tradeable financial assets, together with how the amount of nontradeable risk to which the agent is exposed changes with age.[7] Note that there are other assets besides human capital that may be imperfectly traded or non-traded and could influence portfolio choice. The most important of these are likely to be housing and privately owned businesses. See Heaton and Lucas (2000).

Finally, the quantity of labor supply may be a household choice variable rather than exogenously given. This added opportunity to hedge may induce households to optimally hold a greater fraction of their portfolio in risky assets when young than when old.[8]

2.1.3 Non i.i.d. returns

Samuelson (1991) shows that when asset prices do not follow a "random walk," it can be optimal for individuals to adjust their equity holdings on the basis of age or horizon, even if the other assumptions of the canonical model are maintained. A number of papers in recent years have examined the implications of return predictability for optimal portfolio choice (see Kandel and Stambaugh (1996), Campbell and Viceira (1999), Barberis (2000),

[6]See Dréze and Modigliani (1972), Kimball (1993), Elmendorf and Kimball (2000), and Carroll and Kimball (1996). Hochguertel (1998) simulates the demand for risky assets over the life-cycle using a model that incorporates income uncertainty (uncorrelated with asset returns) liquidity constraints, and precautionary saving behavior. Under his parameterizations, he finds that the share of risky assets in total wealth (human and financial) is hump-shaped over the working lifetime. Consumption and portfolio choice are not separable as a result of liquidity and short sales constraints.

[7]Cocco, Gomes, and Maenhout (2002) solve numerically a life-cycle portfolio choice problem with idiosyncratic labor income risk and find that when the correlation between shocks to labor income and stock market returns is positive and low (matching estimates derived from panel data), the optimal share of financial wealth in equities is generally decreasing with age. They find that even though labor income is risky and nontradeable, it acts, on balance, as a substitute for the risk-free financial asset. While investors subject to more labor income risk hold a smaller share of their portfolios in stocks (all else equal), the measured effect is small for realistic parameter values. They conclude that while labor income *per se* is important in determining optimal portfolio rules, labor income risk is less so.

[8]See, *e.g.*, Bodie, Merton, and Samuelson (1992) and Jagannathan and Kocherlakota (1996).

Campbell and Viceira (2002), Wachter (2002), and the summary in Brandt (2004)). Optimal allocations to risky stocks depend on the stochastic process that returns are presumed to follow: negative serial correlation in returns provides justification for greater exposure to equity as the investment horizon lengthens, *i.e.*, households should decrease the share of equity in their portfolios as they age.

Although this is a plausible reason for individuals to alter portfolio allocations over the life-cycle, the evidence supporting negative serial correlation, or predictability more broadly, is controversial. Several studies have found evidence of predictability in stock market returns based on the dividend yield (see, for example, Fama and French (1988), Campbell and Yogo (2004) and the references therein, and Cochrane (2001), Chapter 20, and the references therein). These estimates typically imply negative serial correlation in stock returns. However, evidence on predictability has been challenged, particularly in the more recent period (see Ang and Bekaert (2004) and Goyal and Welch (2004)).

2.1.4 Alternate utility functions

Iso-elastic utility (CRRA utility) is the *only* expected utility function that generates constant life-cycle portfolio shares in the canonical framework (Mossin 1968).[9] The use of CRRA utility implies that wealth has no impact on optimal portfolio shares and introduces a separation between portfolio allocation decisions and consumption/saving decisions that greatly simplifies the analysis of portfolio problems. If utility is not of the CRRA form, then the optimal fraction of wealth held in risky assets may vary both with age and wealth. As an example, consider a model in which consumption only occurs in the final period (T), and the utility function is:[10]

$$u(w_T) = \begin{array}{ll} (w_T - \bar{w})^{1-\gamma}/1-\gamma & , \text{ if } w_T \geq \bar{w} \\ -\infty & , \text{ if } w_T < \bar{w} \end{array}$$

where w_T is terminal wealth and $\bar{w}$ is a minimum or subsistence level of terminal wealth. Suppose that the other assumptions of the canonical model are maintained (complete markets, no labor income, i.i.d. returns, and no transactions costs). Then, at time t, the individual

[9] If the risk free rate is identically zero, there is no consumption until the final period, and total wealth is held constant, then any member of the HARA class of utility functions will produce a life cycle pattern of portfolio shares that is independent of horizon, *i.e.*, the *partial* derivative of the optimal portfolio share with respect to age/horizon is zero at every age. With the exception of CRRA utility, however, optimal portfolio shares will be function of wealth, implying that the *total* derivative of asset demand with respect to age or horizon may in general be non-zero.

[10] This example is adapted from Jagannathan and Kocherlakota (1996), although it is also addressed in Samuelson (1989a), Samuelson (1989b), and Samuelson (1994).

must place $\bar{w}(1+r)^{t-T}$ in the risk-free asset (with rate of return r) in order to avoid the possibility ending up with wealth less than $\bar{w}$.[11] The remainder of wealth is invested as would be optimal given CRRA utility (*i.e.*, a fixed fraction in equity). In this case, total financial wealth will tend to grow over time at a rate faster than the risk-free rate, so the share of total wealth invested in equity will tend to *increase* as the maximizer ages and period T approaches.

It is important to emphasize, however, that this result is caused by changes in wealth that occur over the life-cycle, and not by changes in age or the number of periods in the investment horizon. In fact, holding total wealth constant (and assuming a positive risk-free rate of return), the closer the individual is to the final period, the *lower* the optimal portfolio allocation to risky assets. This occurs because, given the positive risk-free rate, the absolute amount of wealth that must be set aside to assure attainment of $\bar{w}$ in the final period becomes larger as the final period nears. (See Samuelson (1989a) and Samuelson (1994).)[12]

Another possibility is that risk aversion (i.e., preferences) may change with age. See, for example, Bakshi and Chen (1994), Halek and Eisenhauer (2001), or Ballente and Green (2004). The evidence that age-related changes actually occur in underlying attitudes rests heavily on the assumption that all other factors potentially affecting risk-taking behavior have been adequately controlled for in comparing the behavior of individuals of different ages. A variety of empirical results have been obtained with regard to the relationship between age and risk aversion; overall the evidence of such changes is best described as inconclusive.

Other examples of utility functions that generate an investment horizon or age effect

[11] If $\bar{w}(1+r)^{t-T}$ is greater than total wealth at time t, then all portfolios may potentially produce an infinitely bad outcome, and the portfolio choice problem is ill-defined.

[12] More complicated examples are of course possible. The previous example assumes that there is no consumption as time passes, and all that matters is the level of terminal wealth. Suppose that each period involves some necessary level of consumption, call it $\bar{c}$, so period utility is

$$u(c_t) = \begin{array}{ll} (c_t - \bar{c})^{1-\gamma}/1-\gamma & , \quad \text{if } c_t \geq \bar{c} \\ -\infty & , \quad \text{if } c_t < \bar{c} \end{array}$$

where c_t is period consumption. Similar to the previous case, at time t it is necessary for the maximizer to place the present value (discounted at the risk free rate) of an annuity paying $\bar{c}$ for $T-t$ periods in the risk free asset to ensure that consumption remains above the target for all states and dates. Any remaining wealth will then be invested as if the individual had simple CRRA utility.

The level of "subsistence" wealth held in the risk-free asset will follow a deterministic, declining path independent of the evolution of the remainder of the portfolio. If there is a decline in the non-subsistence portfolio exceeding the rate of decline in the subsistence portfolio, *i.e.* total wealth falls more than subsistence wealth, then the portfolio will become more conservative. Conversely, if the subsistence portfolio falls by a larger amount, then the total portfolio becomes more risky. In general, if and when this occurs in the life-cycle depends on the specific parameters of the model, including level of initial wealth relative to the subsistence amount, the length of the horizon, the coefficient of relative risk aversion, the distribution of asset returns, the risk-free rate, and the real discount rate.

on portfolio composition can be produced. However, necessary and sufficient conditions on utility guaranteeing that the optimal share of current wealth in equities increases with the length of the horizon have not been found.[13]

2.1.5 Transactions costs

Transactions costs can come in many forms, including minimum balance requirements, per-trade fees, or information costs. The latter may include the fixed "setup" costs of acquiring information about investing in the stock market, as well as the ongoing cost of monitoring a portfolio of risky assets. These costs may influence optimal asset allocation over the life cycle.

One reason to think that transactions costs may be important relates to the so-called "stockholding puzzle." While investment professionals and academic economists may not necessarily agree about exactly how individuals should alter their portfolio weights over the life cycle, both groups concur on one prescription regarding stocks: unless individuals own another asset positively correlated with stock market returns, everyone should hold at least some amount of equities in their financial portfolios. Yet our estimates indicate that about half of American households did not have *any* wealth in the stock market. This empirical fact has been discussed and documented by several researchers (see for example, Mankiw and Zeldes (1991), Poterba and Samwick (1995), Haliassos and Bertaut (1995), Vissing-Jørgensen (2002), and Bertaut and Starr-McCluer (2001)), and we present additional evidence in the next section.

Strong risk aversion, coupled with the existence of significant fixed entry and/or holding costs, may in fact explain the stockholding puzzle.[14] Haliassos and Bertaut (1995) have modeled the impact of "fixed costs" on portfolio choice in the context of a model of life-cycle savings; they find that moderate levels of informational costs may be a sufficient explanation of non-stockholding when risk aversion is high. Using panel data from the PSID, Vissing-Jørgensen (2002) finds that the likelihood of participation in the stock market in one

[13] See Gollier and Zeckhauser (1997). More general specifications of utility functions (not necessarily consistent with the axioms of expected utility) incorporate innovations such as separation of the coefficient of relative risk aversion from the intertemporal elasticity of substitution (Epstein and Zin 1989, Epstein and Zin 1991, Weil 1990). The intertemporal portfolio properties of these functions have not yet been fully explored although research in this area is underway. See, for example, Haliassos and Hassapis (2001).

Alternate formulations of utility that allow for nonseparability over time have been used in the asset pricing literature (see, for example, Constantinides (1990), Sundaresan (1989) and Abel (1990)). Utility functions such as these that reflect "habit formation" and "catching up with the Joneses" may also have the potential to generate life-cycle patterns in portfolio choice.

[14] Unlike the "equity premium puzzle" the stockholding puzzle cannot be attributed to extreme household risk aversion alone, as long as households are behaving rationally. Holding some slight amount of equity will always enhance risk-adjusted expected returns on a financial portfolio when compared with the alternative.

period is strongly correlated with participation in the past, which could be consistent with the existence of significant entry or participation costs. In addition, King and Leape (1987) have argued that learning and experience are important factors in lowering such costs over time and explaining the portfolio choices of households over the life cycle. The accrual of experience and knowledge may serve to lower transactions costs for making investments in certain types of securities, leading to age-related patterns in portfolio choice. This would lead to greater exposure to the stock market among older individuals than among younger individuals, all else equal.

The standard portfolio choice model with no transaction costs implies that individuals rebalance their portfolios each period. This model makes no distinction between doing so by changing the allocation of the stock of assets each period or by altering the allocation of the flows of new contributions. As we will see later, in practice most individuals make very few changes in either the allocation of stocks or flows, suggesting the presence of either transaction costs or inertia.

2.1.6 Taxes

Capital income taxes have the potential to impact how stocks and bonds are divided across taxable and tax-deferred (*i.e.*, retirement) accounts and the optimal level of exposure to stocks over the lifecycle. The effective tax rates on stocks, bonds and other investments differ because of the differential taxation of the components of returns (capital gains, dividend payments, and/or interest payments). It is generally optimal for individuals to hold in retirement accounts those assets in their portfolio that are most highly taxed (*e.g.*, taxable bonds) and hold in nonretirement accounts those assets least highly taxed (*e.g.*, equities). In general, the potential impact of taxes on life-cycle asset allocation is a complicated function of the set of investment opportunities available to the investor and the applicable tax regime. No clear results have been derived with regard to the impact of taxes on the relationship between optimal portfolio shares and age. However, Dammon, Spatt, and Zhang (2001) show that the presence of capital gains taxes and step-up of basis at death can result in an optimal pattern of investment allocation in which exposure to stock increases with age.

2.1.7 Time and Cohort Effects

In the previous sub-sections we reviewed the economic rationale for age effects. In this sub-section, we briefly address the possible economic rationale for the existence of time and cohort effects.

Time effects or "trends" in equity ownership may arise for a variety of reasons. For example, the amount, detail, and timeliness of financial information available to households has increased over time while its cost has fallen. This could cause more individuals to own stocks (due to lower fixed information costs) and could also increase the desired level of exposure to the stock market conditional on stockownership (e.g. in a model of costly learning about the distribution of returns).

In addition, the use of employer-sponsored defined contribution pension plans increased dramatically throughout the late 1980s and 1990s. This could have had several effects. The use of these arrangements could lead to increased saving, which could enable those who previously held no financial assets to invest in the stock market. It could also be that fixed costs (information and other) are lower in retirement accounts and therefore new DC participants are more likely to hold stocks as a consequence of joining the plan. Finally, if the ownership of stock in a retirement account has a learning effect, increased participation in retirement accounts could lead to increased levels of ownership and exposure outside of retirement accounts (Weisbenner 2002).

Alternatively, time effects could be related to past stock price changes. If individuals do not rebalance their portfolios, then stock price increases result in higher equity shares among owners.[15] In addition, in general equilibrium, absent any change in the supply of stocks, a large run-up in stock prices will be associated with a greater proportion of the total value of all assets in the economy, and in individual portfolios, held in stocks. Additionally, high stock returns could lead (rationally or irrationally) to upward revisions in expectations for future returns, leading to increased ownership and/or higher equity shares. Finally, high stock returns could generate increased public attention, leading some individuals learn about and participate in the stock market (or increase their exposure).

The rationale for cohort effects is that an individual's life experience, part of which is common to those growing up at the same time, could influence behavior. The importance of cohort effects has been analyzed in a variety of contexts (see the references in footnote 23). One way cohort effects could be important for portfolio choice is if knowledge acquired through firsthand experience has a stronger impact on individual decision making than knowledge acquired secondhand. Such an argument could imply, for example, that at any given age or time, those who have any firsthand memory of the Great Depression or other periods of poor stock market performance will have systematically different expectations about or attitudes toward financial risks than those who have only read about them books. It is certainly plausible that seeing a friend or family member lose everything in a financial disaster may have significant influences on current and future financial decisions. Another potentially important, cohort-related difference would be in educational

[15]Except, of course, for those holding 100% in stocks, whose shares are obviously unaltered.

background. Because individuals receive education primarily at younger ages, differences over time in the quality of the education they receive could generate cohort-specific effects.

2.2 Professional advice

While the prescriptions of economic theory for life-cycle asset allocation depend critically on the details of the modeling framework, the advice that professionals and mutual fund companies give to investors is quite uniform: the longer one's investment horizon, the greater one's exposure to stocks should be.[16] The following table, from a section of the Vanguard Group's web site on retirement investing, provides a concrete illustration of this principle.

The Accumulation Years (ages 20 to 49)	Stocks: 80%; Bonds 20%
The Transition Years (ages 50 to 59)	Stocks: 60%; Bonds 40%
The Early Retirement Years (ages 60 to 74)	Stocks: 40%; Bonds 60%
The Later Retirement Years (ages 75+)	Stocks: 20%; Bonds 80%

Source: http://majestic.vanguard.com/EPA/DA/0.2.lesn9, viewed 11/19/01.

The Vanguard web site also contains a great deal of supplemental materials urging investors to consider other factors when "fine tuning" their asset allocations (after choosing one of the above basic portfolios). These materials mention considerations including job and non-investment income stability, as well as diversification across other assets. While no formalization of the relationship between financial risk and other risks is made, the materials generally suggest that as other risks increase, an individual's level of exposure to stocks should decline. Also, while "diversification" is mentioned as an important consideration, there is no explanation about the exact nature of the "diversification" being advocated.

Although the logic generating portfolio recommendations such as those listed above is not clear, the professional advice appears to be based at least in part on two maintained principles:[17]

[16]TIAA-CREF's asset allocation advice is perhaps less supportive of this "conventional wisdom" than that of many other financial services organizations. As described in TIAA-CREF's *Library Series*, the basis of TIAA-CREF's asset allocation "advice" is not age or investment horizon, but individual risk preferences, and (for annuitants) the desired degree of year-to-year stability in retirement income flows. TIAA-CREF's Chairman and CEO, John Biggs, has expressed some clear opinions on the age issue: "The stock market can still be the place to be as you near retirement, and even as you enter retirement" ... "Beware of facile advice to reduce risk and put your money in more-conservative investments as you get older and approach retirement." (Biggs (1995)). Some material on TIAA-CREF's website appears to be somewhat closer to the conventional wisdom: "Over time, the volatility of certain investments tends to diminish. So, if your time horizon spans beyond a decade, you may want to consider allocating a greater percentage of your contributions to stocks, which have historically offered greater potential for growth than other options." (Source: http://www4.tiaa-cref.org/minn/time.html, viewed 1/15/2000).

[17]Both of these quotations are from http://majestic.vanguard.com/EPA/DA/0.2.lesn5, viewed 11/19/01.

(1) "Over time, stocks have provided better returns than the other primary asset classes (bonds and cash investments) and served as a better hedge against inflation."

(2) "The longer you have to invest, the more time you have to weather the market's inevitable ups and downs. So, with a long time horizon, you are less likely to feel any permanent effects of market volatility—and more likely to see those better returns."

Statements similar to these can be found in the publications of many financial services companies. The first part of the first statement accurately describes historical data; but its relevance to age or horizon effects is unclear. The second statement seems to imply that investing in equities is less risky over the long term than over the short term. This may be based on assumed mean reversion in long-horizon stock prices, *i.e.*, negative long-run serial correlation in returns. If so, then, as described above, the professional advice may be consistent with economic theory. It may also be, however, that the professional advice is based on a misunderstanding about the diversification of risk over time.[18]

2.2.1 Life-cycle funds

A growing number of investment companies offer, or are considering offering, "life-cycle," "life-stage," or "target-date" funds that provide a mechanism to automatically reduce the proportion of the portfolio held in equities as an investor ages.[19] For example, Fidelity Investments offers a set of mutual funds ("Freedom Funds"), each of which has a target year (e.g., 2010, 2020, and 2030). The Vanguard Group ("Target Retirement" funds) and Barclay's Global Investors ("LifePath Funds") offer funds that operate in a similar fashion.[20] As the target year approaches, the investment management will gradually shift the fund's total asset allocation away from equities and into bonds and money market assets. The changes in allocation are not directly linked to any particular investor's age, but the funds

[18] For example, if stock returns are identically and independently distributed over time, then it is true, by the law of large numbers, that as the number of periods increases, the ex-post average rate of return on a stock portfolio will converge to the ex-ante mean rate of return per period. It is also true that the probability that the ex-post average return will be below zero (or below any fixed number below the mean) decreases as the horizon increases. Nevertheless, the variance of the total return grows linearly with time, and with CRRA utility, the optimal portfolio share at any point in time remains constant (as described above). (For the seminal treatment of the "fallacy of large numbers", see Samuelson (1963).)

[19] Assets in these types of funds tripled to $33 billion from March of 2002 to September of 2004, see http://money.cnn.com/2004/09/17/retirement/updegrave_funds_0410/index.htm, http://www.businessweek.com/magazine/content/04_30/b3893417.htm, and Browning (2003) for more information.

[20] Full details about these products can be found on the web sites of each of these companies, fidelity.com, vanguard.com, and barclaysglobal.com/products.

are marketed to those who plan to retire or withdraw a substantial portion of their assets a point in time near the target date of the fund. The projected decline in the percentage of these funds in equities ranges from one-half percentage point to three percentage points per year as the target date approaches.[21]

2.3 Previous empirical evidence

Until recently, there were relatively few empirical studies that examined life-cycle patterns in portfolio choice, partly reflecting a lack of detailed data. As more micro-datasets with portfolio data have become available, both for the U.S. and other countries, the number of empirical papers on household portfolio choice has increased. As part, but not the primary focus, of the analysis, these papers include estimates of age patterns in portfolio shares. The identifying assumptions about age, time, and cohort effects differ across studies, often with little explicit discussion or rationalization. In some cases, the results depend on the choice of identifying assumptions.

Early empirical work on life-cycle portfolio choice was based almost exclusively on cross-sectional data. Studies that estimate age effects based on a single cross section typically assume that there are no cohort effects (and by necessity, no time effects). One of the earliest such studies, King and Leape (1987), uses a single cross section of data and finds that the likelihood of equity ownership increases with age.

Bodie and Crane (1997) use data from a 1996 cross-sectional survey of TIAA-CREF participants (similar to the 1999 survey data we use in part of our analysis). They find evidence in their cross section indicative of a strong negative relationship between the age of participants and the percentage of financial wealth in retirement accounts held in equities. They conclude that "individual asset allocations are consistent with the recommendations of expert practitioners and with the prescriptions of economic theory."

In a series of annual reports, Vanderhei and coauthors analyze data on a large number of 401(k) participants over the period 1996-2003 (see for example VanDerhei, Galer, Quick, and Rea (1999), which analyzes the 1996 data, and Holden and Vanderhei (2004), which analyzes 2003 data.) In each year, they examine age patterns using year-end cross-sectional data. They find that age-related patterns exist in the allocation of assets in retirement accounts: "...the average share held in stocks through equity funds, company stock, and balanced funds declines from 76.8 percent for participants in their twenties to 53.2 percent

[21] Note that with mean reversion, the optimal portfolio share should vary both with the investment horizon and the level of the stock market. Therefore, mean reversion cannot logically be a rationale for an automatic reduction in portfolio share that depends only on the investment horizon. See, for example, Campbell and Viceira (2002), Chapter 4.

for participants in their sixties. In contrast, fixed-income investments rise from 22.1 per-cent for participants in their twenties to 45.9 percent for participants in their sixties" (VanDerhei, Galer, Quick, and Rea 1999, p. 4).

Yoo (1994) uses three separate cross-sections of data, from the 1962 Survey of Financial Characteristics of Consumers and the 1983 and 1986 Surveys of Consumer Finances, to analyze age patterns in asset allocation. He finds that within each of these three cross-sections, the share of financial wealth in equities increases over the working life, and then declines after retirement, generating a "hump-shaped" pattern. His multivariate regression analysis indicates that these age patterns are robust to the inclusion of covariates such as measures of human capital and total wealth.

Using pooled data from the Survey of Consumer Finances from 1983, 1989, and 1992, Poterba and Samwick (1997a) attempt to distinguish the separate impact of age and cohort membership on household asset ownership and portfolio shares (as fractions of financial assets) for several types of financial assets. Throughout their analysis they make the assumption that there are no time effects, and they examine age effects with and without cohort effects. They find that age profiles for ownership and portfolio shares of all taxable equity (*i.e.*, directly held stock plus stock mutual funds and brokerage accounts) are increasing over most ages but flat over older ages. They find no cohort effects in this measure of equity exposure.[22]

Heaton and Lucas (2000) use three separate cross-sections of data from the 1989, 1992 and 1995 Surveys of Consumer Finances to analyze household asset portfolios. Their analysis implicitly assumes no cohort effects. They find age profiles that are generally decreasing—the ratio of stocks to what they call liquid assets (similar to what we call financial assets) is lower for households older than 65 than for younger households.[23]

Bertaut and Starr-McCluer (2001) also use repeated cross-sections of the Federal Reserve's Survey of Consumer Finances to study portfolio allocation patterns in the U.S. Their regression analysis excludes cohort effects, but includes time effects and a number of

[22]We note that their results are not directly comparable to ours because (1) their asset and equity measures exclude retirement accounts, and (2) their sample period differs in that they include 1983, and do not use data from 1995 and 1998. For other asset share and ownership equations (e.g., tax deferred accounts or tax-exempt bonds), they find that cohort effects are economically and statistically significant and that the inclusion of cohort effects substantively changes the estimated age effects.

[23]The emphasis of their paper, however, is on the allocation of two broader measures of assets. The first includes assets such as housing and other real estate, proprietary businesses, and trusts. The second adds capitalized labor, Social Security, and pension income to the first measure. They find that, for the first measure, equity shares for the elderly are similar to those for the young. For the second measure, they find that equity shares among the old are larger than among the young. They emphasize the importance of entrepreneurial risk in explaining these and other patterns in household asset portfolios. Note that they exclude households with less than $500 in stocks or with less than $10,000 in a broad measure of net worth.

other right-hand side variables, including a measure of willingness to take risk, income, total wealth, and education. While specific results vary according to the empirical specification, they generally find that age effects are significant in the decisions to hold risky assets (older are less likely to own than younger), but that age is less significant in decisions with regard to the share of risky assets to hold.

Agnew, Balduzzi, and Sunden (2003) use a four year panel (1994-98) of participants in a large 401(k) plan. They include age and time effects in their regression specification (as well as additional demographic variables such as age, gender, earnings, marital status and employment tenure) and exclude cohort effects. They conclude that "age has a negative effect on the share held in equities: each extra year translates into a lower allocation to stocks by 93 basis points. This is remarkably close to the practitioners' rule of thumb of decreasing one's equity exposure by 1 percent for each additional year of age."

3 Modeling and identification

3.1 Specification

Most recent models of life-cycle saving, in which income uncertainty, liquidity constraints, and/or transaction costs are incorporated, do not allow analytic derivation of closed form solutions for either consumption or asset demand. Nevertheless, the optimal portfolio shares will be functions of certain state variables, possibly including demographic characteristics. Consider the following general form of "demand equation"

$$\omega_{it} = f(a_{it}, b_i, t, W_{it}, \mathbf{Z}_{it}) \tag{1}$$

where ω_{it} is the desired share of wealth held in equities for individual i at time t, t denotes calendar time, and b_i is the birth year of individual i, included to capture cohort effects. The age of any individual i at time t is denoted a_{it} and is equal to $t - b_i$. W_{it} is the total amount of financial wealth of the individual at time t, and Z_{it} is a vector of additional explanatory variables, including variables summarizing the distribution of future labor income.

The theories discussed earlier in the second section of this paper suggest that several factors—including income variability, attitudes towards risk, and transactions costs—may be important in determining an individual's optimal exposure to the stock market. Each of these factors might be components of the Z_{it} vector in the equation above. In analyzing how individuals change their portfolio allocations as they age, an important consideration is to what extent one wishes to hold constant these other factors when conducting the analysis. For example, income and age are positively correlated, as are age and wealth. Do we want to consider the pattern of equity holdings conditional on these variables, or unconditionally? (That is, are we interested in the partial derivative of the asset demand function with respect to age, or the total derivative?) In our empirical work, we focus on the total derivative of asset demand with respect to age, in part because this seems to be the concept most consistent with the professional advice to decrease equity exposure with age.

Under some circumstances, such as if there are fixed transaction costs or short sales constraints, the portfolio decision rule can be decomposed into two parts: first, whether to hold any equity, and second, how large the equity share should be conditional on holding some equity. In our empirical work, we estimate the binary decision to hold equity separately from the demand conditional on being an equity owner.

Under standard assumptions in finance, such as continuous rebalancing and no transactions costs, it is best to examine the share of financial wealth held in each asset. However, if individuals do not continuously rebalance, asset shares may be unduly influenced by recent returns. Therefore, we also look at two additional measures: allocations of the *inflow* of contributions, and "active" asset allocation changes, neither of which is directly affected by returns.

3.2 Identification

3.2.1 The age, time, cohort problem

Because time, age, and cohort do not vary independently, there is no way that we can separately identify all three of these effects without further assumptions. Because of the unbreakable relationship that $a_{it} \equiv t - b_i$, it is impossible to empirically refute the assertion that data generated by any given $f(a_{it}, b_i, t)$ were actually generated by a function of only a pair of the three variables: we can always generate $g(a_{it}, b_i) \equiv f(a_{it}, b_i, a_{it} - b_i)$ or $h(b_i, t) \equiv f(t-b_i, b_i, t)$ or $j(a_{it}, t) \equiv f(a_{it}, a_{it}-t, t)$ such that $g(a_{it}, b_i) = h(b_i, t) = j(a_{it}, t)$. This means that $f(a_{it}, b_i, t)$ cannot be identified solely from the data.[24] In other words, even with panel data, no matter how complete and detailed the data are, there is still no way to separately identify time, age, and cohort effects without imposing further assumptions.

In order to illustrate more clearly the importance of the identification problem, we present (in Figures1-3) three examples of patterns that one might observe after having collected information on the asset allocations of individuals or households over time. We show that different interpretations of these data are possible, depending on assumptions about

[24]This issue has been discussed and analyzed in a variety of other contexts. See, for example, Hobcraft, Menken, and Preston (1982)(demographic changes), Hanoch and Honig (1985) and MaCurdy and Mroz (1995) (life-cycle earnings), Paxson (1996) (life-cycle saving), Chen, Wong, and Lee (2001)(life insurance premiums), and Rentz and Reynolds (1991)(consumer marketing).

time, age and or cohort effects.

In the upper two panels of each figure, we plot "observations" of equity shares (on the y-axis) against age (on the x-axis) for a hypothetical group of individuals of different ages at three different points in time. Note that each of the two panels is a plot of the *same* data points. In the top panel on each page, we connect all observations from the same time period, forming a "cross-section view" of the data. In the middle panel, all observations of individuals in the same birth cohort are connected, forming the "cohort view." Finally, in the lower panel, we show the predicted values that result from estimating two dummy-variable regression models. The line connecting the hollow circles is the prediction that results from a dummy variable regression including age and time dummies only (*i.e.*, in this regression, cohort effects are assumed to be zero). The other line, connecting the solid dots, is the prediction that results from a dummy variable regression including age and cohort dummies only (*i.e.*, in this regression, time effects are assumed to be zero).

Consider first the pattern in Figure 1. In the cross-section view (the upper panel), individuals of all ages hold the same fraction of their assets in equity. However, the "cohort view" (middle panel) shows that across time periods, members of each of the cohorts raise their equity allocations by 1 percent per period. This pattern can be explained in at least two ways:

1. Age and cohort have no impact on portfolio shares: the observed patterns are the result of a pure time effect causing all individuals to raise their equity shares by one percent per year.

2. There are no time effects in portfolio shares. The observed patterns are the results of an age effect that causes all individuals to increase their equity shares by one percentage point per year as they age, and simultaneously an equalized cohort effect that leads each successive cohort to hold 1 percentage point more equity at any given age than those born a year earlier.

Both interpretations of the data are equally valid, and there is no way, without further external information or assumptions, to determine which story in the "correct" story. This is also illustrated by the regression predictions in the lower panel. Based on regression with age and time dummies only, the predicted age profile is a horizontal line, indicating that given such a specification, aging has no impact on equity allocations (this corresponds to the cross-section view). However, in the regression with age and cohort dummies only, the predicted age profile rises by 1 percent per year of age, indicating that age has a strong positive impact on equity allocations (corresponding to the cohort view).[25]

[25]Note that the vertical scale in the lower panel is slightly different from that used in the other panels.

Figure 2 presents cross-section views, cohort views, and regression views of another set of hypothetical data. In the cross-section views in the upper panel of this figure, we observe that portfolio shares are lower for older individuals, by 1 percent per year of age. However, in the cohort view (middle panel), we see that each cohort has not altered its equity holdings over time. This pattern has at least two possible explanations:

1. There are no age or time effects in the data. The observed patterns are the result of a pure cohort effect, in which each cohort holds 1 percentage point more equity at any given age than those born a year earlier.

2. There are no cohort effects in the data. The observed patterns are the result of a time effect causing all individuals to increase their equity shares by 1 percentage point per calendar year in combination with an age effect that leads all individuals to lower their equity shares by 1 percentage point per year of age.

The age effects in these two views are summarized in the regression results in the bottom panel.

Some researchers have in fact found a pattern resembling what is shown in this figure in cross-section views of real-world data (see, for example, Bodie and Crane (1997), Agnew, Balduzzi, and Sunden (2003), and VanDerhei, Galer, Quick, and Rea (1999)). This pattern has typically been interpreted as evidence that age has a significant, and negative, impact on equity allocations. Figure 2 illustrates that while such an age effect is consistent with the cross-sectional data, the existence of an age effect is only one possible explanation for the observed cross-sectional patterns. As the figure shows, it may simply be that members of cohorts born in more recent years choose to hold more equity than those born in earlier years, and that their choices are completely unaffected by age.

Figure 3 presents a more complicated hypothetical picture in which the slope of the cross-sectional age profiles is different in each of the three time periods, as is the slope of each of the age profiles in the cohort view. (We will see later that this picture is an approximation of the overall pattern that we actually observe in the TIAA-CREF data.) There are several possible explanations of this pattern. First, there may be no cohort effects, and the age patterns may have changed over time—so that the age effect is expected to be positive for all individuals as of period t, but negative for all individuals as of $t+2$. Second, it is possible that there is no age effect, and that a time effect has raised the profiles of more recently born cohorts by a larger amount than the profiles of older cohorts. Third, it may be that there is

Although the regression line appears to have a different slope than the lines in the cohort view above, the slopes are in fact the same.

no time effect, but that later born cohorts increase their equity allocations as they age at a faster rate than earlier born cohorts.

Overall, it is impossible that time effects alone, age effects alone, or cohort effects alone could generate the pattern observed in Figure 3. Thus, the picture implies two possibilities: (1) the patterns are generated by an interaction between two or three of these types of effects, or (2) the patterns arise as a result of variation in other omitted variables.

While each of these different stories can explain the past data, they each generate significantly different forecasts of future allocations (assuming persistence in the measured effects). For example, without age effects, we expect the older cohorts will alter their equity allocations in the future only to the extent that future time effects impact the allocations of all investors. We would also speculate that entering cohorts might have significantly different exposure to stocks over their lifecycle than existing cohorts. If on the other hand, there are no cohort effects in the data, then we expect older individuals to change their future allocations according to the pattern observed by age, as well as in reaction to the common time effects. Entering cohorts would also be affected by time-specific effects—but we would expect that the pattern of exposure over time going forward would resemble that observed among existing cohorts.

3.3 Potential resolutions

There are at least two ways to proceed with an analysis in the presence of this age, time, cohort identification problem. The first is simply to impose additional identifying restrictions. For example, Hanoch and Honig (1985) and Paxson (1996) assume that the time effects are orthogonal to a linear trend. A related strategy is to use economic or other theories to generate a set of parametric restrictions on age, time, and/or cohort effects (e.g. Heckman and Robb (1985), and others). For example, based on the previous discussion of the plausible origin of time-related effects, one could assume these effects are proportional to recent past returns, and estimate parameters based on this assumption. Alternatively, if we had a measure of the changes in the fixed cost of participation in the stock market, we could use this to proxy for the time effects. Likewise, if individuals are affected by their own firsthand experience more than information acquired secondhand, it would make sense to restrict the cohort effect to be a function of experienced returns. A related way to proceed is to use economic theory or independent information to place limits on the plausible size of estimated effects. While it is difficult to incorporate such restrictions into an estimation procedure ex-ante, it may still be possible to use such plausibility arguments to rule out certain specifications ex-post.

Another, potentially complementary, way to proceed is to use a criterion of parsimony to distinguish between alternative specifications. Under such a rule, simpler specifications that relies on fewer independent sources of economic effects, are better. For example, in Figure 1 we described two explanations for the pattern shown in the Figure. One explanation involved a simple time effect, the other involved a combination of cohort and age effects of similar size. A criterion of parsimony would imply that time effects alone are a better explanation of the pattern observed in the figure. Similarly, in Figure 2, an explanation based on cohort effects alone is more parsimonious than the combination of time and age effects.

3.4 Estimation

We examine several dependent variables related to household demand for equity. For the SCF and TIAA-CREF data, we analyze separately (a) equity portfolio shares, (b) equity ownership, and (c) equity portfolio shares conditional on ownership of some equity, as a function of age, time, and cohort effects. In addition, using the TIAA-CREF data, we analyze (d) the equity share in the flow of contribution, (e) equity ownership in the flow of contributions, and (f) equity shares in contributions, conditional on flows to equity being positive.

For each of these dependent variables, we present results similar to those in the three panels of Figures 1-3. Specifically, we first calculate means for each age cell in each time period. (These means are equal to the coefficients from a regression of the dependent variable on a full set of age dummies interacted with a full set of time dummies.[26]) We graph these mean portfolio shares against age twice, in one case connecting the age-cells within each time period (yielding the "cross-section view"), and in the second connecting the age cells within each cohort (yielding the"cohort view").

A third graph presents the results from two regressions, corresponding to different identifying assumptions. One specification includes only age and time dummies as independent variables, while the other includes only age and cohort dummies. In each case, we exclude interaction terms. As explained earlier, we are focusing on unconditional estimates of age effects and therefore do not include other independent variables in these regressions. We estimate the ownership equations (based on a dichotomous choice variable) using a probit procedure and the portfolio share equations (based on a continuous choice variable) using

[26]Equivalent results could be obtained by a linear transformation of the results from a regression of the dependent variable on a full set of age dummies interacted with cohort dummies, or a full set of time dummies interacted with cohort dummies. The age cells we use include three consecutive ages; the time cells include only one time period each.

simple OLS. [27]

In addition to these basic results, we also experiment with using observable economic variables to proxy for unrestricted time and/or cohort effects. These are described in Section 5.3.2.

4 Data

The data we use in our analysis come from two different sources. The first source is the 1983, 1989, 1992, 1995, and 1998 Surveys of Consumer Finances, along with the 1962 Survey of Financial Characteristics of Consumers (we will refer these datasets as the "SCFs"). The second source of information is a panel dataset constructed at TIAA-CREF.

4.1 Data from the SCFs

The Surveys of Consumer Finances are sponsored by the Federal Reserve Board and have been conducted by survey research professionals at the University of Michigan and the National Opinion Research Center triennially since 1983. The data include an over-sampling of high-income households in order to more accurately measure aggregate asset holdings.

The survey data in the SCFs are the most complete data source on household balance sheets in the United States. The SCFs include data on assets both inside and outside of retirement accounts and also include extensive demographic information. There are, however, some disadvantages of using these data for purposes of examining portfolio allocation. One in particular is that the survey responses to questions regarding the allocation of assets held in mutual funds or in retirement accounts are categorical in nature, adding noise to the data on household portfolio shares.[28] A second is that the surveys do not follow the same set of households over time.

Table 1 presents some summary statistics on demographics and sample size from the SCF data.[29] These data show the gradual increase in the amount of household financial

[27] While other researchers have used a tobit or Heckman specification to estimate similar asset demand models, these models rely in important ways on specific parametric assumptions that we wish to avoid. See Miniaci, Pelizzon, and Weber (2002) for a review and summary of various econometric issues in estimating portfolio choice models.

[28] For example, individuals are asked in the survey whether they or anyone in their household owns IRA or Keogh accounts. Once the value of these accounts is determined, the respondent is asked how is the money in these accounts is invested. "Is most of it in CDs or other bank accounts, most of it in stocks, most of it in bonds or similar assets, or what?" The answers that respondents gave were recorded categorically. Assumptions are necessary to translate categorical responses into portfolio shares. For example, we assume that those who say "most or all of it is in bonds" in fact have all of it in bonds. This adds an additional source of measurement error into the data. Further details are available from the authors on request.

[29] The patterns and rough magnitudes of these data match results reported in Kennickell, Starr-McCluer,

wealth over the years through 1998. From 1995 to 1998, the data show a significant increase in financial wealth and net worth. Median household financial wealth rose from $12,400 to $18,300, an increase of nearly 50 percent. The growth in median net worth from 1995 to 1998 was smaller, only 16 percent (from $62,600 to $72,600). Even with the recent increase in household financial wealth, the amounts held by typical households remain quite low, with 50 percent of the population holding less than $18,300 in financial assets as of 1998.

Table 2 provides summary statistics on the financial assets in household balance sheets as of 1998.[30] Financial assets are classified into nonretirement and retirement portfolios and are sub-classified into four asset classes: "stocks," "bonds," "cash," and "other." For each asset class, the table contains information on total dollar holdings (the sum across all households of assets in each category), average dollar holdings (total dollars divided by the total number of households), the fraction of total dollars across all categories that is in each category, the average portfolio share across all households, and the fraction of the population owning any assets in the category. All means on the table have been calculated using the survey weights in the SCF, and the table excludes the 7.1 percent of households that had no financial assets at all.[31] Of the total financial wealth held by households, 54.7 percent is held in stocks, 17.7 percent in bonds, 18.7 percent is held in cash or cash equivalents, and 8.9 percent is held in "other" instruments (primarily whole life insurance policies, see appendix). Note that these numbers are the ratio of the averages in each category. The average of the ratios differs from these numbers, primarily because of the large number of low-asset households who hold no stock.

The data show several interesting features of household balance sheets. First, 54.7 percent of the total amount of financial assets held by households is in stocks; however, the average portfolio share across all households is roughly half as large, at only 26.7 percent. This indicates strong skewness in stockholding related to wealth, as it implies that households with more financial wealth hold significantly larger fractions of that wealth in the form of stocks. Holdings of cash show the opposite pattern; those with less financial wealth hold relatively more cash. Another interesting pattern in stockownership is that the fraction of

and Surette (2000); however, our estimates of household financial assets and net worth are slightly higher. We believe that this discrepancy is a result of our including non-withdrawable DC pension amounts in our measures of financial wealth. In addition, our statistics on mean and median family income are slightly different than those they report; this is a result of our use of the CPI-U as a deflator, while they use the Consumer Price Index research series using current methods.

[30]These tabulations include paper financial assets (claims) only. They do not do not include other non-financial assets or liabilities, such as real estate holdings, privately owned businesses, housing, future social security or defined-benefit pension benefits, future labor income, or debts of any type.

[31]Table A1 in the appendix reverses the order of categorization and provides more detail about the specific assets comprising each asset class. Details regarding the construction of the variables in these table are available from the authors upon request.

households owning stock through retirement accounts is greater than the fraction of households owning stock through non-retirement accounts (42.7 percent versus 30.1 percent—see appendix). However, substantially more stock market wealth is held outside retirement accounts than inside retirement accounts (34.2 percent versus 20.5 percent of financial assets). In other words, there are more people with stock in retirement accounts, but more dollars of stock are held outside of retirement accounts.

4.2 Data from TIAA-CREF

The second data source we use is detailed account data from TIAA-CREF, a not-for-profit organization that is the largest private pension provider in the United States, managing nearly $300 billion in total assets for more than 2 million individuals. The people TIAA-CREF serves ("participants") are mainly employed at institutions of higher education and research, the majority at private institutions. This typically includes faculty members as well as other full-time employees in a broad range of occupations (e.g. administrative and maintenance staff). Note that the TIAA-CREF accounts we examine are tax-deferred.

Table 3 presents a listing of the investment choices typically available to individuals who have TIAA-CREF as an option in their defined contribution retirement plans.[32] The table also lists the June 30, 2000 accumulated net asset totals and the date of introduction of each of the investment accounts. From 1918 to 1952 (before CREF existed), the only investment choice was the "traditional annuity" account offered through TIAA. (This investment choice is commonly referred to as "TIAA," although TIAA is an organization, not an account or fund.) From 1952 to 1987, the CREF Stock Account was a second option.[33] In 1988, a money market account was added, and between 1988 and 1998, four new equity funds, two bond funds, and a real estate fund were introduced.

Participants who choose to direct retirement plan contributions into the TIAA traditional annuity account are guaranteed a certain percentage return on these contributions (currently 3 percent). Contributions to the traditional annuity may also be credited with additional dividends as declared (such dividends are not guaranteed, but have been declared in every year since 1948). The TIAA traditional annuity investment account includes mainly "fixed income" investments.[34] Contributions to the accounts other than the traditional an-

[32]The vast majority of participants have access through their plans to all of the TIAA-CREF investment accounts, and almost all participants have access to at least the TIAA Traditional Annuity, The CREF Stock Account, and the CREF Money Market Account. Certain employers may, however, prohibit their employees from contributing to some accounts under the terms of their retirement plans.

[33]Until 1967, participants could allocate no more than 50 percent of their contributions to the CREF stock account. This maximum was increased to a maximum of 75 percent in January 1967 and was eliminated in July 1971.

[34]As of 6/30/2000, TIAA traditional annuity account's total invested assets were composed of: publicly

nuity purchase "accumulation units" in each account that change in value according to the performance of the underlying investments in each account; investments in these accounts are not guaranteed. The CREF Stock Account is an "omnibus" equity account, including both foreign and domestic equities and actively managed and indexed sub-components. The names of the other investment accounts listed on Table 3 (CREF Bond Market Account, CREF Global Equities Account, CREF Growth Account, CREF Equity Index, TIAA Real Estate Account, and CREF Inflation-Linked Bond Account) provide a general description of the main types of assets held in each account. The CREF Social Choice Account contains a mix of stocks, bonds, and money-market investments that meet certain social criteria or "screens." Table 3 shows that as of the end of 1999, a total of 58 percent of all TIAA-CREF pension assets were held in the accounts that contain mostly equity-based investments. The CREF Stock Account contained (by far) the largest fraction of these equity-based investments.

Figure 4 shows the quarterly percentage changes in the CREF Stock Account accumulation unit value from 1985-Q4 1999. (These unit value changes reflect all capital gains and dividends.) The quarter-on-quarter changes over the period have fluctuated from more than a 20 percent decline in the 4th quarter of 1987 to more than a 20 percent increase in the first quarter of 1987 and the 4th quarter of 1998. The arithmetic average of the annual percentage changes over the period 1985-1999 was 18.05 percent (the geometric average was 17.47 percent).

Upon enrollment, TIAA-CREF participants make an initial choice about how much of each contribution "flow" will be allocated to each investment account. These "flow allocations" can be altered at any time, free of charge, by participants, by contacting TIAA-CREF via mail, telephone or an internet service. Subject to some restrictions, participants can also transfer their accumulated assets between the various TIAA-CREF investment accounts, *i.e.*, change their "asset allocations," at any time by contacting TIAA-CREF. Such changes are effective the same day if received by TIAA-CREF before U.S. markets close. An important restriction is that funds accumulated in the TIAA Traditional account under a regular retirement annuity (RA) or group retirement annuity (GRA) can only be transferred out of TIAA Traditional to another investment account in roughly equal installments over a ten year period, through a mechanism called a "transfer payout annuity (TPA)."[35]

traded bonds (44%), direct business loans (27%), commercial mortgage loans (20%), real estate (5%), and other assets (4%). Source: http://www.tiaa-cref.org/financials/accinvtradann.html, viewed 9/22/2000.

[35] According to TIAA-CREF, this restriction on transferability enables TIAA to make long-term investment commitments that generate higher returns than other, more liquid investments. Funds in *supplemental* retirement annuities (SRAs) can be transferred freely back and forth between all TIAA and CREF accounts. However, these transferable TIAA accumulations under SRAs return a lower total rate of interest than TIAA accumulations in RAs and GRAs. Also, as of June 1998, asset transfers involving the TIAA Real Estate

We have constructed a unique panel dataset that tracks the account balances, contributions, and transaction history for the same set of individuals over an extended period. Demographic information includes the individual's date of birth and sex. The sample is constructed by combining data from two separate sub-samples: First, a random sample was drawn from the population of individuals who were making contributions to their TIAA-CREF accounts in 1987. This group (approximately 8,000 individuals) is then followed through the next 12 years to the end of 1999. The second sub-group is a random sample of all individuals who had accumulations on a TIAA-CREF contract at the end of 1996 (another 8,000 individuals).[36] These two groups are pooled together to form the sample we use. For those individuals who do not enter or leave our sample over this period, we have 52 quarters of data beginning with the first quarter of 1987 and ending with the last quarter of 1999.

Our data include information on unannuitized assets held by the sample members from 1987-1999. We also have transactional data that provides information on the allocation of assets converted to immediate (payout) annuities at any point during the sample period. While most of our analysis focuses on the allocation of unannuitized balances, some results at the end of the paper incorporate information about distributions and the allocation of annuitized assets.

In addition, we have data on responses to a one-time direct-mail survey of the household finances (including assets inside and outside of retirement accounts) and the demographic characteristics of roughly 2,000 TIAA-CREF participants, as of 1999, along with actual account balance data from TIAA-CREF. [37]

Summary statistics on the age, sex, number of observations in the sample are presented in Table 4. The average age of sample members with accumulated assets in 1987 was 44.5, and 54.3 percent were male. Over time, as individuals left and entered the sample, average age increased to 51.9, while the fraction of the sample that was male fluctuated, declining until 1996, then rising. (This pattern in part reflects our sample selection procedure.)

The second set of rows in the table provides summary data for the fourth quarter of each year for those individuals who had assets and made contributions in that quarter. The third set of rows provides data on the balanced panel of observations: this is the set of individuals in the sample who had accumulations in *all* 52 quarters of the sample period.

Account were restricted to one each calendar quarter. A policy limiting "excessive" electronic transfers was adopted in 1999.

[36]Our data originally spanned the period 1986-1996 only. We were able to update the data on account balances and flows of contributions, but not other transactional activity, to include information through 1999. We continue to follow the same individuals as in our original sample.

[37]This survey is similar to an earlier survey conducted in 1995-96, and analyzed by Bodie and Crane (1997).

We use this sample to examine patterns in the data that do not reflect the beginning or end of participation at TIAA-CREF. The last set of rows in the table provides information on a balanced panel of individuals who had accumulations and made contributions in all quarters.

Table 5 shows the average portfolio shares, based on account balances and contribution flows. The share of balances held in equity accounts, as of 1998, (for comparison to the SCF data) is 56.6 percent, and the share of aggregate flows to going to equity accounts is 63.4 percent.

There are a number of features of this dataset that make it especially attractive for analyzing portfolio behavior. First, the data contain the actual account balances and transaction activity of the sample members as recorded by TIAA-CREF, and are therefore not subject to the reporting error that can occur in household surveys. Second, the datasets track the *same* individuals over time. Most other researchers have had to use repeated cross-sectional samples to study the financial behavior of individuals over time.[38] Third, the data contain information on both the "stock" of accumulated assets in each retirement contract and the amount and allocation of periodic "flows" or contributions to each retirement contract, allowing us to examine different mechanisms through which individuals may alter portfolio allocation.

Several caveats should be made regarding the data. First, while the SCF is designed and weighted to be representative of the overall U.S. population, the TIAA-CREF population is not representative. This is because the people that TIAA-CREF serves—individuals employed in higher education and research—are generally better educated than the U.S. population as a whole.[39] Higher education is also an industry with some unusual features, such as the institution of tenure, which may affect the financial behavior of some participants.[40] In addition, all TIAA-CREF participants participate, by definition, in a defined contribution pension plan, whereas only 35.7 percent of households in the general population have assets in such plans (according to 2001 SCF data).

Second, the financial account information available to us is limited to the amounts that participants have on their TIAA-CREF contracts. Thus we do not include either other financial assets held by participants (in or out of tax-deferred accounts) or assets held by

[38]Recently Holden and Vanderhei (2004) and Agnew, Balduzzi, and Sunden (2003) have each separately assembled and analyzed balanced panel datasets of 401(k) participants, containing seven and four years of data, respectively.

[39]If a higher level of education is associated with greater financial literacy and more disciplined financial behavior, the behavior of the TIAA-CREF population may provide an optimistic example—a useful "upper bound"—of how individuals utilize defined contribution pension accounts.

[40]At the same time, education and research has been an atypically stable industry, making possible the analysis of financial choices in an economic environment that is relatively isolated from exogenous disturbances.

other family members. This raises the question of whether our results on allocations within TIAA-CREF are similar to allocations of total household financial wealth. We examine this using data from a survey done in early 2000 (on a separate sample) that collected data on wealth holdings both inside and outside of TIAA-CREF.[41] Two pieces of evidence based on this survey suggest that our results may accurately capture the patterns in total household financial wealth. First, we find that TIAA-CREF accounts represent a significant portion of financial wealth for most individuals in the sample, especially those that have been making contributions to their accounts continuously over long periods. For 49%, the TIAA-CREF plan is the only private employer-sponsored pension they have.[42] For about half of the sample (51%), TIAA-CREF wealth represents 50% or more of total financial wealth. Among those aged 45 or older who are making contributions to their TIAA-CREF accounts (or whose employer makes contributions on their behalf), half hold at least 64% of their household's financial assets in the form of their TIAA-CREF balances. Second, we find a fairly close relationship between the stock allocation within TIAA-CREF and the stock allocation of all household financial assets. The correlation between those shares is .57.[43]

Finally, there were a variety of changes at TIAA-CREF between 1987 and 1999, including the introduction of eight new investment accounts as well as changes in the rules and technology used to administer how retirement contributions and accumulations may be allocated, reallocated, withdrawn, or borrowed. While it is possible that some or all of these changes may have had an impact on behavior, the present analysis does not attempt to model these effects.

5 Results

Before focusing directly on the issue of age effects in equity allocations for our TIAA-CREF and SCF data, we discuss three features of these data that we believe have an important role in the analysis of household portfolio behavior.

[41] Details regarding the survey structure can be found in Ameriks, Caplin and Leahy (2001), and Ma (2002). Because these data were obtained from responses to a voluntary eight-page questionnaire, the survey sample may not be representative of our sample. However, the survey respondents and the individuals in our sample have similar average account balances ($266,000 versus $216,000 in our sample) and average age (51 in both). Also, there is a fairly close correspondence between the value of participants' actual TIAA-CREF account balances and balances that they reported in the survey, suggesting accurate reporting of wealth holdings.

[42] This number is significantly higher than the corresponding estimate for 401(k) plan participants (?estimate?), because 401(k) plans often supplement a second (typically defined benefit) pension plan, rather than being the "primary" retirement plans offered by the employer. Most other studies on asset allocation in retirement accounts (e.g., Agnew, Balduzzi, and Sunden (2003)) have examined data from 401(k) plans.

[43] The correlation between the equity share within TIAA-CREF and outside of TIAA-CREF is also positive, equal to 0.18. This is similar to the numbers (based on an older survey) reported in Bodie and Crane (1997).

5.1 Important features of household portfolio behavior

5.1.1 Non-stockownership

The first important feature of household portfolio behavior is that a majority of U.S. households do not hold stock, either directly or indirectly (this is the "stockholding" puzzle mentioned earlier). In this section, we use data from the SCFs to measure carefully the extent of stockownership in the U.S., and how this has changed over time.[44]

Table 6 presents data on several measures of stockownership, ranging from most narrow to most broad.[45] For each measure in the table, we first present our best estimate of the percentage of households who own stock. Not all components of stockownership are consistently available across the surveys, however, and for this reason we also construct "upper-bound" estimates that are consistent across years, but likely include some non-stockholders in the calculations.[46]

Line 1 shows the percent of the population in each year that owns publicly traded stock directly. The fraction of households owning stock directly ranges over time from 14 percent in 1962 to 21 percent in 2001. While direct ownership increased between 1995 and 2001, overall there was remarkably little change during this 39-year period in the fraction of households directly holding stock.

Line 2 shows the fraction of households that own stock either directly or through equity-based mutual funds (outside of trusts or retirement accounts). This measure of equity ownership rose by only 3 percentage points between 1962 and 1995, and then by almost 8 percentage points from 1995 to 2001. The upper bound estimate just below line 2 includes all households who own any mutual funds, whether or not they are equity mutual funds.

Line 3 adds in households that own stock through trust arrangements. Including trusts changes the stockownership measure by less than one percent in each year. Immediately below line 3 is the maximum fraction of the population that could possibly own shares through direct holdings, mutual funds, or trusts.

Line 4 adds stock in defined contribution pension plans to the stockownership measure (these data are not available for 1962 and 1983). Adding ownership through employer-

[44]For previous estimates of the extent of stockownership, see NYSE Shareownership studies (NYSE 1998, NYSE 1995, NYSE 1990), Mankiw and Zeldes (1991), Poterba and Samwick (1995), Aizcorbe, Kennickell, and Moore (2003), Vissing-Jørgensen (2002), and Bertaut and Starr-McCluer (2001).

[45]Specific details regarding the construction of this table from the survey data are available from the authors upon request.

[46]For example, while not all of the surveys contained a question asking about ownership of equity-based mutual funds, all asked questions about ownership of "taxable" mutual funds (that are not money market mutual funds). All equity funds are taxable, but some bond funds are also taxable. Because some households may hold taxable bond mutual funds, but no equity mutual funds, using the question on taxable mutual funds provides an upper bound on stockownership that can be calculated for all survey years.

sponsored retirement accounts increases stockownership by 9.2 percent in 1989, but by a much higher 17.9 percent in 2001. This indicates that stockownership through DC pension plans has been an important source of the growth in overall stockownership by households since 1989.

While data on equity ownership within DC plans in 1962 are not available, the 1962 survey did ask about ownership of some types of DC pension plans.[47] We use this information to calculate the line 4 upper bound on stockownership in all forms in 1962 (29.6 percent of households). We also construct an estimate of 1962 stockownership as follows. In 1989, 15.5 percent of households owned DC pension plans but did not own stock through other channels, whereas the comparable number in 1962 was 9.7 percent. In 1989, 50.1 percent of these households held stock in their DC plans. If we apply this same 50.1 percent to 1962 (*i.e.*, we add .501 times 9.7, or 4.8, to our line 3 estimate of stockownership on Table 6), we arrive at an estimate for line 4, in 1962, of 23.9 percent.[48] This is the estimate we include in the table.

Line 5 shows our preferred, and most comprehensive, measure of stockownership: It shows the fraction of households that own stock through any of the vehicles described previously, as well as through IRA accounts. Including IRAs increases total stockownership by between 3 percent and 6 percent of the population in the years for which we have data. Because there were no IRAs in 1962, our constructed estimate of 1962 stockownership is 23.9 percent. Based on this most comprehensive measure, 52.2 percent of U.S. households were stock owners as of 2001.

There has been a substantial increase in stockownership in recent years. The rise in stockownership in the twelve years between 1989 and 2001 (18.8 percent of households) was approximately twice as large as the rise over the entire 27 years between 1962 and 1989 (9.5 percent of households).[49]

[47]Specifically, withdrawable assets in profit sharing plans and retirement plans.

[48]Estimates based on 1992 and 1995 SCF data would put stockownership in 1962 at 24.1 and 25.4 percent respectively.

[49]The data in Table 6 indicate slightly higher ownership levels than those reported by Kennickell, Starr-McCluer, and Surette (2000) in their Table 6 (p. 15). They report comprehensive measures of direct and indirect stockownership of 31.6, 36.7, 40.4, and 48.8 percent for 1989, 1992, 1995 and 1998, respectively. Their calculations differ from ours because we include all account-type pensions in our definition of net worth, while Kennickell, *et al*, include only account-type pension assets if the pension type is 401k, 403b, thrift, savings, SRA, or if the participant has the option to borrow or withdraw assets. In addition, our results are based on the public-use versions of the SCF as of March 10, 2000, while the Kennickell, *et al*, tables are based on internal versions of the SCF that use data and weight adjustments different from those in the public use file. As a check we recalculated line 5 using the Kennickell, *et al* definition of stockownership through other vehicles. This yielded line 5 estimates of 31.7, 36.7, 40.4, and 48.9 percent for 1989, 1992, 1995, and 1998, respectively. We have confirmed that these exactly match estimates generated at the Fed when their stockownership program is run on the public use versions of the 1989-1998 SCFs (personal communication, Martha Starr-McCluer).

While stockownership has risen significantly, it is still the case that about half of the population does not own stocks either directly or indirectly. Part, but not all, of this non-stockownership is related to low financial assets. In Table 7, we examine those with no stock or very little ($1,000 or less) stock in 1998; 54.9 percent of households fit in this category.[50] About two-thirds of this group, 37.9 percent of households, has very little ($10,000 or less) financial wealth. However, almost 30 percent of the population with more than $10,000 in financial wealth also holds very little or no stock.

Next, we consider stockownership in the TIAA-CREF data. Table A2 in the appendix shows patterns in stockownership among TIAA-CREF participants over the 13 year period for which we have data, for the entire sample and the balanced panel of participants. The data show that in 1987, roughly 80 percent of the sample had some stock in their TIAA-CREF assets. Since then, the fraction having some stock in their TIAA-CREF assets has risen in both the unbalanced and balanced panels by about 5 percent.

It is important to note that the difference between the TIAA-CREF population and the population of households in which there is a DC plan participant is much less extreme than this overall population data might appear to indicate. As was noted previously, only 32.2 percent of U.S. households have a member who participates in a DC plan (according to 1995 SCF data). However, within this 32.2 percent, 71.2 percent owned some form of equity in their DC plan—an ownership figure that matches much more closely with what we observe in the TIAA-CREF data.

5.1.2 Population heterogeneity

The second important feature of household portfolio behavior is that there is a great deal of heterogeneity across households in the share of financial wealth allocated to stocks. Figure 5 shows the distribution of "flow allocations" to the equity-based TIAA-CREF accounts for the third quarter of 1989, 1992, 1995 and 1998. There are three aspects of these data worth emphasizing. First, there is significant clustering at specific points in the distribution of flow allocations, namely at 0, 25, 50, 75, and 100 percent to equities. In 1992, for example, 83 percent of participants had flow allocations to equities at one of these five discrete levels, with 35 percent choosing a 50 percent equities / 50 percent other split. Second, there is significant heterogeneity over the entire range of possible flow allocation choices, including the two "extreme" choices: In 1992, 22 percent of individuals had none (0 percent) of their contribution flows allocated into the equity accounts, while 8 percent of individuals had all (100 percent) of their contributions flowing into the equity accounts. Third, there is a trend toward increased flow allocations into equities, with reductions over time in equity shares

[50] Thus, 5.5 percent of the population owns stock with a value of $1,000 or less.

less than or equal to 50 percent and increases in equity shares greater than 50 percent. The fraction of participants allocating 100 percent of their contributions to equities rose from less than 5 percent in 1989 to almost 25 percent in 1998.[51]

A similar, but less obvious pattern is evident in Figure 6, which shows the distribution of equity allocations in the accumulated stock of TIAA-CREF assets ("asset allocations") at the end of 1989, 1992, 1995, and 1998. As with the flows, the asset allocations show significant heterogeneity. There is also a shift over time toward a greater share in equities, in particular a decrease in those holding 0 percent equities, and an increase in those holding 100 percent equities.

These charts indicate that there is significant heterogeneity in choices made by individuals, including a set who hold no stocks in their portfolios. This heterogeneity could arise from several sources, both observable and unobservable (*e.g.*, individual tastes, income, wealth, or age).

5.1.3 Frequency of changes

The availability of a panel of data from TIAA-CREF that follows the same individuals across time allows us to examine changes in portfolio allocations, rather than just levels. To our knowledge, our data set is the first that enables such an analysis over such a long period of time.

Table 8 presents results on the incidence during our ten-year sample period of two possible types of portfolio changes.[52] For each individual with contribution flows in all 40 quarters, we calculate the number of (a) quarters with an accumulation transfer transaction, and (b) quarters with changes in flow allocations (*i.e.*, the number of quarters in which the allocation of contribution flows for the quarter differed from the percentage allocation for the previous quarter). The results demonstrate our third important feature of household portfolio behavior: the vast majority of households make few or no changes over time to their portfolio allocations.[53] In terms of flows, 47 percent of individuals made no changes in flow allocations over the entire ten-year period, and another 21 percent made only one change.[54] Roughly 73 percent of those that we track made no change in asset allocations over

[51] These data all show similar patterns as data from the entire population of TIAA-CREF participants as presented in Ameriks, King, Warshawsky, and Stern (1997). As of June 30, 2000, the fraction of TIAA-CREF participants with 100 percent equity flow allocations had risen to over 30 percent.

[52] Note that this table is for the period 1986-1996 only. We intend to update this table in a future draft to incorporate data from 1997-1999.

[53] The finding that participants rarely change either asset or flow allocations is consistent with earlier evidence reported in Samuelson and Zeckhauser (1988).

[54] The table includes *any* changes made, including changes that do not alter the overall equity allocation in flows or assets.

the entire ten-year period, and another 14 percent made only one change. A full 44 percent of the population made no changes whatsoever to either their flow or asset allocations over the ten-year period, and another 17.2 percent made only one change to either stocks or flows. These striking results imply that much of the observed variation in portfolio shares is driven by initial choices and subsequent asset returns.[55] [56]

When transfers do occur, they tend to be large. Conditional on an asset transfer occurring in a given quarter, the average absolute value of the transfer is 23.5 percent of assets. Conditional on a flow allocation change in a quarter into or out of equity, the average absolute value of the change is 18.4 percent.[57] This pattern of large, infrequent changes may be consistent with the existence of some type of non-monetary fixed cost per transaction.

5.2 Estimates of age effects in equity shares

5.2.1 Estimates based on SCF data

Figures 7-9 present data on equity portfolio shares from the Survey of Consumer Finances in 1989, 1992, 1995, and 1998.[58] Each data point in the top two panels represents the equity share averaged over all households in a 3-year age group in a given year. For example, the three data points in Figure 7 directly above age 46 on the x-axis are averages of equity shares for households aged 45, 46, and 47 in each of the three survey years. This age-grouping helps to reduce the influence of outlying observations at each age—although, as the picture shows, the patterns in the data are still far from smooth.

Paralleling Figures 1-3, each of the figures presents two different views of exactly the same data points, as well as the regression estimates of the age effects. The top panel of each figure presents the cross-section view, in which all observations from the same time period (1989, 1992, 1995 or 1998) are connected together. This view accurately presents age effects and time effects under the assumption that there are no cohort effects. The middle section of each figure shows the cohort view, in which observations in the same birth cohort are connected together across the three time periods. This view accurately presents age effects

[55] It is interesting to note that while the most economically relevant variable that the participant controls is asset allocation, the data show that people are more likely to make flow allocation changes. Of course, one of the complicating factors specific to this data set is that making a lump-sum asset allocation change that would transfer assets out of the TIAA Traditional annuity is not allowed on basic retirement annuity contracts, whereas flow allocations can be changed without such a restriction. This may explain some of the discrepancy between the relative frequency of asset allocation changes versus flow allocation changes.

[56] This demonstrates that many households are not rebalancing their portfolios. Vissing-Jorgenson (2002) argued that this lack of rebalancing could be responsible for the large changes in equity shares over time that she observed in PSID data.

[57] These mean absolute change estimates are based on a larger unbalanced panel of observations.

[58] We include these years because they correspond most closely to the years covered by our TIAA-CREF dataset (1987-1999).

and cohort effects under the assumption that there are no time effects. The bottom section shows the fitted values from an OLS regression using dummy variables to control for either age and time effects, or age and cohort effects. As mentioned earlier, no other covariates are included in the regression. (The "age and time" regression predictions are for 1992; the "age and cohort" predictions are for the cohort aged 43 in 1992.)

Figure 7 presents data on the share of equity in financial assets for all households with positive financial assets. Importantly, these averages include households with a zero equity share. The cross-section view shows a hump-shaped pattern in the age profile. In all three cross-sections, younger individuals have relatively lower equity shares than the middle aged, and older individuals also have lower equity shares than the middle-aged. This view also shows upward shifts of these profiles over time. One interpretation of this pattern is that it is generated by a hump-shaped age effect together with time effects that shift the profiles up over time. However, the upward shift is not quite parallel—the shift for young households is greater than that for older households.

Examination of the cohort view of the same data, as shown in the middle section of the figure, might lead one to different conclusions. The cohort view shows that for all cohorts born after those who were age 55 in 1989, equity shares are monotonically increasing with age. In the case of the cohort that was age 31 in 1989, the average equity fraction was nearly 3 times as high in 1998 (31 percent) as in 1989 (11 percent). The cohort view also shows that among individuals who were 52 in 1989, equity shares rose from roughly 17 percent in 1989 to just over 28 percent in 1998. Thus, following any given cohort through time, we see clear increases in equity shares. Assuming away any time effects, this would have to reflect an increase in equity exposure as households age.

The regression results succinctly summarize the general sense that one gets from examining the cross-section and cohort views of the data. The regression prediction excluding cohort effects (the connected hollow circles in the bottom panel of the figure) shows that the cross-sectional age profile is approximately hump-shaped. Those in the age categories between 49 and 58 hold higher equity shares than both younger and older individuals, as in the cross-section view. The regression excluding time effects (the solid circles) results in predicted equity ownership profiles that are strongly increasing in age—so much so that individuals aged 42, 43, or 44 in 1992 would, if this simple model were correct, have *negative* equity shares at ages younger than 34. This increasing pattern reflects the shapes of the cohort-specific lines in the "cohort view" in the middle panel.

Figure 7 showed the patterns of equity shares averaged across all households with positive financial assets, including those that held no equity. We now decompose these equity share data into two parts: first, data regarding age-patterns in equity ownership (stockownership versus non-stockownership), and, second, data regarding age patterns in the share of equity in financial assets among equity owners. This enables us to examine the relative importance of the extensive choice of whether or not to own equity versus the intensive choice of how much equity to hold conditional on owning some.

Figure 8 presents data showing the fraction of households in each age cell that own any stock among their financial assets. These data show some of the same patterns as Figure 7, suggesting at least a part of the age pattern in the "overall" average equity shares seen in Figure 7 is the result of differences in the probability of ownership across age groups. The regression results for the model with no cohort effects (bottom panel of Figure 8) show a strong hump shape in the age-ownership profile. The regression model with no time effects yields a profile that is increasing up to age 58 and relatively flat at older ages.

Figure 9 shows the average equity share in financial assets held by those households who owned at least some equity. These graphs show strikingly different patterns in comparison to the previous two figures. In the cross-section view, the hump-shaped pattern disappears, leaving a nearly flat age profile that suggests the absence of any age effects. This is highlighted in the regression results in the bottom panel, in which the "age and time" regression is nearly a straight horizontal line. We conclude that the age patterns in the overall portfolio shares seem to be induced by differences in ownership probabilities, and not by differences in equity shares conditional on ownership.[59] The cohort view in this figure, similar to the previous two figures, shows dramatic increases in equity exposure with age for nearly all cohorts. This is also reflected in the bottom panel regression estimates of the age profiles assuming no time effects.

The question arises as to which of the two views of the data conveys the most appropriate information regarding the age effect. Recall that the two views reflect different identifying assumptions. Identifying assumptions cannot, of course, formally be tested. However, *a priori* beliefs about the plausible sign and magnitude of estimated effects, or a criterion of parsimony, can provide a means to choose between the alternatives. We discuss this in more detail in Section 5.3 below.

The significant upward shift in the cross-section profiles over time could have been due to an active decision by households to increase their portfolio shares, or it could have been due to the overall rise in the value of the stock market coupled with inactivity on the part of households. The TIAA-CREF results, to which we now turn, may be helpful at distinguishing between these possibilities.

[59]This pattern was first observed in the 1989 SCF cross-section by Blume and Zeldes (1994).

5.2.2 Estimates based on TIAA-CREF data

Figure 10 presents data on the average equity share in the assets held by individuals in the panel data from TIAA-CREF.[60] Based on the cross-section view, there appears to have been a change in the slope of the age profile over time: There is a hump-shape age profile in the early years of the sample, but a generally declining age profile in the later years. Similar to the cross section views in the SCF data, the cross-sectional age profiles shown in Figure 10 have generally risen over time—individuals at each age in 1999 held relatively more equity in 1999 than individuals of the same age in 1989. In the first few years for which we have data (1987-1990) the lines in the cross-section figure criss-cross with one another, indicating that there was very little change in average equity shares during this period. Beginning in 1991, however, the cross-sections rise steadily. This pattern may be related to the substantial rise in the value of stocks over this period.

The cohort view of this data shows how remarkably uniform the behavior of each of the cohorts was over time. From 1987-1990, equity shares declined for all cohorts. The bottom of the "J" shapes of the individual cohorts represents observations for 1990. Beginning in 1991, equity shares rose for all cohorts and rose dramatically for younger cohorts. In 1990, members of the cohort who were 29 in 1990 had only 32 percent of their assets in the equity based accounts, while at the end of 1999, members of this same cohort held 60 percent of their assets in the equity based accounts. While the changes were more modest among members of older cohorts, the data show sizable equity share increases among almost all cohorts over this period. The regression with no cohort effects generates a modest hump shape, while the regression with no time effects generates a nearly linear, increasing profile, with shares increasing about 2 percentage points per year. The regression with only age effects (not shown) again looks similar to that with age and time effects.

Figure 11 shows data on equity ownership probabilities for this sample of TIAA-CREF participants. As was the case with the SCF data, a hump-shaped pattern is present in these data. In addition, the ownership profiles have generally shifted up over time. However, these increases have been generally smaller than in the SCF (reflected by the fact that the profiles remain, for the most part, clumped together.) Also, the cohort view of these data reveals that while equity ownership probabilities for younger cohorts increased with age, these probabilities decreased among members of some older cohorts. The regression-based profiles for ownership show patterns similar to those found in SCF data (Figure 8); the regression with no cohort effects showing a hump shape that peaks around age 50, and the

[60]For figures 10-15 the data include some individuals who entered the sample and some individuals who left, and figures 10-12 include only unannuitized assets at TIAA-CREF (which we track until the quarter prior to annuitization).

regression with no time effects showing a steady increase until about age 58 and then a leveling off thereafter.

Figure 12 presents data on the average share of equity in assets among only those that owned some equity. Consistent with the SCF data, the cross section view of these data is flatter than the corresponding view of all participants, suggesting that the hump-shaped pattern in the overall equity share data is primarily due to differences or changes in ownership probabilities rather than differences or changes in shares conditional on ownership. The cohort data again show increases in average equity shares among all cohorts, with particularly strong increases among the more recently born cohorts.

Note that we observe similar age patterns in the SCF (figures 7-9) and TIAA-CREF (figures 10-12) datasets, despite the fact that the TIAA-CREF dataset contains information on only a subset of retirement assets for a sample that is not fully representative of the overall population. This suggests that conclusions drawn from the TIAA-CREF dataset might also apply to the overall population's holdings of all assets.

As mentioned earlier in the context of the SCF data, the large increase in the equity portfolio shares could simply be due to strong equity returns with no active changes by individuals. To investigate this further, we now examine patterns in the allocation of contribution *flows*. Figure 13 shows data on the average allocation of contribution flows among those members of the sample with any flows. Unlike the data on assets, the flow data are not directly affected by changes in stock prices. In the presence of adjustment costs, they may provide a clearer indicator of the asset allocation preferences of sample members. Interestingly, the "flow" allocation data show patterns very similar to the "asset" allocation data in Figure 10. Clearly, not all of the increases in equity asset shares arise from a passive response to large capital gains in the stock market; at least part of the increase is attributable to increases in flow allocation.[61] The regressions again neatly summarize the data as shown in the cohort and cross-section views – the "age and time" only regression is slightly hump-shaped, while the "age and cohort" only regression results in a strongly increasing age profile.

One striking result is the large increase in the share of contributions allocated to equity by the young. For example, the average equity share in flows for 29 year-olds increased by a factor of almost 2.5 over the last nine years in our sample period: from 31 percent in 1990 to 73 percent in 1999. This corresponds to a change in the shape of the cross-sectional age profile from hump-shaped in 1990 to generally decreasing in 1996. It is important to emphasize here again that because these data relate to the flow of new contributions, the

[61]In the cohort view, there is no sharp decline in 1990 as there is in Figure 10; but there is a gradual decline.

patterns cannot simply be due to the automatic effects of market movements on equity shares.

Figure 14 shows data on the probability of having at least some contribution flow allocated to the equity based accounts (a measure analogous to the "ownership" data in Figure 8). The cross-section view of these data (and the regression results including age and time effects) shows a pronounced hump shape in which the probability of contributing to an equity-based account declines with age after age 50. However, the cohort view (and the regression including age and cohort effects) shows that with only a few exceptions among the older cohorts, the fraction of each cohort allocating some of their contributions to equity increased as the cohort aged.

Figure 15 shows that, as in Figure 9, age patterns in more recent cross sections (showing declining flow allocations with age) appear to be different from those in the earliest cross sections (showing a mild hump-shape). Overall, however, based on the regression results using all of the available data, the age profile is essentailly a flat line, and we cannot statistically reject the hypothesis that there are no age effects. The hump-shaped age effects in Figure 13 thus appear to be coming from ownership probabilities and not age-related patterns in average shares conditional on ownership. Similar to the cohort views throughout all the TIAA-CREF data, the cohort view in Figure 15 shows positively sloped, and extremely steep, age profiles. We discuss this result further below.

5.3 Further attempts to pin down age effects

In the previous section, we saw that estimates of age effects based on a cross-sectional view are very different from estimates based on a cohort view. Specifically, regressions based on age and time effects produce a flat or mildly hump-shaped pattern, while regressions that include age and cohort effects produce a strongly upward-sloping pattern. In this section, we attempt to use additional information and techniques to determine which (if either) of these sets of estimates more closely resemble the true underlying relationship between age and portfolio shares. First, we look closely at the time and cohort effects implied by our previous estimates and apply criteria of parsimony and plausibility. Second, we use economic variables to proxy for time and cohort effects. Third, we examine changes made by individuals in the TIAA-CREF sample.

5.3.1 Examining cohort and time effects

So far our analysis has focused on estimates of age effects. We now examine estimates of cohort and time effects, and we apply the criteria of plausibility and parsimony to help discriminate between identifying assumptions. In this section, we focus our analysis on flow allocations in the TIAA-CREF data. The estimated patterns based on asset allocations (in SCF and TIAA-CREF data) are reported in Figures A1 and A2 in the Appendix, and are very similar to what we obtain based on flow allocations.

Figure 16 presents estimates of age, time, and cohort effects together in one graph, under a variety of assumptions. Each of the four rows reflects a different identifying assumption. Each the the three columns represents different dependent variables—unconditional equity shares, the probability of equity ownership (i.e., flows to equity being positive), and equity shares conditional on a positive allocation to equity, from left to right, respectively.[62] The age effects shown in the first two rows are the same as those shown in Figures 13-15, but here they are plotted along with the corresponding time and cohort effects.[63] Note that we plot the cohort effects in order of decreasing birth year.

The first row shows estimated effects obtained from a model in which time effects are constrained to be zero. The resulting estimates of age and cohort effects are extremely large and offsetting. For example, the figure shows a 100 percentage-point difference between predicted conditional equity shares of the youngest and oldest cohort. In a parallel pattern, the figures show a more than 80 percentage point difference in the conditional equity shares of the youngest and oldest ages.

While we cannot say that this X pattern is theoretically impossible, it strikes us as extremely implausible, for several reasons. First, the size of the estimated cohort effects are implausibly large. That the oldest individuals would inherently prefer such dramatically greater exposure to stocks simply seems questionable on its face. Second, the fact that these two types of effects interact to coincidentally offset one another also seems highly unlikely and counter-intuitive. We can think of no plausible theory that would imply a secular decreasing trend in the amount of equity exposure successive new cohorts would like to hold throughout their lifetime.

The second row shows the patterns from a model that includes time and age effects, but excludes cohort effects. The X pattern is no longer present. As we saw in the earlier figures, the age pattern is hump-shaped in ownership probabilities and essentially flat in the conditional equity share. The slope of the time effect is large; showing an increase of about 20 percentage points over the 12-year time period in conditional (and also unconditional) equity shares. [64]

[62] As in the previous section, the ownership regressions are probits, while the conditional equity allocations are OLS. We graph predicted probabilities for the probit regressions, and the predicted shares for the OLS regressions. As before, the indicated sets of dummy variables are the only variables included in these regressions.

[63] In Figure 16, the intercept is different from that in Figures 13-15, so the lines are shifted by a constant.

[64] When we estimated a regression with only age effects (no time or cohort effects), the resulting coefficients

The third row shows results from a model that includes time and cohort effects, but excludes age effects. The resulting pattern of cohort effects looks very similar to the age effects in the second column—hump-shaped in the ownership probabilities and fairly flat in the conditional shares.[65] The time effects are again large and follow a pattern similar to that in the second row.

What do we conclude from these graphs? First, on the basis of plausibility, the appropriate specification for conditional and unconditional equity shares as well as ownership must include time effects. For the reasons mentioned above, we reject as implausible the X pattern that results in all three pictures when time effects are eliminated. As a consequence, we focus below on specifications that include time effects.[66] Second, we observe that once time effects are included, age patterns in conditional equity shares are economically insignificant (in row 2 by estimation and row 3 by assumption). Therefore, on the basis of parsimony, age should not be included in the specification for conditional shares. Third, the hump shape that exists in ownership probabilities could plausibly be explained by either cohort effects (with no age effects) or by age effects (with no cohort effects). We discuss this further below.

Finally, the fourth row shows what the cohort and time effects look like when we impose a restriction that the age effects decline by one percentage point per year, in line with the popular advice.[67] These graphs show another extreme X pattern: time effects that increase by 30 percentage points over twelve years coupled with cohort effects that decline by 50 percent over 45 years (i.e. cohorts born in 1970 would, all else equal, have equity shares that are 50 percentage points *lower* than those born in 1920. We reject this specification on the basis of both plausibility and parsimony.

5.3.2 Parameterizing time and cohort effects

In this section, we follow the approach, described above, of replacing some or all of the unrestricted dummies with a small number of economic variables intended to capture the relevant effects.

(not reported) looked very similar to those from a regression with both age and time dummies.

[65]The one exception is the drop in shares between the 1972 and 1962 cohorts.

[66]If one were to exclude time effects from ownership and/or share regressions this would amount to a specification error, in which case age and/or cohort effects would be misestimated. The components of the X shape—the upward sloping age effects and downward sloping cohort effects—that arise in our data when time effects are omitted and age and cohort effects are estimated jointly, do not appear when age or cohort effects are estimated independently (even though standard statistical tests would suggest that conditional on including age, one should include cohort effects, and vice versa).

[67]Such advice is not applicable to ownership, hence we do not estimate a restricted regression for the ownership graph.

Proxying for time effects One possible explanation for the widespread increase in equity shares in the 1990s is that the high stock returns in that decade encouraged individuals to actively increase their exposure to stocks. To examine this idea, we estimate a set of regressions that use lagged stock returns in place of unrestricted time effects. We examine equity shares in flow allocations only, in order to ensure that any results are not a direct consequence of market returns in prior periods.

We first examine a linear regression of the unconditional fraction of equity in contribution flows at the end of each year on the 3-year annual average real return on the S&P 500 (and a constant).This regression yields a coefficient of 0.69 on the 3-year average return, with a t-statistic of 45.8, indicating that a one percentage-point increase in the average recent stock return leads households to allocate .69 percentage points more of their flow contributions to the stock market.[68] These results are consistent with the hypothesis that recent past stock returns influence individual's equity share decisions.

We next examine a regression that includes this 3-year return as well as unrestricted age and cohort effects. If the 3-year return fully captures time effects, we have broken the identification problem mentioned previously. Although the estimated coefficient on the 3-year real return is statistically significant, it is small in magnitude (0.20). Also, the estimated age and cohort effects are very close to those from a model that includes only unrestricted age and cohort effects (recall that these were large and offsetting). These results leave us with two possible conclusions: either time effects are fully captured by this proxy variable and the resulting estimates of age and cohort effects are valid, or this variable is not fully capturing important time effects. Since we argued above that large and offsetting age and cohort effects are neither plausible nor parsimonious, we conclude that the 3-year return variable, while important, is not fully capturing the relevant time effects.[69]

Proxying for cohort effects As discussed previously, one possible source of cohort effects in asset allocation could the history of financial returns experienced by individuals during their lifetime. It is possible that individuals who witnessed poor stock market returns early in their life would tend to choose to be less exposed to stocks later in life. To examine this idea, we estimate a set of regressions that use the average real stock return experienced by the individual from age 15 to age 25 (the "age 15-25 return") in place of unrestricted cohort

[68]In calculating these t-statistics, we use a procedure to adjust for arbitrary serial correlation across individual observations over time. We also estimated an alternative specification using three lags of the annual total real return on the S&P 500 instead of the 3-year annual average return. This yielded coefficients of .32, .24, and .11 on lags 1, 2, and 3, respectively, each with large t statistics.

[69]Further evidence for this is the finding that when both the 3-year return and time dummies (with one more time dummy excluded) are included in the specification (either alone, or with age effects) we can strongly reject the overidentifying restriction that the time dummies are equal to zero.

effects.

We first regress the unconditional fraction of contribution flows allocated to equity on the age 15-25 return alone. We obtain a coefficient estimate of 0.06 with a t-statistic of 1.3. Thus, the variable on its own does not appear to be related to allocation patterns. We next examine a regression that includes this return as well as unrestricted age and time effects. Although the estimated coefficient on the age 15-25 return is now statistically significant (with a t-statistic of 5.4), it is still small in magnitude (an increase in average returns over this 10-year period of one percentage point increases current flow allocations by only 0.34 percentage points), indicating again that this variable has only weak explanatory power. The estimated age and time effects are very similar to those from a model that includes only age and time effects alone. Since this specific parameterization of cohort effects does not do much to explain the patterns in portfolio decisions, we must conclude either that cohort effects are captured by this variable but not important to portfolio decisions, or that cohort effects are potentially important but not captured by this variable.

5.3.3 Results based on individuals making changes

In this section we exploit the longitudinal nature of our data by examining individual level changes in equity allocations. Before doing so, we note that by looking at the changes that individuals make over time rather than at their underlying level of equity exposure at different points in time, we lose potentially useful information for identifying life-cycle patterns in allocation decisions. For example, under the assumption that no cohort effects are present in allocation decisions, with only data on changes we can no longer separately identify unrestricted age and time effects (we can only identify their sum). However, we can use the information on changes to assess whether the activity we observe could plausibly result from the presence of underlying age, time or cohort effects in the level of equity exposure. For example, if we were to observe that no one, or very few individuals, made any active changes to their equity shares, we would interpret this as evidence consistent with a lack of an age effect.

There are at least two important advantages of using the TIAA-CREF panel data. First we can observe changes in the equity allocations (in assets or in flows) for *each* individual, rather than changes in the cohort average, which allows us to examine the population heterogenity in changes. For example, we can determine whether the average changes over time are a result of a few individuals making large changes, or many individuals making small changes. Second, because we can identify specific actions that individuals take, such as asset transfers, asset withdrawals, and changes in flow allocations, rather than only observing portfolio outcomes, we can separate active changes individual make from changes that directly result from market fluctuations.

We analyze several measures of the extent of changes in each individual's asset allocations. We note that an individual's asset allocation over any period of time may change as a result of several factors, including (a) the transfer of assets from one account to another, (b) periodic contribution flows (and changes to the allocation of those flows), (c) the withdrawal of funds from the accumulated stock of assets, and (d) asset returns (*i.e.*, market fluctuations).

Theory suggests that in the absence of any transaction costs or inertia, the overall change in asset allocation from one period to the next is the most appropriate measure of the change in optimal portfolio allocation. However, if there are transactions costs, or if inertia is a factor, it may be informative to examine separately the changes in asset allocation that are a result of each of the aforementioned factors (transfers, flows, withdrawals, and returns).

To begin, we denote the allocation change, AC_t, that occurs from time $t-1$ to t for a given individual as follows

$$AC_t \equiv \frac{A_t^e}{A_t^T} - \frac{A_{t-1}^e}{A_{t-1}^T} \tag{2}$$

where A is assets, and the superscripts e and T denote equity-based assets and total assets, respectively. We then decompose this change into the sum of five separate effects, as follows:

$$AC_t = XE_t + WE_t + AFE_t + PFE_t + ME_t \tag{3}$$

Where XE_t (the transfer effect) is the change in the allocation that is attributable to asset transfers, WE_t (the withdrawal effect) is the part attributable to withdrawals, AFE_t (the active flow effect) is the part attributable to a change in the allocation of periodic flows from their initial allocation, PFE_t (the "passive" flow effect) is the part attributable to the existence of a flow of incoming contributions at the initial flow allocation, and ME_t (the market effect) is the part attributable to market returns.

To define each of these separate effects, note that given daily data on opening balances, transactions and returns, the following relationship would hold exactly:

$$A_t^e = A_{t-1}^e(1+R_t^e) + W_t^e + F_t^e + X_t^e \tag{4}$$

$$A_t^T = A_{t-1}^T(1+R_t^T) + W_t^T + F_t^T \tag{5}$$

where W is withdrawals, X is transfers, F is flows, and R is returns.[70] Therefore,

$$AC_t \equiv \frac{A^e_t}{A^T_t} - \frac{A^e_{t-1}}{A^T_{t-1}} \equiv \frac{A^e_{t-1}(1+R^e_t) + W^e_t + F^e_t + X^e_t}{A^T_{t-1}(1+R^T_t) + W^T_t + F^T_t} - \frac{A^e_{t-1}}{A^T_{t-1}} \tag{6}$$

If we assume that the transactions occur in a given sequence, e.g., returns, flows, withdrawals, transfers, we can define each of the separate components of the allocation change as the incremental change that would have occurred as the result of that "transaction." Thus, we define the market effect,

$$ME_t = \frac{A^e_{t-1}(1+R^e_t)}{A^T_{t-1}(1+R^T_t)} - \frac{A^e_{t-1}}{A^T_{t-1}} \tag{7}$$

as the change in asset allocation due solely to the difference between the rate of return on the stock market and the rate of return on other assets. Similarly,

$$PFE_t = \frac{A^e_{t-1}(1+R^e_t) + \alpha^e_0 F^T_t}{A^T_{t-1}(1+R^T_t) + F^T_t} - \frac{A^e_{t-1}(1+R^e_t)}{A^T_{t-1}(1+R^T_t)} \tag{8}$$

where $\alpha^e_0 = F^e_0/F^T_0$,

$$AFE_t = \frac{A^e_{t-1}(1+R^e_t) + F^e_t}{A^T_{t-1}(1+R^T_t) + F^T_t} - \frac{A^e_{t-1}(1+R^e_t) + \alpha^e_0 F^T_t}{A^T_{t-1}(1+R^T_t) + F^T_t} \tag{9}$$

$$WE_t = \frac{A^e_{t-1}(1+R^e_t) + W^e_t + F^e_t}{A^T_{t-1}(1+R^T_t) + W^T_t + F^T_t} - \frac{A^e_{t-1}(1+R^e_t) + F^e_t}{A^T_{t-1}(1+R^T_t) + F^T_t} \tag{10}$$

and

$$XE_t = \frac{A^e_{t-1}(1+R^e_t) + W^e_t + F^e_t + X^e_t}{A^T_{t-1}(1+R^T_t) + W^T_t + F^T_t} - \frac{A^e_{t-1}(1+R^e_t) + W^e_t + F^e_t}{A^T_{t-1}(1+R^T_t) + W^T_t + F^T_t} \tag{11}$$

By construction, the sum of all of these effects for a given t equals the overall allocation change (AC_t). For each individual, we then sum each effect across all periods that the individual is in the sample. This enables us to use the entire history of the individual's transactional activity to determine the source of any (net) allocation change over the entire period.

[70] Note, however, that we do not have daily data on transactions for each individual; our data are quarterly. Because transactions may take place at different times within a given quarter, the relationship described in these equations will not hold exactly. In order to make these equations hold, we use the quarterly data we have on transactional activity and beginning and ending balances to solve these equations for R^e_t and R^T_t for each person in each time period. This introduces some error into the calculations that is a function of the actual sequence of transactional activity within the quarter. These errors should not, however, introduce a systematic bias into the calculations.

Examining the sample with no withdrawals or annuitizations Table 9 presents the results of this decomposition of nine-year allocation changes. The sample used in this table includes only those individuals who had some assets on their TIAA-CREF contracts in all forty quarters in our sample period and excludes all individuals with any annuitizations or distributions at any point over the period.

Focusing on the top panel, in the column labeled "change in asset allocation," we see that the average change in the asset allocations to equity was +8.1 percentage points, or an average *increase* of almost 1 percentage point per year. Nearly 77 percent of sample members had larger equity asset allocations at the end of the nine-year period than at the beginning, while 15 percent had no change in their equity allocation. (The individuals with no change over the period were those who had either no equity or all equity.) Only 9 percent of the sample had a lower equity allocation at the end of the period than they did at the beginning. These data show that for almost all individuals, equity exposure either increased or remained unchanged as they aged.

The "market effect" column on the table shows the strong influence of market returns on individual asset allocations over this period. In this sample, the average net increase in equity allocation due to market returns was +9.2 percentage points. In contrast, the column labelled "non-market effect" shows that, on average, actions taken by individuals offset this increase in equity exposure by only –1.1 percentage points.

Recall that the standard rule of "100 minus your age" implies that individuals should reduce their equity allocations by 1 percentage point each year. The overall change in equity exposure over nine years prescribed by the rule is therefore –9 points. The data in Table 9 show that the market effect was, on average, +9.2 points over this period. This means that if individuals were following the rule, they should have taken action to lower their equity exposure by an average of –18.2 points over this period. We observe only a –1.1 percentage point change.

This –1.1 percentage-point change is further decomposed into its sub-components in the three rightmost columns, labelled "transfer effect," "active flow effect," and "passive flow effect." These three effects have a –2.1, +2.5, and –1.5 percentage point impact, respectively, on the overall nine-year average allocation change. If we ignore the –1.5 percentage point passive effect of simply making periodic contributions in the same allocation as they were at the start of the period, the data show that the average change in allocation among those who did anything actively to change their allocations (the sum of the remaining two effects) is +0.4 percentage points. In other words, on average, over this nine year period, active changes caused an *increase* in exposure to stocks.

At the same time, it is important to note that among the minority of individuals who decreased their exposure to the stock market over this period, the changes were relatively large. The sets of rows of the top panel of Table 9 present three ways of separating the sample into those who effectively increased, decreased, or did not alter their equity allocations. The first set of rows, denoted "changes in asset allocation," separates the sample members on the basis of whether their ending asset allocation to stocks was higher, the same, or lower than their initial allocation to stocks. The second set of rows divides the sample by whether the transfer effect was positive, zero or negative for each individual, and the third set does the same for the active flow effect.

The table shows that no matter which definition of "lowering" is used, only about one in ten (9-12 percent) sample members lowered their equity allocations over the nine-year period. However, among those who did decrease their allocations, their initial equity allocations were much higher than for those who raised or did not alter allocations, and the changes they made were on average quite large. For those whose equity allocations actually declined over the period (the first set of rows), the transfer effect was –31.2 percentage points, and the active flow effect was -8.9 percentage points. For those whose transfer effects were negative, the average effect was –31.8 percentage points. For those who made changes to their flow allocations that served to lower their equity asset allocations, the effect of these flow changes was –12.2 percentage points. These individuals also had large negative average transfer effects of –10.1 percentage points. It is interesting to note that those who raised their flow allocation to equities did not have similarly large positive transfer effects.[71]

In the bottom panel of Table 9, we examine the data on flow allocation changes among those who were making periodic contributions in the forty quarters from 1987 through 1996. It is important to emphasize that market returns have no *direct* relationship to flow allocations—the only way the allocation of flows can change is if a participant takes some action to do so. These changes therefore do not require any decomposition into active and passive pieces.

Among the 4,045 individuals in the sample contributing in all periods, only 7.2 percent decreased the equity allocation in their periodic contributions over the nine-year period.[72] While their flow allocation changes were large and negative (on average, among those who decreased the stock allocation, the change was –27.0 percentage points), the average increase

[71] It is possible that their ability to transfer assets to the equity based accounts may have been hindered by the transferability restrictions on the TIAA traditional account.

[72] There are two likely reasons that the percentage of individuals making no changes to flows was 54.9 percent in this table, but only 47.1 percent in Table 8. First, this table excludes annuitants and withdrawers, who are somewhat more likely to make changes to the allocation of flows. Second, the definition of a flow change differs somewhat. Table 8 included as a flow change *any* change in *any* quarter, whereas Table 9 includes only flow changes across broad categories and only compares the first and last quarters of the sample.

among the 37.9 percent of individuals who raised the equity allocation in contributions was an even larger +43.3 percentage points. Taken together, the average change in flow allocations to equity among those contributing throughout the period was +14.5 percentage points—representing an increase of about 1.5 percentage points per year. At least among this group, these data seem inconsistent with any attempt to lower stock market exposure as age increases.

Overall, what we learn from Table 9 is that, over this nine year period, the vast majority of individuals who did not receive distributions from their accounts either increased or left unchanged their equity allocations as they aged. Only a very small fraction of the population reduced their equity allocations as they aged.

Recall that by examining changes as we are doing, we have not solved the "age = time – cohort" identification problem. Under a no-cohort-effects assumption, the data in Table 9 can be interpreted in two ways: (1) there were major time effects over this period that led individuals to increase their allocations to the stock market, and these time effects swamped any negative age effect, or (2) the age effect is positive. If, instead, we assume there are no time effects in the levels, then by differencing the data we have eliminated the cohort effects. Under this assumption, the results in Table 9 provide an accurate estimate of pure age effects. In other words, interpreting these first-difference results as capturing pure age effects *requires* the assumption that there are no time effects in the data. Under this assumption, we would conclude that age effects were positive, *i.e.*, that equity shares increase with age.

Examining the sample with annuitizations and/or withdrawals In Table 10, we focus on asset allocation changes made by those individuals who began to take distributions of assets from their TIAA-CREF retirement contracts in the form of either withdrawals or immediate annuities during the sample period (we include only those individuals whose first withdrawal occurred at a point in time when they were older than age 50 as younger individuals may simply be moving assets to other accounts). [73] We do not impose the restriction that individuals remain in the sample for the full nine-years; in fact, many do not, because at some point they either withdraw their entire balance in a lump-sum or convert their assets into an immediate annuity. The statistics reported on the table (averages of the sums of individual effects over time) are calculated from 12/31/1987 through the last observation we have for each individual (as late as 12/31/96).

[73] Balances in most of the TIAA-CREF investment accounts can be converted to a variable immediate annuity that generates a flow of income based on the returns of that account. Unless assets are transferred to a different account before annuitization, the annuity income is based on the returns for the same account. Thus annuitization without prior transfer activity does not change asset allocation.

We decompose the asset allocation changes into the same effects as in Table 9, plus a withdrawal effect. The top part of Table 10 shows data for those with either withdrawals or annuitizations (or both), while the bottom part includes only participants whose distributions come in the form of annuities (i.e., those in the bottom panel are a sub-sample of the group in the top).

The allocation changes in Table 10 are different than in Table 9. Individuals with any distribution (withdrawal or annuity, in the top panel) changed their asset allocations by –8.0 percentage points, on average, before they withdrew or annuitized everything or before the sample period ended, whichever is earlier. Of these, individuals with annuities only (bottom panel) lowered their equity allocations by an average of –10.0 percentage points. Large fractions of individuals in both groups (37.1 percent in the former, 34.4 percent in the latter) had lower equity allocations at the time they were last observed in the sample than at the end of 1987. In addition, nearly 30.3 percent of those with any distribution, and 32.3 percent of those with annuities only, had transfers that lowered their equity allocations. In both cases, those with negative transfer effects greatly outnumber those with positive effects: 6.4 percent of those with any distribution, and only 2.3 percent of those with annuities only, had positive transfer effects.

As was the case in Table 9, those with negative transfer effects had very large effects on average: –37.1 percentage points for those with any distribution, and –40.8 percentage points for those with annuities only. These effects are large enough to more than offset the market effects over the period; the market effects in both samples on Table 10 are generally lower than the effects shown for the nondecumulators in Table 9.

The individuals represented in Table 10 are generally older than those in Table 9 (which included only those who did not take any distributions from their accounts). Thus, these data imply that older individuals are moving away from equity, at least prior to taking a withdrawal or annuity. However, there are at least two reasons other than an age-related effect that may explain this pattern. First, the restrictions on TIAA may affect behavior. The inability of most participants to withdraw or transfer TIAA accumulations as a lump sum may mean both that (1) they can't move via a transfer into equity-based accounts, and (2) a larger fraction of any withdrawals taken will come from the non-TIAA accounts than would have been the case in the absence of the restrictions. Second, there are other possible interpretations of the data in Table 10. For example, suppose all individuals begin their careers and contributions to their retirement accounts with a 50/50 asset allocation that is "optimal" at all ages. Over time, average cumulative returns have been greater for equities than non-equities. If there are some fixed transactions costs, older individuals who have accumulated more assets would be more likely to make changes: for those with greater assets, the cost of sub-optimal allocation would be higher relative to the fixed transaction cost. We would therefore expect to see more changes occurring later in life, and more negative percentage transfers among older individuals—despite our supposition that the optimal allocation remains at 50/50 for all ages. Therefore, observing older individuals transferring larger amounts out of equity does not necessarily imply that older individuals desire to lower their equity allocations because of their age.

6 Conclusions

The recent and projected future expansion of individually controlled and managed pension accounts means that understanding how individuals allocate their financial portfolios is of increasing importance to economists and policymakers. One critical component of that behavior is how individuals adjust their exposure to the stock market as they age. Under a set of simplifying assumptions, a benchmark model of portfolio choice yields the result that the fraction of financial wealth held in the stock market should be independent of both age and wealth. When these assumptions are relaxed, age effects may become important, but there is no uniform prediction about whether the share of wealth held in stocks should increase or decrease with age. In contrast, asset allocation advice from financial planners and other professionals clearly prescribes that as individuals age, they should reduce the fraction of financial wealth held in equities. A typical rule of thumb is that the equity share should equal 100 minus one's age.

In this paper, we have used data from the Surveys of Consumer Finances and from TIAA-CREF to examine whether individuals follow this type of standard advice. Determining whether equity shares decrease with age is not as straightforward as it might seem, because of some key features of individual portfolio behavior, because of a fundamental identification issue, and because of the lack of a perfect data set that tracks all of the components of financial wealth over an entire lifetime. After taking into account these complexities, we conclude that the evidence indicates that individuals do not gradually decrease equity shares as they age.

We begin by documenting three key features of portfolio behavior. First, a substantial number of households own no stock, either directly or indirectly. Although stockownership has risen dramatically in the U.S., especially in the 1990s, there remains almost 50 percent of households that are not stockowners. Second, there is significant heterogeneity across individuals in portfolio allocations. Seemingly similar individuals make widely different choices about the fraction of wealth held in the stock market. Third, individuals seldom take direct action to change their portfolio allocations over time. Over a ten year period, 47 percent of a balanced sample of TIAA-CREF participants made no changes to their allocation of inflows, 73 percent made no changes to their allocation of existing assets, and 44 percent made no changes of either type; 66 percent made either zero or one change along each dimension.

When estimating age effects, there is a well-known identification problem: since age equals calendar year minus birth year, regressions cannot include unrestricted age, time, and cohort effects. We demonstrate that the results on age effects are highly sensitive to the identifying assumptions about time and cohort effects. In fact, some of the differences in findings across other papers in the literature stem from differences in identifying assumptions about these effects. Our analysis may be helpful for those studying age, time, and cohort effects in other contexts.

One identifying assumption is to exclude time effects and include unrestricted age and cohort effects (as in Poterba and Samwick (1997b)). This approach essentially follows the path of each birth cohort as it ages, and observes how portfolio shares vary. When we follow this approach, we find strong evidence in both the SCF and TIAA-CREF data that the share of financial wealth held in stocks has tended to increase with age. With TIAA-CREF data, we also find increases with age in equity allocations in flows of periodic contributions. Similar results are obtained when we examine the changes, in both stocks and flows, made by individuals. These effects are large, with estimated increases between 1 and 2 percent per year. One interpretation is that there is a general tendency to increase equity allocations with age, in stark contrast to the generic advice of financial planners. We do not believe this combination of identifying assumptions and conclusions, however, on the basis of plausibility and parsimony. First, an estimate of this size seems too large to be believable; someone investing for 60 years would be projected to increase their equity allocation by up to 120 percentage points! Second, parsimony implies that it is better to explain the data with one large time effect than with the combination of large and roughly equally sized age and cohort effects. In addition, when plotted together the age and cohort estimates form a dramatic X-shaped pattern, in which the strong positive age effects described above are largely offset by strong and negative cohort effects. It seems too coincidental that the quantitative effect of age increasing by one year and birth year increasing by one year are so similar in magnitude but opposite in sign. Third, the high equity returns over much of our sample period suggest that there are economic reasons to believe that time effects might be important, most obviously for the data on balances (due to direct effects of market movements) but also for the data on flows. Overall, we conclude that time effects should be included in the specification.

An alternative approach is to exclude cohort effects—essentially estimating the future behavior of young people by looking at the current behavior of old people. This has been the approach followed, for example, by Bodie and Crane (1997), VanDerhei, Galer, Quick, and Rea (1999) and Holden and Vanderhei (2004) (using cross-sections in which time effects are not included), and Agnew, Balduzzi, and Sunden (2003) (using a panel, and including time effects). Each of these papers uses data from 1995 or later and finds negative effects. Agnew, Balduzzi, and Sunden (2003) estimate that age effects in asset portfolio shares decline by about one percentage point per year. Both Bodie and Crane and Agnew et al claim that their results are consistent with individuals following the standard advice of financial planners. We reach a very different conclusion, however, for a variety of reasons.

Suppose, for the moment, that we accept the identifying assumption (explicit or implicit in these papers) that there are no cohort effects, and thus include time and age effects in the regression. There are at least two reasons to question the declining age conclusions in these papers. First, the age estimates appear to be sensitive to the sample period used. Figure 10 showed that the age profile was humped-shaped for the years 1987 to 1992, but declining for the years 1995 to 1999. Over the full sample period, age effects are basically flat for those aged 25-55 and negatively sloped solely for those aged 56-70.

Second, a decomposition of the data into the probability of ownership and equity shares conditional on ownership calls even this decline into question. Virtually all of the declining age profile for this age group comes from the extensive decision to own or not to own stock at all, while very little of it is due to patterns in the intensive decision of exactly how much stock to own. The estimated age profile for the equity share conditional on any ownership is extremely flat. So the age effects in the unconditional shares for the 55-70 year olds corresponds to an increased probability with age of being a non-participant in the stock market, rather than a lower equity share conditional on ownership.

In addition, we question whether even these effects are age effects rather than cohort effects, i.e., we question the identifying assumption that there are no cohort effects. Recall our evidence that individuals make few changes as they age. In a hypothetical extreme case in which no individuals made any changes with age, it would still be possible to observe (as in Figure 2) a declining age profile, but it would obviously make no sense to conclude that individuals reduce their equity share gradually as they age. In reality this decline would simply be due to the fact that earlier-born cohorts are, and always were, less likely than later-born cohorts to hold stock. In our data, individuals do make some changes, but the paucity of changes raises the possibility that a greater fraction of earlier-born cohorts simply never held stocks. If this were true, it would suggest that the lower incidence of equity ownership among currently older households represents differences across birth cohorts rather than a decline in ownership with age.

The only evidence supporting declines with age comes from looking at decumulators: those with annuitizations and/or withdrawals over age fifty. For these individuals, withdrawals and transfers led to about a 13 percentage point drop in equity shares in the years leading up to and including the distributions (an effect that was partly offset by a 5 percentage point increase due to market movements). However, even this decline could be a result of restrictions on withdrawing or transferring into stocks money from the TIAA traditional annuity.

Finally, our analysis indicates that a great deal of the observed variation in portfolio behavior may be explained by the outcome of a few significant decisions that individuals make infrequently, rather than by marginal adjustments made continuously. This suggests the importance of investigating more carefully how individuals choose their initial asset allocation upon joining a retirement plan.

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Table 1
Summary Statistics from the Surveys of Consumer Finances, 1962-1998
(Dollar amounts in September 1998 dollars)

	1962		1983		1989		1992		1995		1998	
Variable	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Age of head	48.9	48	46.8	44	47.9	45	48.4	45	48.5	45	48.7	46
Years of education of head	11.9	10	12.2	12	12.5	12	12.9	12	12.9	12	13.1	13
Household income	34,800	28,000	43,600	31,700	54,400	34,600	46,900	31,200	48,100	33,100	53,300	33,600
Financial wealth	18,300	3,000	68,700	8,900	87,600	11,100	81,800	10,200	99,700	12,400	137,800	18,300
Net worth	79,100	29,100	200,600	59,100	251,100	63,100	220,600	58,800	231,000	62,600	287,800	72,600
Surveyed households	2,557		4,103		3,143		3,906		4,299		4,305	

Notes: All tabulations use SCF survey weights. Dollar amounts adjusted for inflation using September CPI-U for each survey year for the financial data, and the annual average CPI-U for income data. (The surveys request data on income in the year prior to the survey year, while the household asset information is gathered as of the late summer/early fall of the survey years.)

Table 2
Financial Asset Allocation in the 1998 Survey of Consumer Finances
Nonretirement, Retirement, and Total Asset Portfolios

	Total Dollars ($ bil.)	Average Dollar Amount ($ 000)	Fraction of Total (pct)	Average Share[1] (pct)	Percent Owning (pct)
Non-retirement assets					
Stocks	4,830.8	50.9	49.7%	14.7%	30.2%
Bonds	1,582.0	16.7	16.3	9.0	34.8
Cash	2,225.8	23.5	22.9	62.3	98.0
Other	1,079.3	11.4	11.1	14.0	32.8
Total	9,718.0	102.4	100.0	100.0	100.0
Retirement assets					
Stocks	2,899.7	54.9	65.7	56.9	76.9
Bonds	926.0	17.5	21.0	24.8	51.4
Cash	413.7	7.8	9.4	13.3	50.5
Other	173.9	3.3	3.9	4.9	6.8
Total	4,413.3	83.5	100.0	100.0	100.0
All financial assets					
Stocks	7,730.5	81.1	54.7	26.7	53.1
Bonds	2,508.1	26.3	17.7	14.1	50.4
Cash	2,639.5	27.7	18.7	47.3	97.9
Other	1,253.2	13.1	8.9	12.0	35.0
Total	14,131.3	148.2	100.0	100.0	100.0

Notes:

Each section of the table includes only those with some financial assets in the indicated portfolio.

1 Within each portfolio, average share for an asset class is an equal-weighted average across individuals of the asset class shares.

Table 3
Asset Classes, Inception Dates, and Total Assets for TIAA and CREF Accounts, as of June 30, 2000

Asset class and account name	Date of Inception	Assets ($ mil.)	Percent	
Equity				
CREF Stock	July 1, 1952	$132,985	45.3%	
CREF Social Choice*	March 1, 1990	$4,206	1.4	
CREF Global Equities	May 1, 1992	$9,680	3.3	**57.6%**
CREF Growth	April 29, 1994	$17,172	5.8	
CREF Equity Index	April 29, 1994	$5,128	1.7	
Fixed Income				
CREF Money Market	April 1, 1988	$6,606	2.2	
CREF Bond Market Account	March 1, 1990	$2,790	0.9	
CREF Inflation-Linked Bond Account	May 1, 1997	$245	0.1	**41.7%**
Guaranteed				
TIAA Traditional Annuity (estimated)	April 23, 1918	$112,927	38.4	
Real Estate				
TIAA Real Estate	October 2, 1995	$2,001	0.7	

*The CREF Social Choice Account is a balanced account; as of 6/30/2000, the stock portion was 62% of total assets.
Note: All variable products reported on the SEC (net) assets reporting basis.

Table 4
Summary Statistics for TIAA-CREF Panel Data

Sample and variable	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
All observations with "stock" of accumulated assets													
Number of observations	11,475	11,507	11,790	12,001	12,290	12,645	13,010	13,471	13,913	14,256	13,996	13,755	13,497
Average age (years)	44.5	45.3	45.8	46.4	47.0	47.5	47.9	48.4	48.8	49.3	50.2	51.0	51.9
Percent male (%)	54.3	54.2	53.7	53.1	52.7	52.2	51.6	51.0	50.5	50.2	50.3	50.5	50.5
All observations with "stock" of assets and flow of contributions													
Number of observations	10,096	9,533	9,366	9,178	9,214	9,264	9,336	9,368	9,370	9,287	8,709	8,151	7,662
Average age (years)	44.4	45.4	46.0	46.4	46.9	47.3	47.7	48.0	48.4	48.8	49.8	50.6	51.4
Percent male (%)	54.3	54.7	54.1	53.9	53.4	52.7	52.1	51.6	51.4	51.4	51.9	52.3	52.7
Balanced panel with "stock" of assets in all 52 quarters													
Number of observations	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794	8,794
Average age (years)	43.2	44.2	45.2	46.2	47.2	48.2	49.2	50.2	51.2	52.2	53.2	54.2	55.2
Percent male (%)	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0
Balanced panel with "stock" of assets and flow of contributions in all 52 quarters													
Number of observations	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965	3,965
Average age (years)	42.5	43.5	44.5	45.5	46.5	47.5	48.5	49.5	50.5	51.5	52.5	53.5	54.5
Percent male (%)	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5

Notes:

All data are for the fourth quarter of each year.

Table 5
Asset Allocation for Sample of TIAA-CREF Participants as of September 30, 1998

	Fraction of Total (pct)	Average Share[1] (pct)	Percent Owning (pct)
Stock of retirement assets*			
Equity	56.6%	52.7%	84.7%
Non-equity	43.4	47.3	88.4
Total	100.0	100.0	100.0
Flow of contributions**			
Equity	63.4%	59.2%	87.3%
Non-equity	36.6	40.8	75.3
Total	100.0	100.0	100.0

1 Average share is the average across all participants of the their individual portfolio shares.

*Includes all sample members with assets.

**Includes all sample members with flows of contributions.

Table 6
Percent of U.S. Households Owning Stock, 1962-2001

Households owning stock through:	1962	1983	1989	1992	1995	1998	2001
(1) Direct ownership of publicly traded stock[+]	14.1%	19.1%	16.9%	17.0%	15.2%	19.2%	21.3%
(2) Direct + mutual funds	19.0	--	20.0	21.1	22.3	27.6	30.0
Upper bound, based on ownership of any taxable mutual funds	*19.0*	*21.4*	*20.4*	*21.7*	*22.8*	*28.1*	*30.3*
(3) Direct + mutual funds + trusts	19.1	--	21.0	22.1	23.2	27.9	30.4
Upper bound, based on ownership of any trust assets	*19.9*	*22.7*	*22.2*	*23.8*	*24.8*	*28.6*	*30.9*
(4) Direct + mutual funds + trusts + defined contribution (DC) pensions[++]	23.9*	--	30.2	31.8	37.7	44.8	48.3
Upper bound, based on ownership of any DC plan assets [+++]	*29.6*	*37.3*	*39.3*	*41.5*	*45.9*	*49.7*	*51.7*
(5) Direct + mutual funds + trusts + DC pensions + IRAs (Comprehensive measure)	**23.9***	**--**	**33.4**	**37.7**	**41.3**	**49.4**	**52.2**
Upper bound based on ownership of any IRA assets	*29.6***	*43.7*	*47.5*	*49.6*	*54.0*	*57.0*	*59.7*

Source: Authors' tabulations of the 1962 Survey of Financial Characteristics of Consumers and the 1983, 1989, 1992, 1995, 1998, 2001 Surveys of Consumer Finances.

Notes: The first line in each entry lists the percentage of households owning stock through the corresponding vehicles. The second line (in italics) presents an upper-bound estimate of the percentage holding stock by including all households who hold assets in a vehicle, regardless of whether they indicate holding any stock. These upper bounds are cumulative. For example, the upper bound for (5) = upper bound for (4) plus all households owning any IRA assets.

[+] For 1962 and 1983, includes stock reported as held in "investment clubs." In 1962, a small percentage of households reported owning assets that were either publicly traded stock, mutual fund shares, or investment club shares, but did not provide sufficient information to classify the asset as falling into one of these categories. We include such households (who did not elsewhere list holdings of publicly traded stock) in line (2). Including these households in line (1) would produce a direct stock ownership measure of 17.2% for 1962.

[++] Stock owned in DC plans includes stock owned in all "account type" pensions, regardless of participant's ability to withdraw or borrow.

[+++] For 1962, this is the percent of households that could withdraw any assets from an employer-sponsored profit-sharing or retirement plan. This may be an overestimate of the percent of households with DC plans. It may also exclude some households with non-cashable DC plans.

* This number is a estimate, assuming that of households with retirement plans and no stock outside retirement plans, the fraction with stock in their retirement plans in 1962 was the same as in 1989.

** IRAs not available in 1962; this bound is therefore equal to the upper bound on (4).

Table 7
Distribution of U.S. households by household financial wealth and value of stocks owned, 1998
(Percent of all U.S. households)

Amount of financial wealth	**Value of stock owned in any form**		
Total $	$0 - $1,000	$1,001 +	All
$0 - $10,000	37.9	3.6	41.5
$10,001 - $50,000	10.7	13.6	24.3
$50,001+	6.3	27.9	34.2
All	54.9	45.1	100.0

Source: Authors' calculations based on data from 1998 Survey of Consumer Finances. Percentages based on 1998 SCF sample of 4,305 observations weighted to represent 103 million households.

Table 8
Changes in Quarterly Asset and Flow Allocations, 1987-1996
Sample of participants with flows in all 40 quarters
(n=4,782)

Asset Allocation Changes	**Flow Allocation Changes**						
Count	Zero	One	Two	3-5	6-10	11+	Total
Zero	44.3%	15.3%	6.6%	5.3%	1.1%	0.2%	72.8%
One	1.9	4.2	3.2	3.5	0.8	0.1	13.7
Two	0.5	0.8	1.1	1.9	0.7	0.0	5.0
3-5	0.4	0.6	0.6	2.4	1.0	0.1	5.1
6-10	0.1	0.2	0.3	0.4	0.7	0.2	1.9
11+	0.0	0.1	0.2	0.4	0.4	0.3	1.5
Total	47.1	21.2	12.0	14.1	4.7	0.9	100.0

Notes: "Asset allocation changes" are the number of quarters in which assets are transferred from ***any*** deferred annuity investment account to another via an "accumulation transfer" transaction, or in which assets are transferred from a TPA to a deferred annuity account. "Flow allocation changes" also reflect changes in the allocation of contributions to *any* of the investment accounts.

Table 9
Nine-Year Changes in Equity Allocations, 1988-96, Various Measures, TIAA-CREF Data
Participants with no annuities or withdrawals

			Count	% of sample	Initial asset allocation	Change in asset allocation	Market effect	Non-market effects: Total	Non-market effects: Transfer effect	Non-market effects: Active flow effect	Non-market effects: Passive flow effect
Assets in 40 quarters	**ALL**		7,354	100.0	40.0	8.1	9.2	-1.1	-2.1	2.5	-1.5
	Change in asset allocation	>0	5,628	76.5	43.6	13.5	11.1	2.4	0.9	4.3	-2.8
		=0	1,075	14.6	10.9	0.0	0.0	-0.1	-0.1	-0.1	0.1
		<0	651	8.9	56.8	-24.9	7.9	-32.9	-31.2	-8.9	7.2
	Transfer effect	>0	581	7.9	34.7	25.9	9.4	16.3	13.2	6.9	-3.8
		=0	6,058	82.4	39.1	9.4	9.3	0.1	0.0	2.4	-2.3
		<0	715	9.7	52.3	-17.0	8.3	-25.5	-31.8	-0.9	7.2
	Active flow effect	>0	2,066	28.1	33.4	16.7	9.8	6.9	-1.0	13.9	-6.0
		=0	4,421	60.1	40.7	6.5	8.7	-2.3	-1.0	0.0	-1.3
		<0	867	11.8	52.5	-3.9	10.0	-14.0	-10.1	-12.2	8.2

			Count	% of sample	Initial flow allocation	Change in flow allocation
Flows in 40 quarters	**ALL**		4,045	100.0	38.2	14.5
	Change in flows	>0	1,533	37.9	32.6	43.3
		=0	2,220	54.9	39.7	0.0
		<0	292	7.2	55.8	-27.0

Notes: Allocations are percentages of assets in or flows into equity accounts. Each effect measures the increase in equity allocation as a result of a specific factor. Market effect + non-market effect = change in asset allocation. Transfer effect + active flow effect + passive flow effect = non-market effect. In the top part of the table, effects are measured from 12/31/87 to 12/31/96. For the bottom part (flows), the effects are measured from the first quarter of 1987 through the fourth quarter of 1996. See text for further details.

Table 10
Changes in Equity Allocations, 1988-date of last distribution, Various Measures, TIAA-CREF Data
Participants with annuities and/or withdrawals

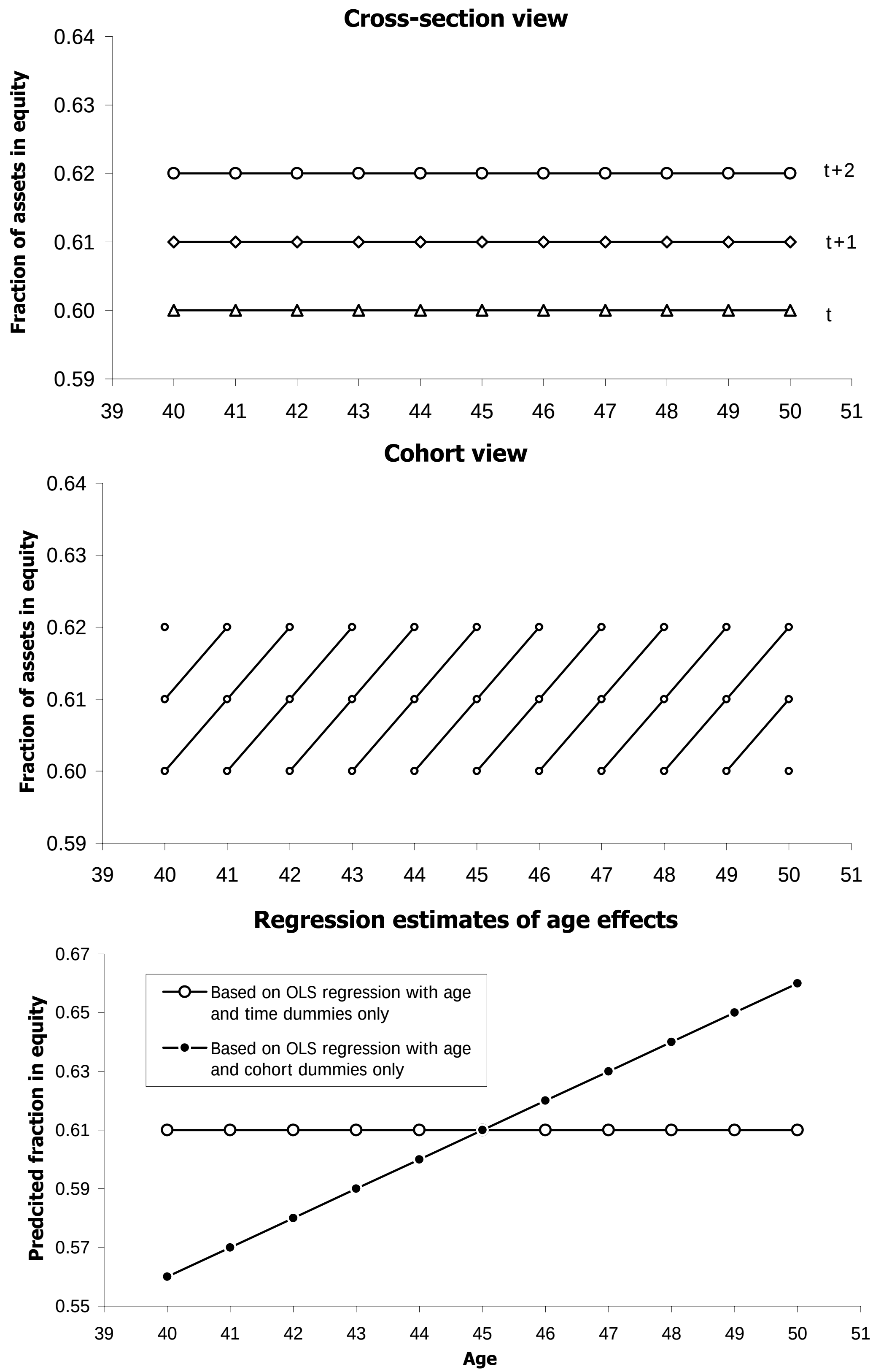
			Count	% of sample	Number of quarters	Equity allocation 12/31/87	Change in asset allocation	Market effect	Non-market effects: Total	Non-market effects: Transfer effect	Non-market effects: Active + passive flow effect	Non-market effects: Withdrawal effect
Participants with withdrawals or annuitization	**ALL**		1,887	100.0	26.3	38.6	-8.0	5.1	-13.2	-10.5	0.2	-2.8
	Change in asset allocation	>0	774	41.0	28.7	43.9	12.4	7.8	4.4	0.7	0.8	3.0
		=0	413	21.9	21.7	8.2	0.0	0.0	0.0	-0.1	0.2	-0.1
		<0	700	37.1	26.5	50.6	-35.3	5.2	-40.5	-29.1	-0.6	-10.9
	Transfer effect	>0	121	6.4	34.1	35.3	17.0	8.5	7.9	11.6	2.1	-5.9
		=0	1,194	63.3	25.5	33.4	0.6	4.9	-4.3	0.0	-0.6	-3.7
		<0	572	30.3	26.4	49.9	-31.3	4.9	-36.2	-37.1	1.2	-0.3
	Withdrawal effect	>0	284	15.1	34.1	48.6	11.4	8.9	2.5	-8.5	0.0	11.1
		=0	1,236	65.5	22.8	33.3	-8.0	3.4	-11.5	-11.4	-0.1	0.0
		<0	367	19.5	32.2	48.5	-22.9	8.0	-31.3	-9.2	1.1	-23.1
Participants with annuitizations only	**ALL**		774	100.0	20.7	33.4	-10.0	3.1	-13.2	-12.9	-0.2	
	Change in asset allocation	>0	262	33.9	23.8	43.8	6.5	5.9	0.6	0.4	0.2	
		=0	246	31.8	18.9	5.7	0.0	0.0	0.0	0.0	0.0	
		<0	266	34.4	19.2	48.9	-35.6	3.3	-38.9	-37.8	-1.0	
	Transfer effect	>0	18	2.3	30.0	38.7	15.5	5.7	9.8	10.4	-0.6	
		=0	507	65.5	20.8	25.7	2.4	2.9	-0.5	0.0	-0.5	
		<0	249	32.2	19.8	48.7	-37.1	3.4	-40.6	-40.8	0.3	

Notes:

Effects are sums from 12/31/87 to last observation for individual. See text for description of how effects are measured.

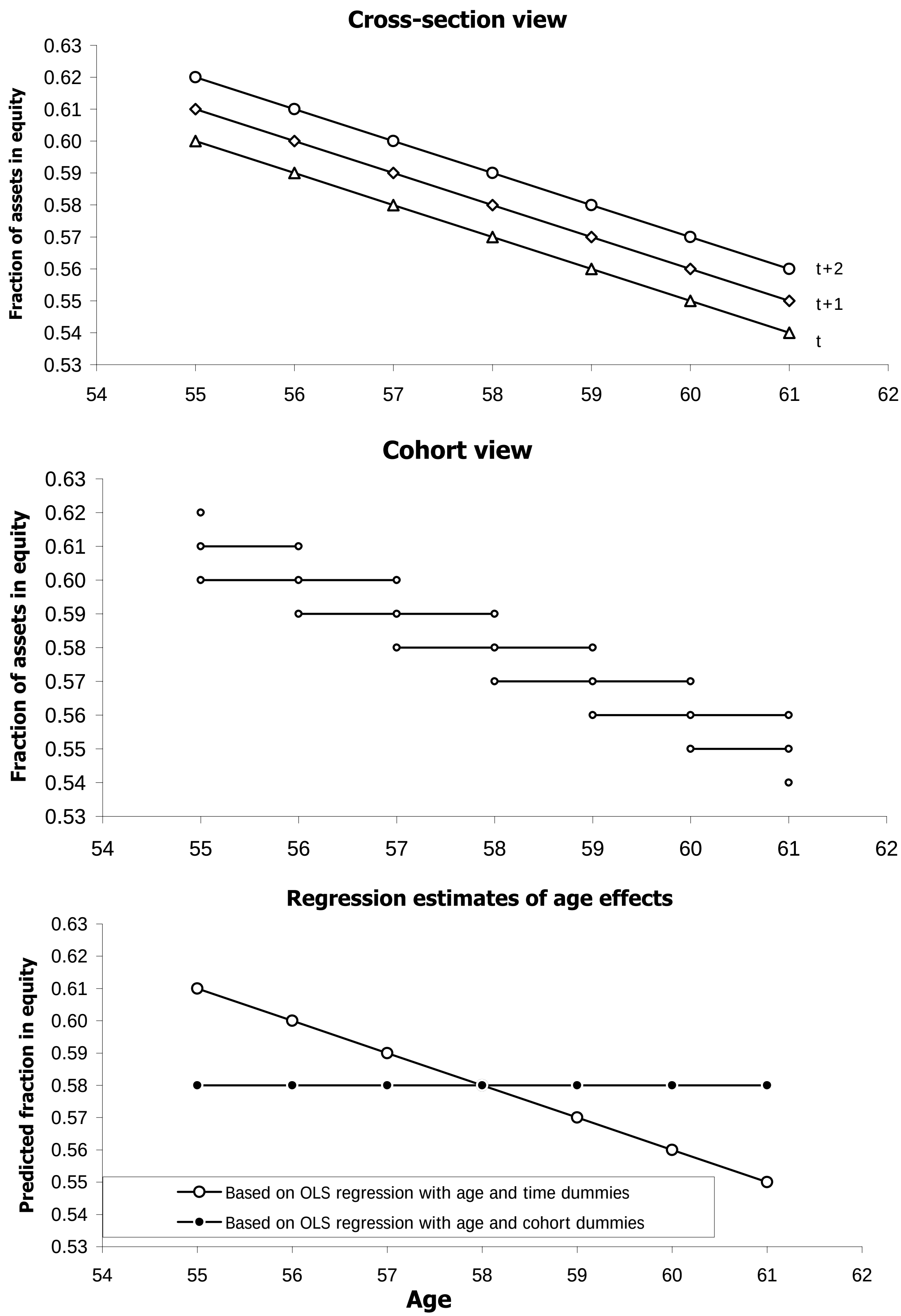
Includes only those whose first withdrawal or annuity was taken after age 50.

Figure 1
Hypothetical portfolio share data



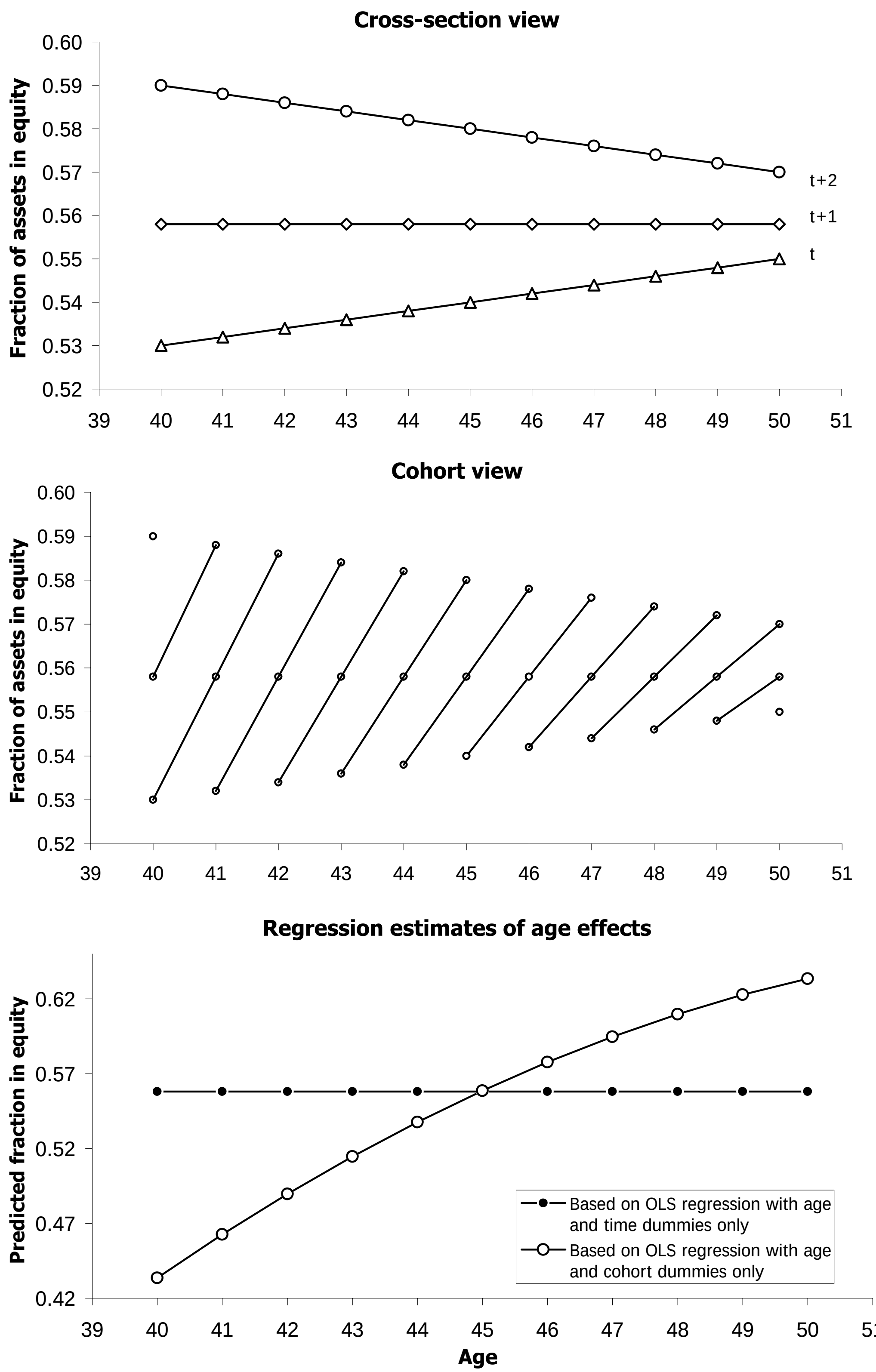
Connecting all observations in a single cross section yields parallel horizontal lines (first panel above).
Connecting all observations of a single cohort yields parallel upward sloping lines (second panel above).
Regression yields two different estimates of age effects (third panel above).
There are at least two possible explanations for this pattern of data:
(1) a pure time effect, (2) age effect plus equal size cohort effect.

Figure 2
Hypothetical portfolio share data



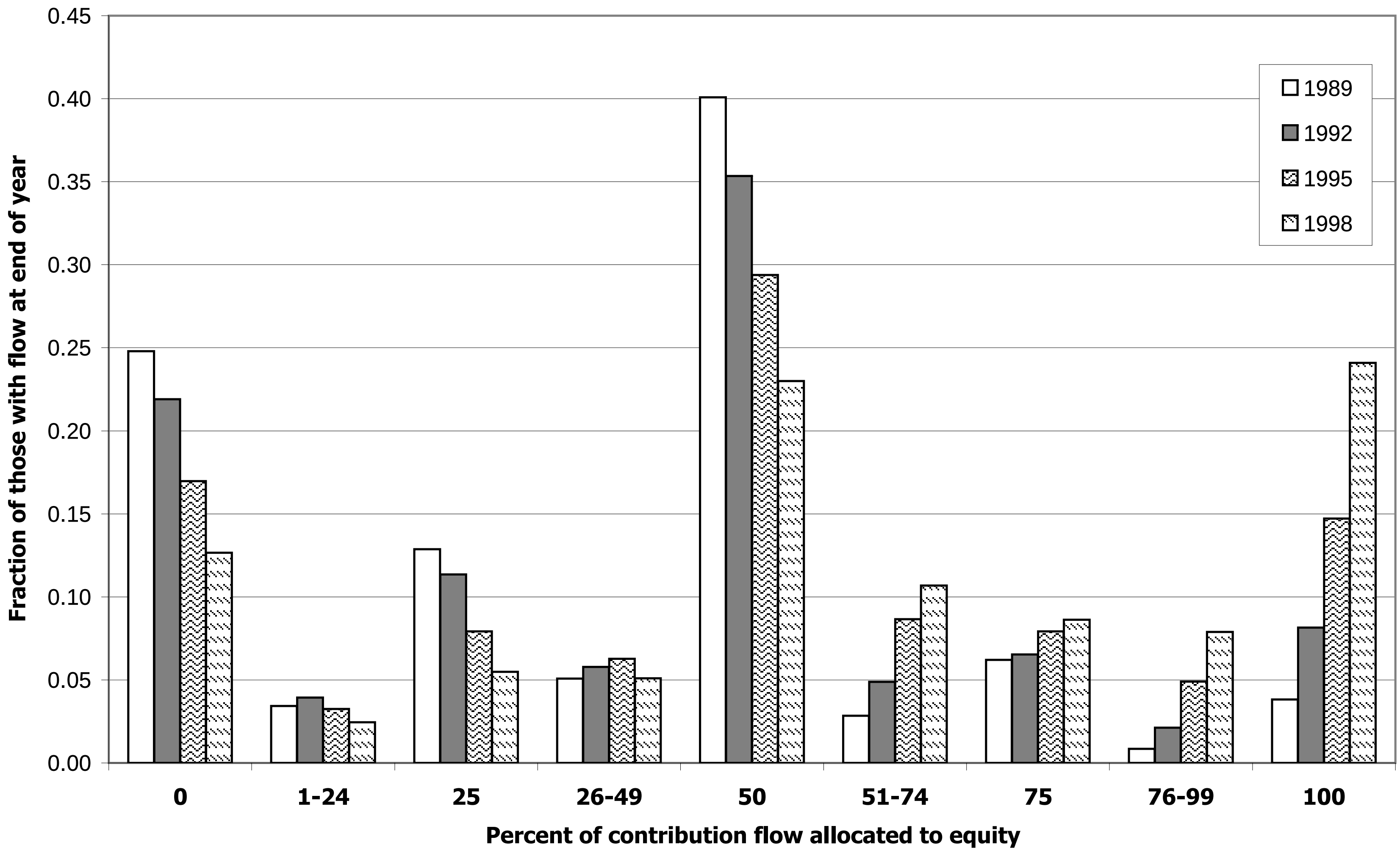
Connecting all observations in a single cross section yields parallel, downward-sloping age profiles (first panel above).
Connecting all observations of a single cohort yields parallel horizontal lines (second panel above).
Regression yields two different estimates of age effects (third panel above).
There are at least two possible explanations for this pattern:
(1) a pure cohort effect, or (2) a time effect plus an equal size age effect of opposite sign.

Figure 3
Hypothetical portfolio share data



This pattern can be explained in at least three ways:
1. Age/time interaction --> age patterns change over time, (t: upward sloping age profile, $t+1$: flat age profile, $t+2$: declining age profiles).
2. Cohort/time interaction --> time effect raises profile for individuals born more recently more than profile of individuals born earlier.
3. Age/cohort interaction --> different cohorts change portfolio shares at different rates with age.

Figure 4
Distribution of flow allocations to equity among TIAA-CREF participants
1989, 1992, 1995, and 1998



All observations with flows in the third quarter of 1989, 1992, 1995, and 1998.

Figure 5
Distribution of asset allocations to equity for TIAA-CREF participants
1989, 1992, 1995, and 1998

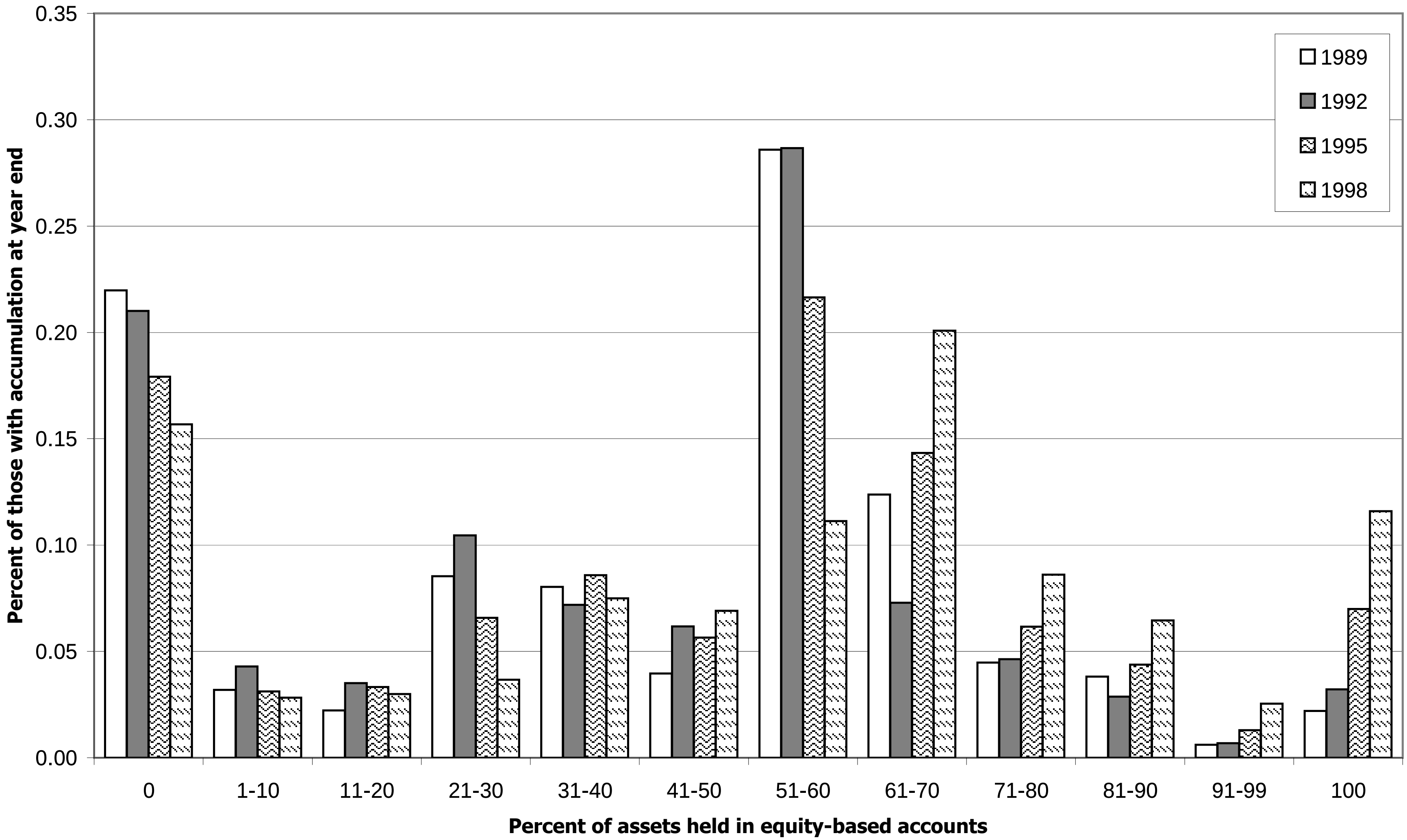


Figure 6
Changes in CREF Stock Account Accumulation Unit Value
Quarterly Data, 1985-Q1 through 2000-Q2

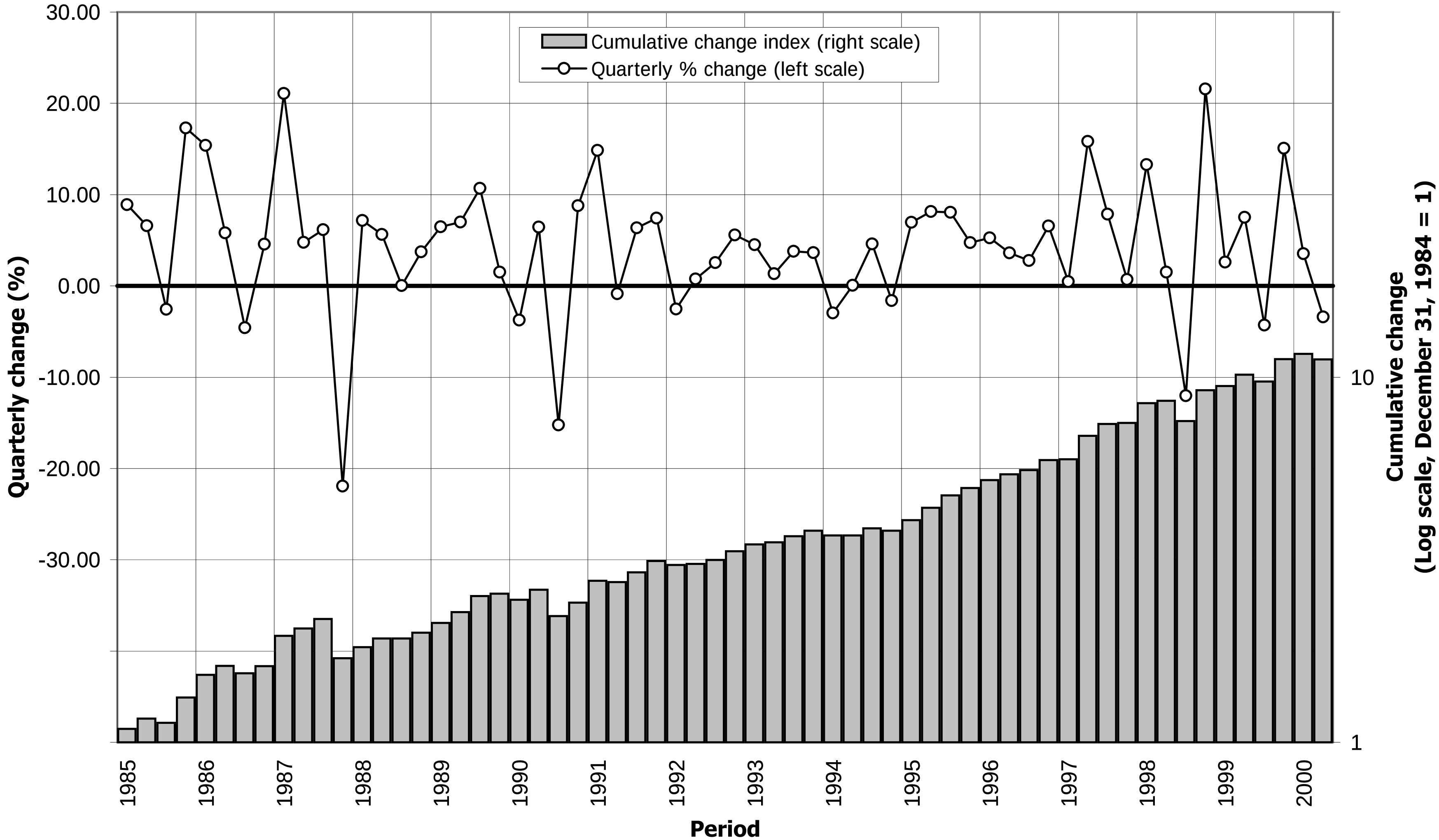


Figure 7
Equity Shares in Financial Assets, SCF data, 1989-1998

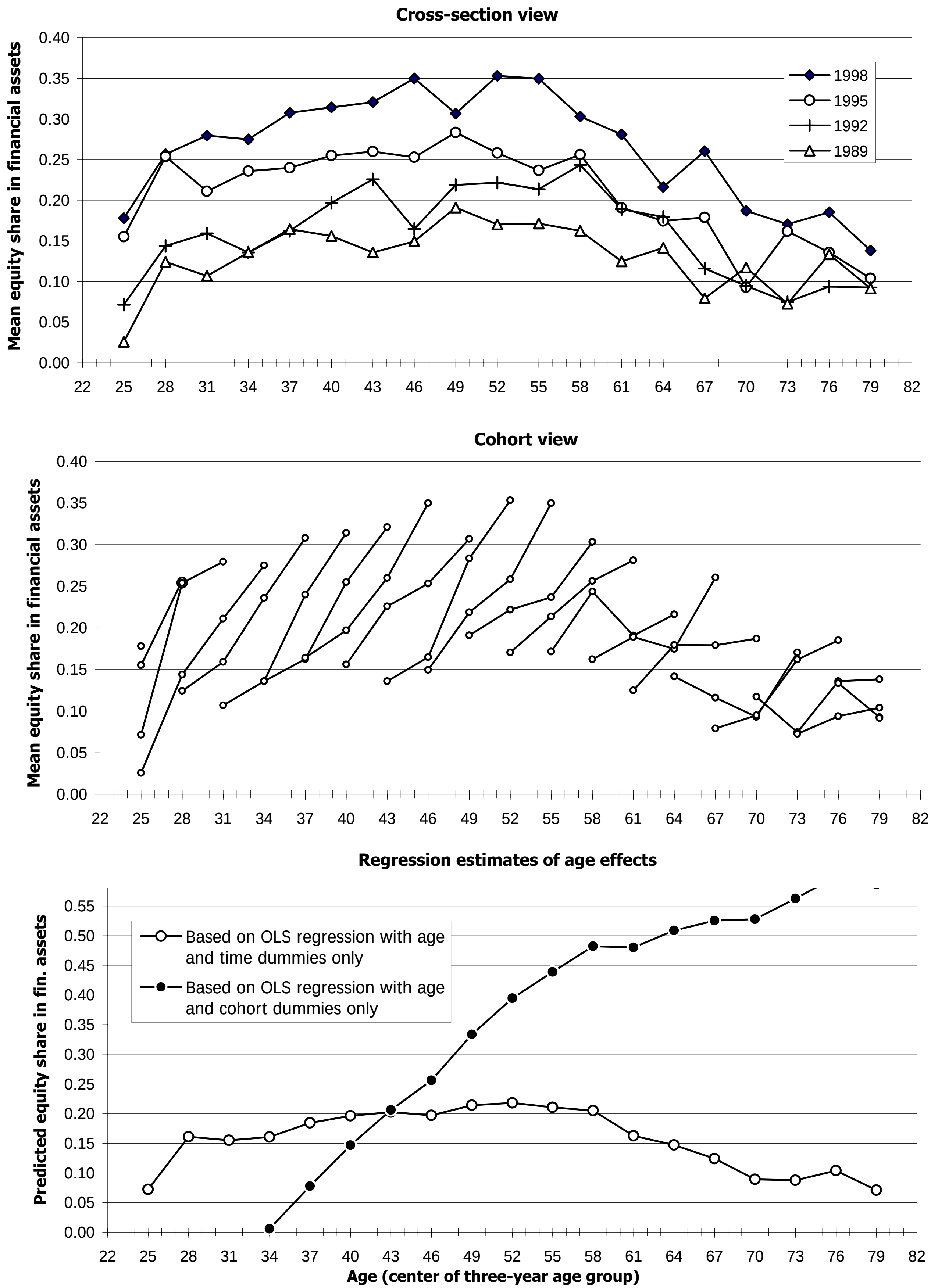


Figure 8
Fraction of Population Owning Equity, SCF data, 1989-1998

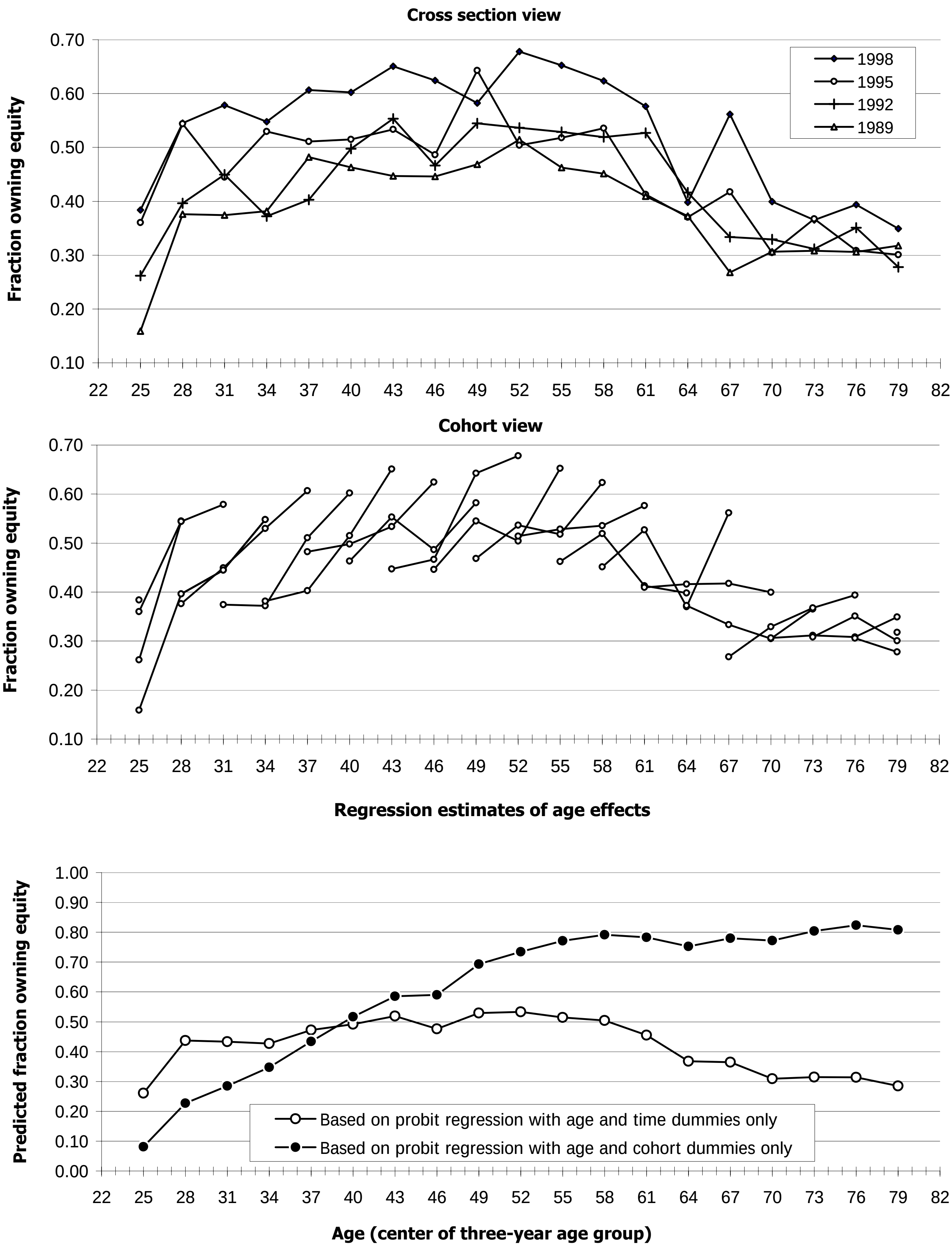


Figure 9
Equity Shares among Equity Owners, SCF data, 1989-1998

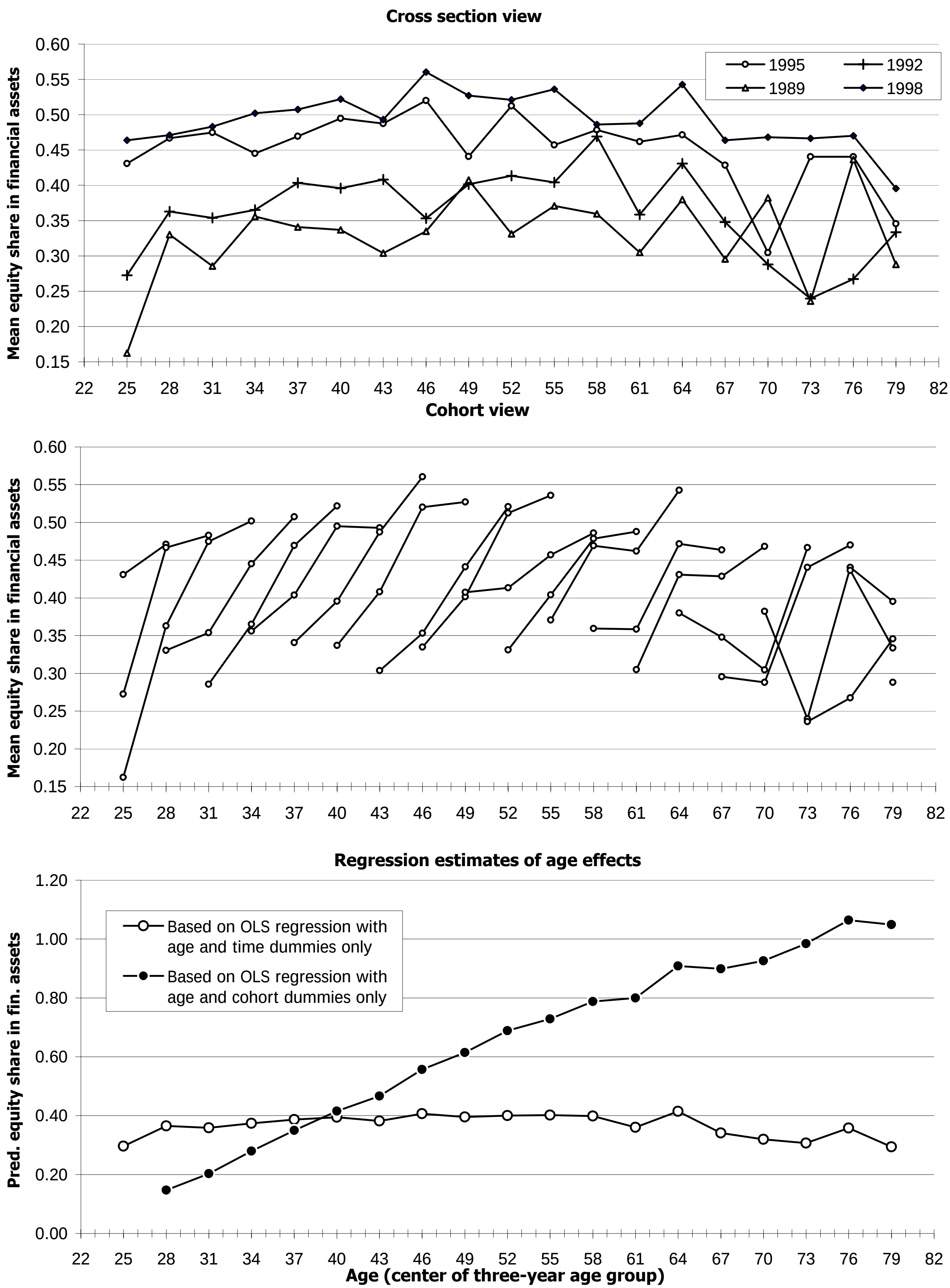


Figure 10
Equity Share in Assets, TIAA-CREF Data, 1987-1999

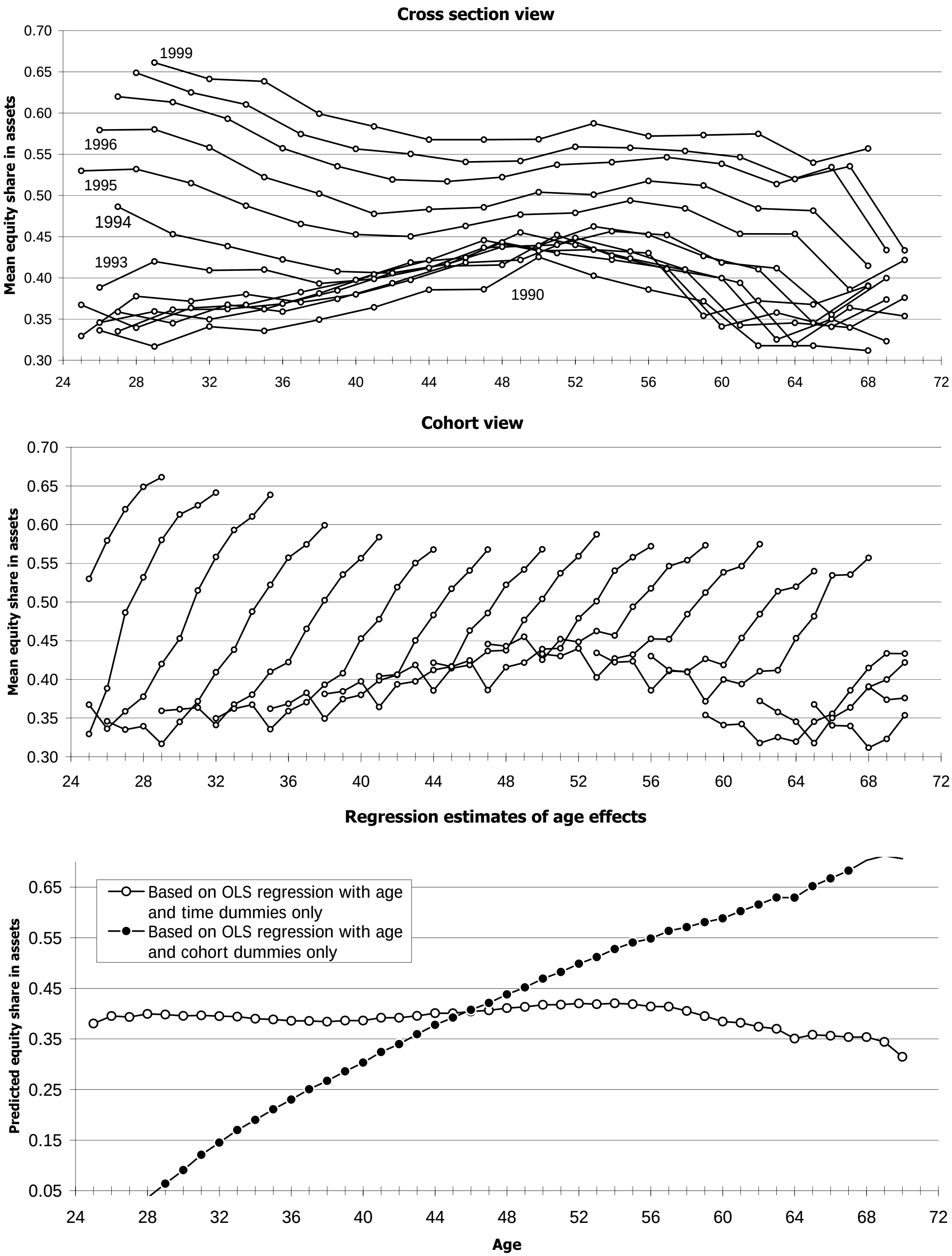


Figure 11
Fraction of Participants with Equity in Assets, TIAA-CREF data, 1987-1999

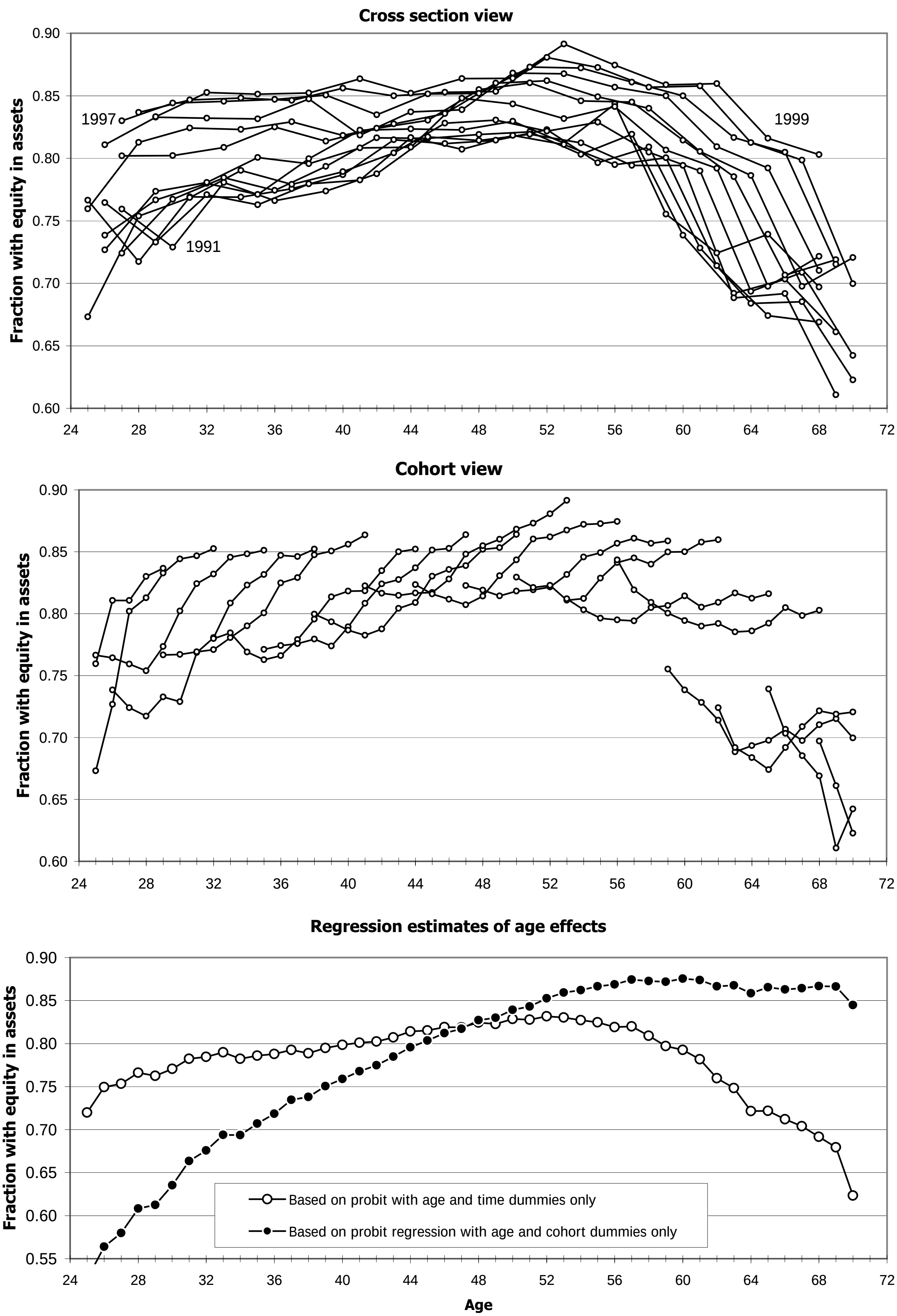


Figure 12
Equity Share in Assets among Equity Owners, TIAA-CREF data, 1987-1999

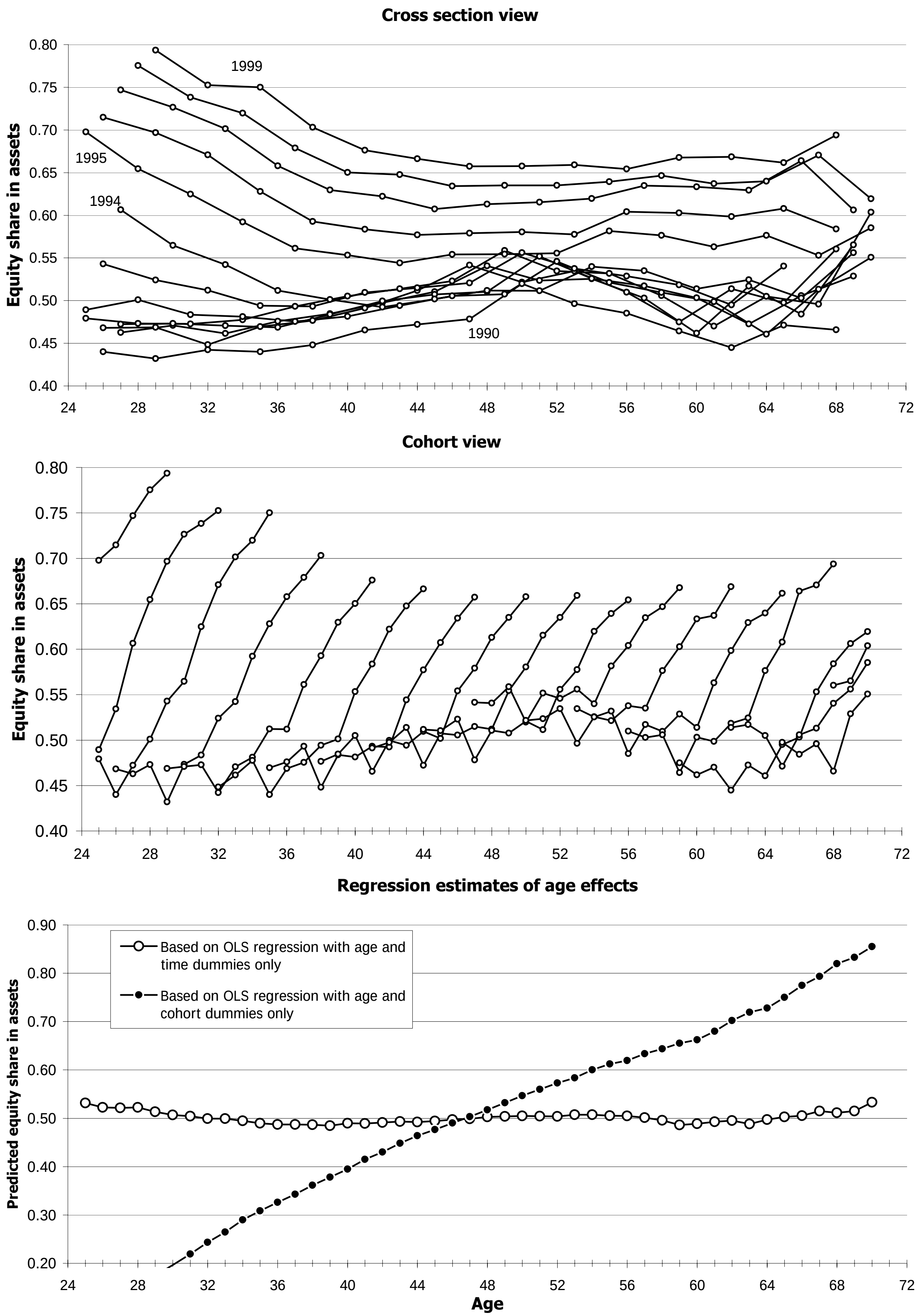


Figure 13
Equity Share in Contribution Flows, TIAA-CREF Data, 1987-1999

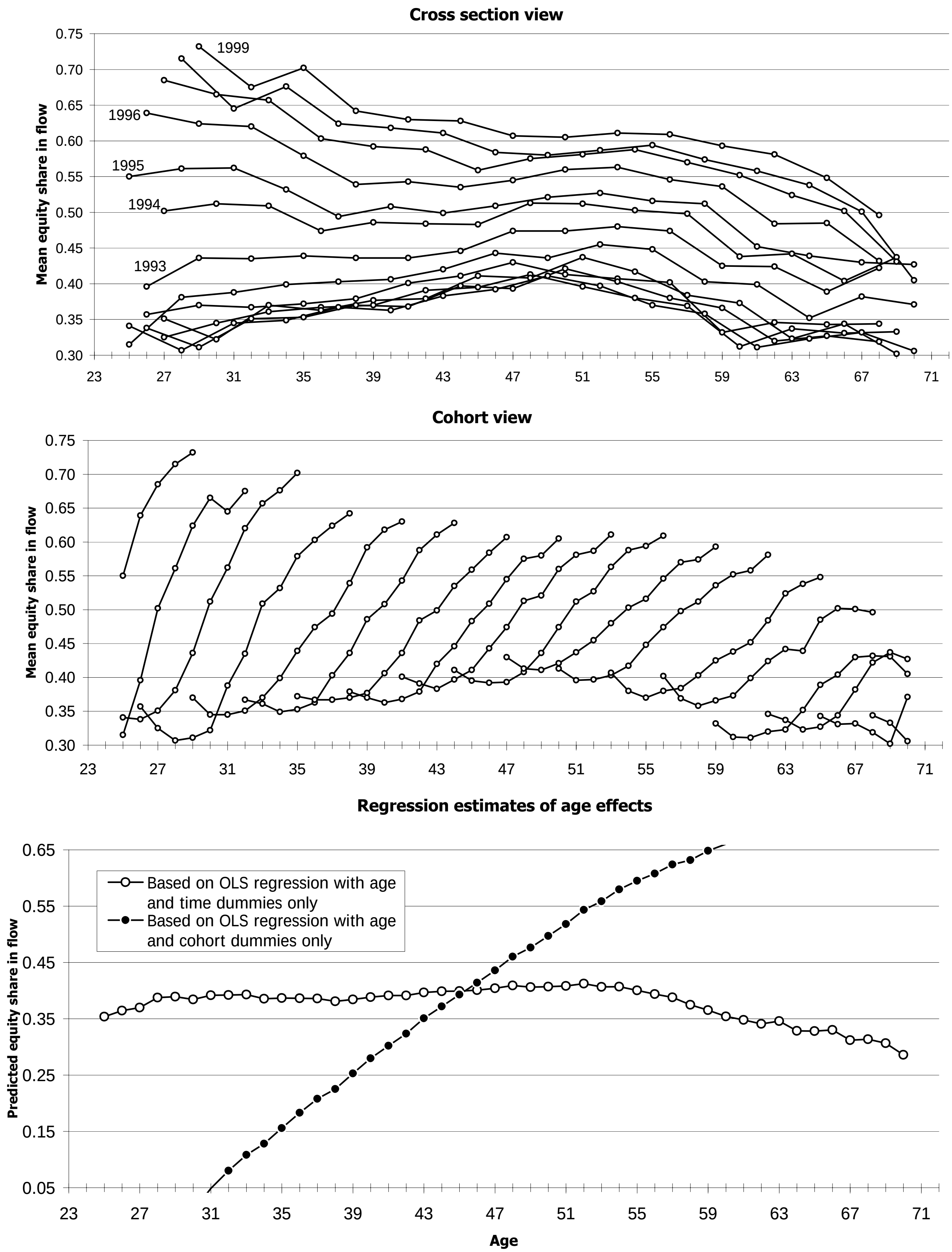


Figure 14
Fraction of Participants with Equity in Flows, TIAA-CREF data, 1987-1999

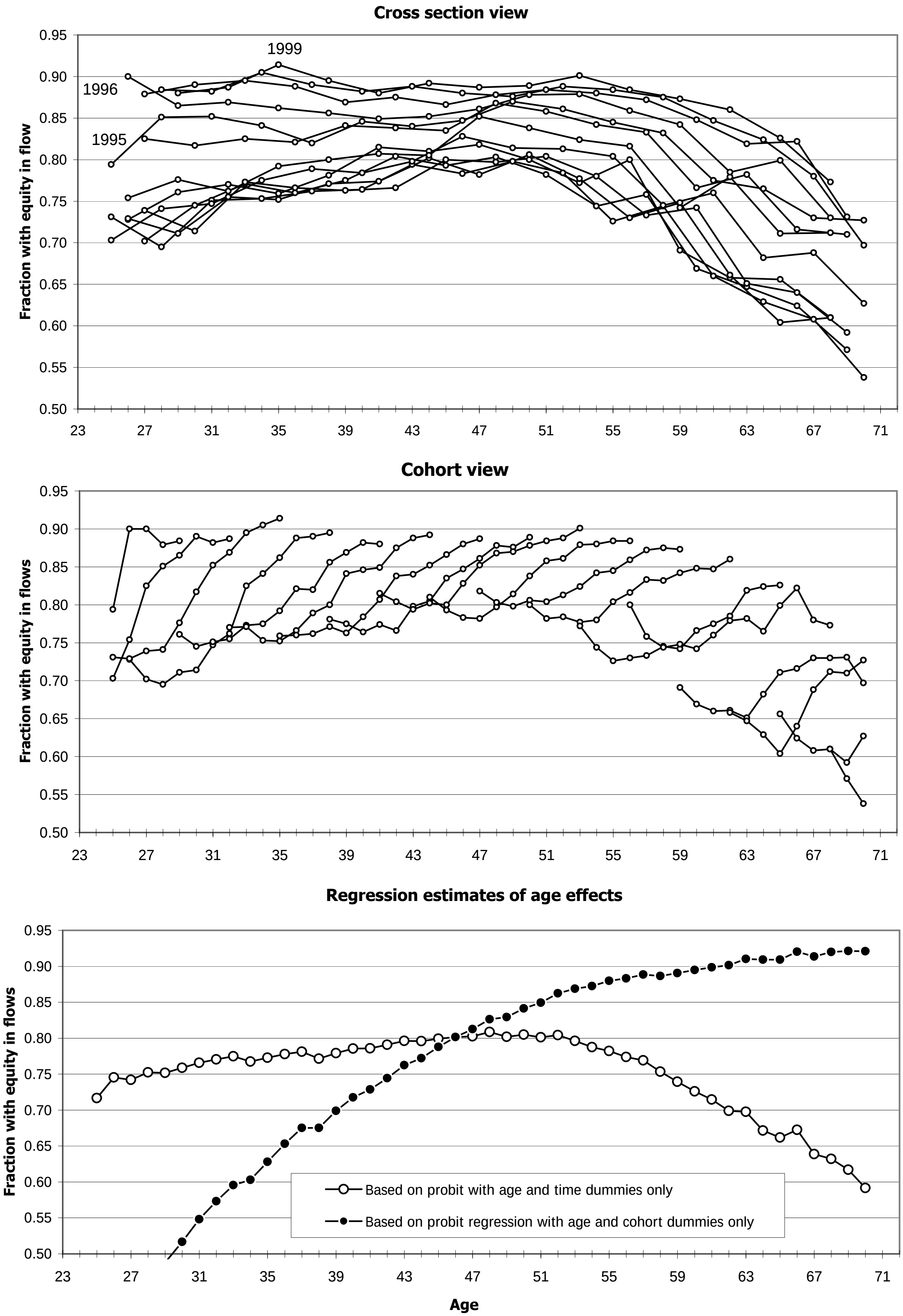


Figure 15
Equity Shares for those with Equity in Flows, TIAA-CREF data, 1987-1999

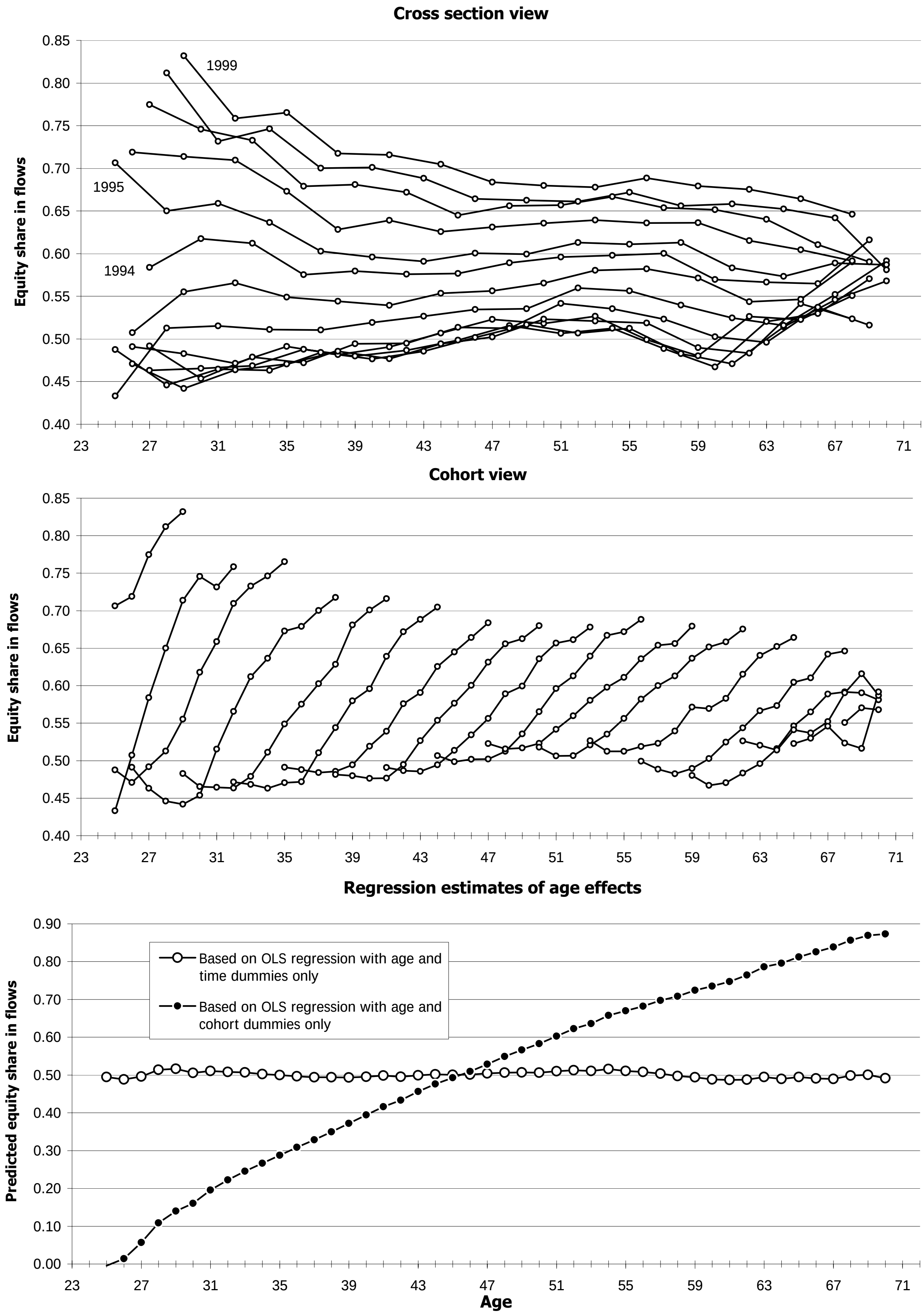


Figure 16
Age, Time and Cohort Effects in TIAA-CREF Flow Allocations

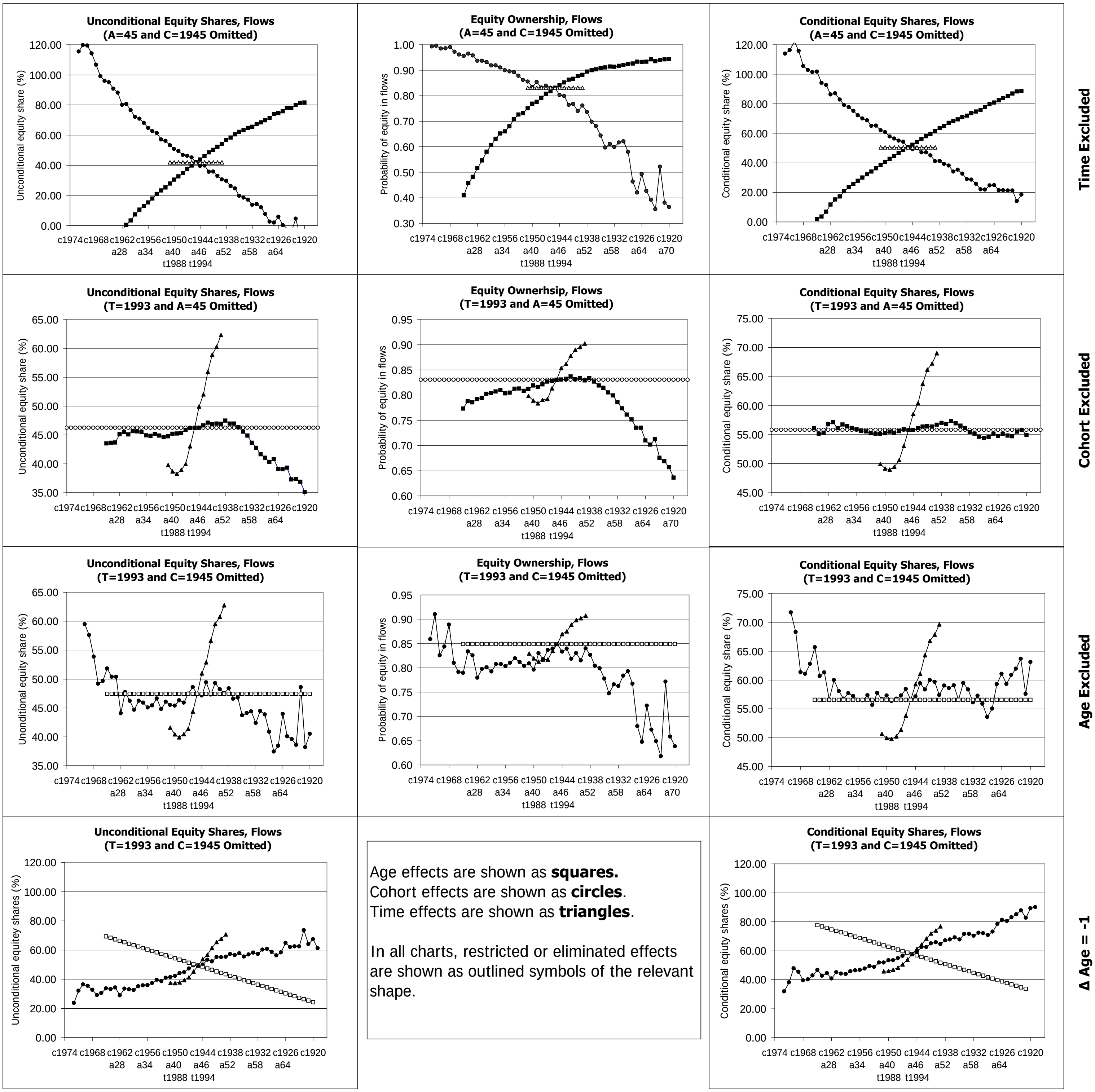


Table A1
Financial asset allocation in the 1998 Survey of Consumer Finances

Financial assets	Total Dollars ($ bil.)	Average Dollar Amount ($ 000)	Fraction of Total (pct)	Average Share[1] (pct)	Percent Owning (pct)
Stocks					
Non-retirement assets	*4,830.8*	*50.7*	*34.2%*	*9.9%*	*30.1%*
Directly held	3,130.4	32.9	22.2	5.4	20.7
Mutual funds	1,199.3	12.6	8.5	4.1	16.4
Trusts	501.1	5.3	3.5	0.4	1.2
Retirement assets	*2,899.7*	*30.4*	*20.5*	*16.8*	*42.7*
Annuities	147.0	1.5	1.0	0.6	3.1
IRAs	1,421.1	14.9	10.1	6.0	20.6
DC pension accounts	1,331.6	14.0	9.4	10.1	29.4
Total	*7,730.5*	*81.1*	*54.7*	*26.7*	*53.2*
Bonds					
Non-retirement assets	*1,582.0*	*16.6*	*11.2*	*6.6*	*34.6*
Directly held	592.4	6.2	4.2	0.7	3.2
Savings bonds	93.2	1.0	0.7	2.0	20.8
Bond mutual funds	495.8	5.2	3.5	1.2	7.2
Loans to others	132.2	1.4	0.9	2.4	9.1
Trusts	268.4	2.8	1.9	0.3	1.1
Retirement assets	*926.0*	*9.7*	*6.6*	*7.5*	*28.5*
Annuities	116.1	1.2	0.8	0.6	3.4
IRAs	339.7	3.6	2.4	1.9	7.3
DC pension accounts	470.1	4.9	3.3	5.0	20.4
Total	*2,508.1*	*26.3*	*17.7*	*14.1*	*50.4*
Cash					
Non-retirement assets	*2,225.8*	*23.4*	*15.8*	*43.8*	*97.2*
Checking accounts	332.8	3.5	2.4	20.9	86.6
Saving accounts	455.6	4.8	3.2	13.2	59.7
CDs	591.4	6.2	4.2	5.7	16.5
Money market funds	633.6	6.6	4.5	3.7	19.6
Call accounts	141.1	1.5	1.0	0.2	2.2
Trusts	17.6	0.2	0.1	0.1	2.4
Other[2]	53.8	0.6	0.4	0.1	0.8
Retirement assets	*413.7*	*4.3*	*2.9*	*3.5*	*28.0*
Annuities	19.0	0.2	0.1	0.1	2.6
IRAs	277.1	2.9	2.0	2.1	7.6
DC pension accounts	117.5	1.2	0.8	1.2	20.4
Total	*2,639.5*	*27.7*	*18.7*	*47.2*	*97.6*
Other					
Non-retirement assets	*1,079.3*	*11.3*	*7.6*	*10.3*	*32.5*
Cashable life insurance	872.7	9.2	6.2	9.8	31.7
Miscellaneous other[3]	82.9	0.9	0.6	0.5	1.2
Misc. other in trusts[4]	123.8	1.3	0.9	0.0	0.1
Retirement assets	*173.9*	*1.8*	*1.2*	*1.7*	*3.8*
Annuities[4]	0.0	0.0	0.0	0.0	0.0
IRAs[4]	34.5	0.4	0.2	0.2	0.5
DC pension accounts[4]	139.3	1.5	1.0	1.5	3.3
Total	*1,253.2*	*13.2*	*8.9*	*12.0*	*34.8*
Total	14,131.3	148.3	100.0	100.0	100.0

Notes:

Table includes only those respondents with financial assets (7.1% have no financial assets).

1 Average share is the average across all households of the household portfolio shares.

2 Other includes cash in combination mutual funds, and cash not elsewhere classified.

3 Miscellaneous other includes proceeds from lawsuits, estates, deferred compensation, commodity futures contracts, royalties, non-publicly traded stock, future lottery prize receipts.

4 Other includes allocation categories not involving stock, bonds, cash, or some combination. For DC plans, the majority of "other" assets are those in DC plans from earlier employment.

Table A2
Stock Ownership in TIAA-CREF Assets

	All Observations		Balanced Panel	
Year	% With Stock in Assets	Standard Error	% With Stock in Assets	Standard Error
1987	79.9%	0.4%	81.1%	0.4%
1988	79.1	0.4	80.7	0.4
1989	78.6	0.4	80.8	0.4
1990	78.4	0.4	80.9	0.4
1991	78.4	0.4	81.3	0.4
1992	79.7	0.4	82.5	0.4
1993	80.8	0.4	83.6	0.4
1994	82.2	0.3	84.8	0.4
1995	82.5	0.3	84.9	0.4
1996	83.3	0.3	85.5	0.4
1997	84.3	0.3	86.1	0.4
1998	84.6	0.3	86.0	0.4
1999	85.3	0.3	86.3	0.4

Figure A1
Age, Time and Cohort Effects in SCF Asset Shares and Ownership

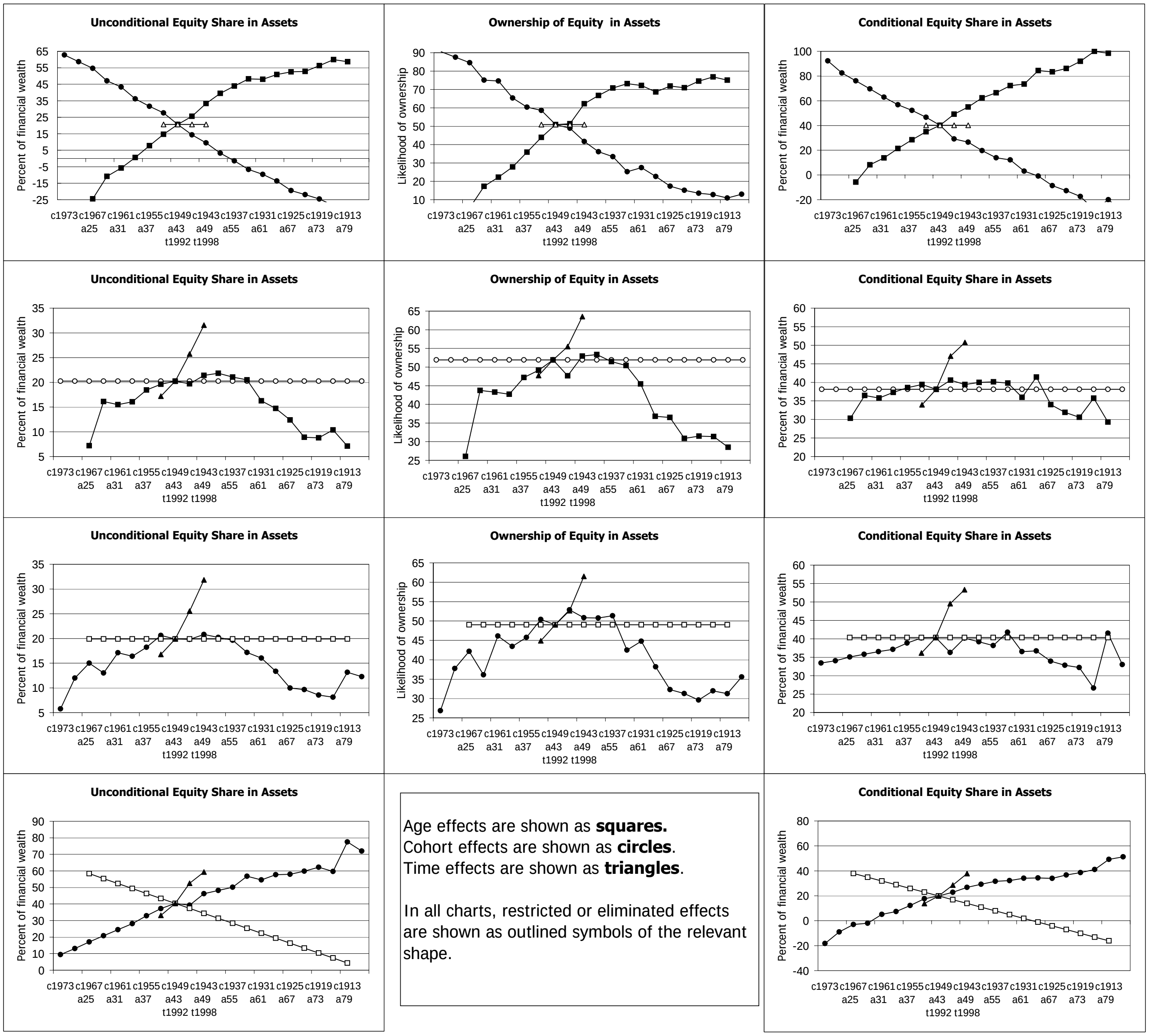
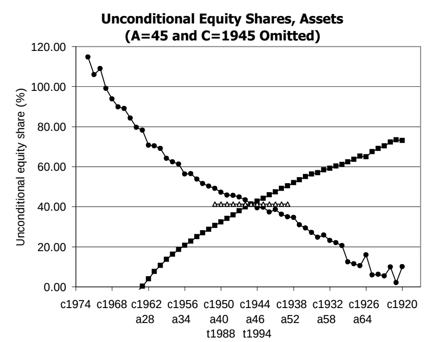
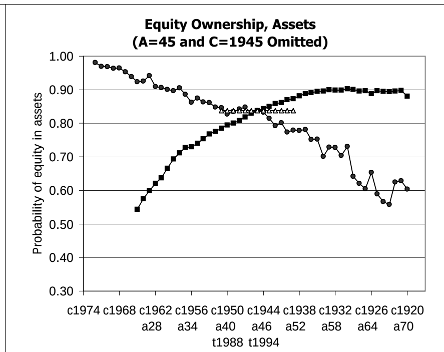
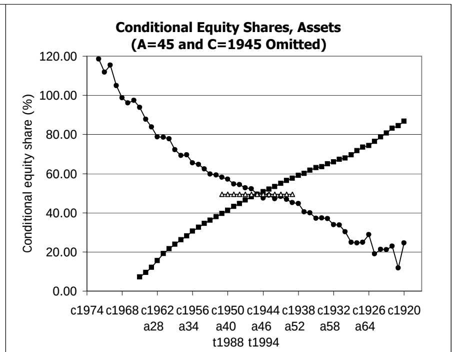


Figure A2
Age, Time and Cohort Effects in TIAA-CREF Asset Shares and Ownership

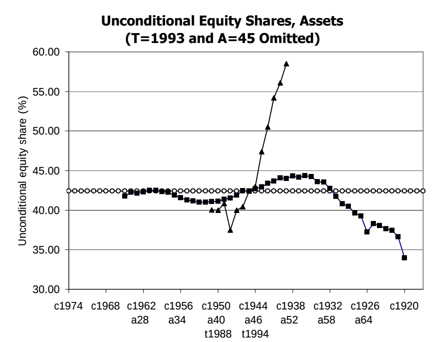
Time Excluded

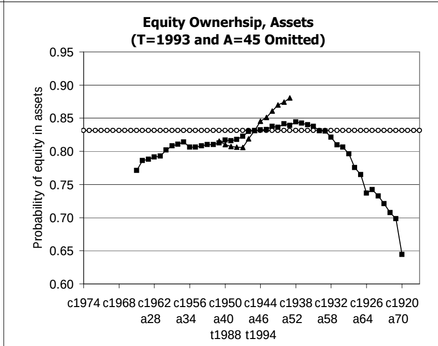


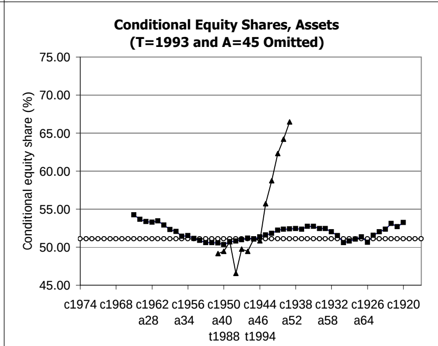




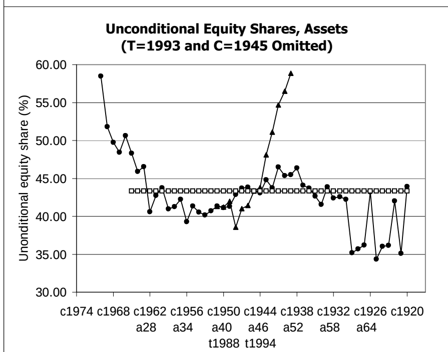
Cohort Excluded

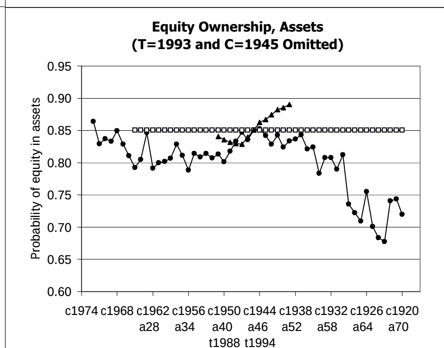


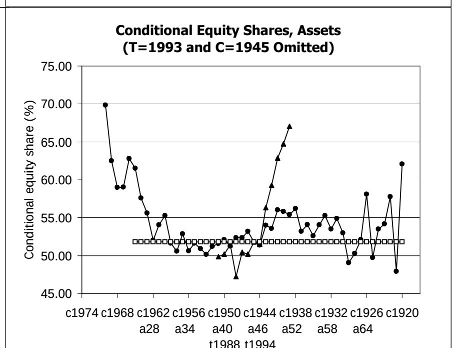




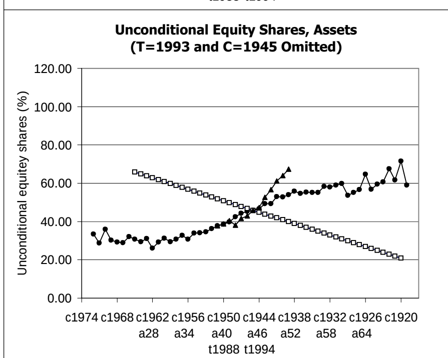
Age Excluded







Δ Age = -1



Age effects are shown as **squares.**
Cohort effects are shown as **circles**.
Time effects are shown as **triangles**.

In all charts, restricted or eliminated effects are shown as outlined symbols of the relevant shape.