PORTFOLIO CHOICE, TRADING, AND RETURNS IN A LARGE 401(K) PLAN

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Abstract

This paper examines portfolio choice, trading behavior, and realized rates of return following a panel of nearly seven thousand 401(k) retirement accounts during the April 1994-August 1998 time period. The distribution of equity allocations in the panel is strongly bi-modal: 48% of the average annual equity allocations in the panel are zero, while 22% of the allocations are 100%. The overall average allocation to stocks is 41%. Regression results show patterns of stock allocations by marital status, earnings, age, and seniority that are broadly consistent with the implications of normative models. Stock allocations are higher for married investors and for investors with higher earnings and more seniority on the job; stock allocations are lower for older investors. The evidence on trading activity indicates very limited portfolio reshuffling, in sharp contrast to existing evidence from discount brokerage accounts: Over 87% of the annual number of trades in the panel are zero, and only 7% of the observations exceed one. This evidence is consistent with the implications of models of optimal portfolio choice with fixed transaction costs. Daily changes in equity allocations correlate only weakly with same-day equity returns and do not correlate with future equity returns. This evidence suggests that investors take only partial advantage of the wildcard option in equity-fund shares and are not able to time the market.

1. Introduction

Recent papers by Barber and Odean (1998, 2000) and Odean (1999) provide evidence on trading activity and portfolio performance of individual investors. Three behavioral implications emerge from their analysis: individual investors tend to trade too much (Odean, 1999), trading impairs realized portfolio returns (Odean 1999 and Barber and Odean 2000), and men trade significantly more than women (Barber and Odean 1998). These issues are important since assumptions about individuals' motives and trading behavior underlie all existing models of asset market equilibrium. Yet, these papers investigate a narrow subsample of individual investors: those who hold discount brokerage accounts. Because "overconfident" investors with an appetite for trading are likely to self-select into this sample, it may not be representative of the investor population at large.

Hence, it is useful to ask whether the stylized facts from previous research extend to broader classes of individual investors. Participants in 401(k) plans, for example, represent another potential database. Currently, about one-third of all workers (over 25 million) are enrolled in 401(k) plans, managing over $1 trillion in funds, and most plans allow for easy reshuffling of portfolios from one asset class to the other.

This paper follows a panel of nearly seven thousand 401(k) accounts from a single plan for a period of over four years, from April 1994 through August 1998. The plan data include detailed information on participants' trading activity and asset allocations. The data also include demographic and employment information such as gender, age, marital status, salary, and tenure on the job.

Three main results emerge from the analysis of summary statistics for the plan. First, the distribution of allocations to stocks is strongly bi-modal: 48% of the average annual equity allocations are zero, while 22% are 100%. Second, patterns of stock allocations by marital status, earnings, and job seniority are broadly consistent with the implications of normative models: Stock allocations are higher for married investors and for investors with higher earnings and more seniority on the job.[1] Third, trading by participants is infrequent: Over 87% of the annual number of trades in the panel are zero and only 7% of the observations exceed one; the average number of annual transactions is 0.26, or one trade every 3.85 years, and average annual turnover is 19%. Infrequent rebalancing is consistent with the implications of models of optimal portfolio choice with realistic transaction costs (see, for example, Lynch and Balduzzi, 2000).[2]

This evidence contrasts with existing evidence drawn from discount brokerage accounts: Average annual transactions in our sample are less than one-fifth of the annual transactions in the discount brokerage account examined by Odean (1999), and annual portfolio turnover is roughly one-fourth of the annual share turnover documented by Barber and Odean (2000). There are various possible explanations for this difference, in addition to the sample-selection bias mentioned above.[3] One explanation could be that the range of choices in our 401(k) plan is quite limited: there are only three equity funds and one fixed-income alternative. A 401(k) participant can change his asset allocation, but is completely unable to engage in stock-picking. If most of the trading in discount brokerage accounts is stock-picking, rather than asset allocation, then our results can be

[1] See, for example, Bodie, Merton, and Samuelson (1992) and Jagannathan and Kocherlakota (1996).
[2] Souleles (1999), on the other hand, *estimates* threshold models of securities purchases in the presence of transaction costs.
[3] We thank the referee for suggesting these possible explanations.

reconciled with those of Odean and Barber and Odean. A second explanation could be that the 401(k) assets studied here are only a fraction of the financial assets held by an individual or a household. For example, based on the 1995 Survey of Consumer Finances (SCF), while most equity investment takes place through retirement plans (on average a share of 63%), the average fraction held directly (brokerage accounts) is a still substantial 19%.[4] Hence, it is possible that the same investor would trade frequently through his brokerage account, but would rebalance his 401(k) asset holdings infrequently.[5]

Regression tests examine how demographics and other characteristics jointly affect allocations, trading, and equity portfolio returns. Males invest more in equities than women. They also trade more actively and realize lower returns on their equity portfolios than their female counterparts. Married investors invest more in equities and churn their portfolio more than their single counterparts. A higher salary tends to make investors more aggressive in their allocations, increases trading activity, and reduces equity portfolio returns. Age induces investors to allocate less to equities and to rebalance more frequently. Older investors also realize higher returns on their equity portfolios.

In addition to the effect of participants' characteristics on portfolio choices, trading, and portfolio performance, we examine whether investors reacted to contemporaneous and lagged market changes (feedback trading) or whether they were able to anticipate market movements (market timing). We perform these tests at the daily frequency by investigating the time series properties of returns on participants' equity

[4] Ameriks and Zeldes (2000).

[5] Note, though, that while reallocating the 401(k) plan is free, commissions are incurred for trades in a brokerage account. This suggests that there should be *more* trading in the 401(k) account, all other things equal.

portfolios and of changes in participants' equity allocations. We find that changes in equity allocations correlate significantly and positively with the previous day's equity return, 0.31, while the correlation with the contemporaneous return is much weaker and not significant, 0.12. Hence, investors react with a lag to market developments, and take only partial advantage of the wildcard option in mutual-fund shares (Chalmers, Edelen, and Kadlec, 1999). The correlations between allocation changes and returns over the following two days are small, negative, and insignificant, suggesting the absence of market-timing abilities.

Our study joins Ameriks and Zeldes (2000) in relating retirement-account portfolio behavior to various demographic variables and other participants' characteristics. Ameriks and Zeldes consider pooled cross-sectional data from the 1962-63, 1983, 1989, 1992 SCF, and a panel data of TIAA-CREF accounts for the 1987-1996 period. Our study differs from theirs in two main respects. First, Ameriks and Zeldes focus exclusively on the effects of age on equity allocations. Our study considers the effects of several additional demographic variables and other characteristics, such as gender, marital status, time in the plan, salary, and time on the job. Second, Ameriks and Zeldes focus their analysis on the effects of age on equity allocations. Our study considers the effects of participants' characteristics on trading activity and equity portfolio performance, in addition to equity allocations.

Other existing studies of 401(k) and other retirement plans (e.g. Bajtelsmit and VanDerhei, 1997, Bodie and Crane, 1997, Hinz, McCarthy, and Turner, 1997, and Sundén and Surette, 1998), focus on asset allocation choices *at one point in time*. What distinguishes our study and Ameriks and Zeldes (2000) from the previous literature is that we follow the plan participants *over time*. The time-series dimension allows us to investigate how equity allocations change as individuals age and gain seniority on the job. The time-series dimension also allows us to model individual equity allocations as a function of common time effects. Finally, we are able to investigate trading activity and portfolio performance, which can only be measured over a period of time.

This paper is organized as follows. Section 2 describes the data set. Section 3 presents summary statistics concerning asset allocation decisions, trading behavior, and returns. Section 4 describes the regression results. Section 5 concludes.

2. Data

The data in this study come from the 401(k) plan for a large firm. The data set includes information on 6,778 participants for the time period April 1994-August 1998.[6] The plan data set originally included information for a larger sample. From this data set, individuals who were eligible but not participating in the plans were eliminated. We also eliminated participants who were no longer in the plan as of April 1994. Further, participants were eliminated due to data errors.[7] Finally, we eliminated participants who were in the plan for less than one full year, and we consider year/participant observations as valid only if the participant was in the plan for the whole year.[8] The reason for this choice is that observations for a fraction of a year can introduce substantial noise in the analysis. For example, consider a participant who is in the plan only for one month

[6] State Street Global Advisors generously supplied the data used for this study.
[7] Some individuals did not have unique participant numbers making it difficult to match demographic and employment information with trading activity. Some participants were deleted because at some point in time their asset allocation percentages did not sum to 100%; and other participants were eliminated because of missing plan entry dates.

during a given year, and rebalances his allocations once during that month. The annualized figure would be 12 annual trades. This is most likely to exceed the annual number of trades for that participant had he been in the plan for the whole year. A similar problem arises when we consider measures of returns on equity portfolios. In this case we eliminated participants who had equity investments for less than one full year, and we consider year/participant observations as valid only if the participant had a positive equity allocation for the whole year. This further reduces the sample to 3,954 participants. The plan data include detailed information on participants' trading activity and asset allocations.[9]

2.1 Participants' Characteristics

Descriptive statistics on the demographic characteristics of the participants are presented in Table 1. Marital status and age are measured as of August 1998, while salary is the 1997 annual salary measured as of October 1997.

The majority of the individuals in the sample are males (78%) and married (76%). The average salary is $69,389. Almost three-quarters of the participants stay in the plan for the entire time period. The remaining one-quarter, either enter the plan after April 1, 1994 and remain until the end of the time period; are in the plan as of April 1, 1994 and leave before August 1998; or enter the plan after April 1, 1994 and leave before August

[8] Participants who were in the plan only in 1994 and 1998 were eliminated if they were not in the plan from April to December and from January to August, respectively.

[9] Although the plan existed before April of 1994, data before this date is not relevant to this study. Before April 1994 participants were only able to invest in Guaranteed Investment Contracts (GICs), thus eliminating the possibility of studying any trading activity or asset allocation choices during this time period. In addition to the 401(k) plan, the plan's sponsor offers participants a defined benefit plan. There is no specific information available related to this defined benefit plan because it is not administered through State Street Global Advisors.

1998.[10] The average age of plan participants is 40 years old. On average participants have been employed by the company for approximately 9 years.

To explore how representative our sample is relative to the U.S. population, Table 2 compares earnings by age group in our sample to earnings by age group from the Current Population Survey (CPS) 1997 data. Our sample differs from the U.S. population in two main respects. First, for all age groups, participants in our plan earn substantially higher salaries than the population in general: two to three times higher. Second, although median salaries peak with the 45-54 age group for the U.S. population, they peak with the 55-64 age group for our sample. Finally, while for the U.S. population the 65+ age group earns the lowest median annual salary, in our sample the oldest age group earns the second-highest salary. Hence, we are considering a sample of investors who earn substantially more than the rest of the U.S. population, and the association between age and income is more strongly positive.

2.2 Investment Choices

The plan offers participants four investment choices: a Guarantee Income Contract (GIC) fund; a large-stock domestic equity fund; a small/medium-stock equity fund; and an international equity fund. Alternatively, participants can invest in one of four pre-mixed "balanced" portfolios comprised of the previously mentioned funds.

Summary statistics for the rates of return on the three basic equity funds are presented in Table 3.[11] For each year we calculate the continuously-compounded rate of

[10] Note that this study considers a participant out of the plan when the participant receives his/her first distribution unless an allocation change occurs after the distribution. In that case, the last allocation change after the first distribution is considered the last date in the plan. A distribution can occur before or after the participant's termination date if it exists.

return on a fund. For each year, we also calculate the standard deviation of the monthly returns and the Sharpe ratio, defined as the ratio between the average monthly return, in excess of the average one-month T-bill rate, and the standard deviation of the monthly returns.[12]

The large-stocks fund is the best performer, both on a simple and risk-adjusted basis. Annual returns on large stocks vary between 3.24% and 31.26% per year. Sharpe ratios vary between –2.89% and 136.55%. Returns on small/medium stocks vary between –26.86% and 34.74%, with Sharpe ratios between –34.36% and 95.81%. International stocks have returns between –7.39% and 11.58%, with Sharpe ratios between –35.08% and 26.61%.

For the purpose of this study, participants' asset choices are divided into two main categories: equity investments and bond investments. Investment in the GIC fund is considered a bond investment while investment in the large-stock domestic equity fund, small/medium domestic equity fund, or international equity fund are considered equity investments. If a participant chooses to invest in a pre-mixed balanced fund, the investment is divided according to the asset breakdown for that fund.

The plan allows participants to freely change their asset allocations on a daily basis. When the asset allocation is changed, the participants' funds are redistributed to match the new allocation and all future contributions by the participant are invested according to the new allocation. The plan data include a record of the date of the allocation change and the new and old allocations.

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[11] The annual rates of return on the GIC fund, not reported, are very stable through the five years, varying between 6.2% and 6.65%. Volatility of monthly GIC returns within the year is also minimal, ranging between 4 and 7 basis points.

[12] Returns for 1994 and 1998, which are not full years, are *annualized*.

In our analysis we consider both *desired* and *actual* allocations. Desired allocations are the fractions of *new contributions* invested in the different asset classes. Actual allocations are the fractions of the *existing assets in the account* invested in the different asset classes. Desired and actual allocations coincide immediately after a rebalancing, but then tend to drift apart because of the different returns on the different funds.

3. Allocations, Trading, and Equity Portfolio Performance: Summary Statistics

This section summarizes asset allocation choices, trading behavior, and portfolio performance. This evidence is a "nonparametric" description of the data set, which usefully complements the regression analysis of the following section.

We present summary statistics for the panel data set to be used in the regression analysis. For asset allocations and trading measures, we follow the 6,778 participants for five years, for a total of 28,775 observations. For measures of equity portfolio performance, we follow the 3,954 individuals who held equities for at least one entire year, for a total of 12,464 observations.

Each table is organized in two panels. Panel (a) presents the frequency distribution of all the observations in the panel data set. The observations are then sorted by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). Means and standard deviations for these subsamples are presented in Panel (b) of each table.[13]

3.1 Equity Allocations

Table 4 shows annual averages of monthly desired equity allocations. We focus on desired equity allocations, rather than actual allocations, because they are more likely to reflect a participant's intentions. Most average annual allocations are at the two extremes of the admissible range:[14] 47.61% of the equity allocations in the panel are zero, while 21.73% of the allocations are 100%. Hence the distribution is strongly bimodal. The overall average allocation to equities is 40.54%, with a standard deviation of 43.08%.

Asset allocations vary over time with a marked positive trend: the average annual equity allocation monotonically increases from 28.07% in 1994 to 55.55% in 1998. It appears that participants responded to the bull market of 1994-1998 by adjusting their allocations upwards.[15]

Asset allocations also vary systematically with participants' characteristics. First, the average equity allocation is significantly higher for men than for women: 42.45% as opposed to 33.37%.[16] Second, marital status matters.[17] The average allocation for

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[13] We also calculated medians by subgroups. These are not reported in the tables. In the case of equity allocations and measures of equity portfolio returns, medians by subgroup tend to follow the same patterns as the means. In the case of measures of trading activity, medians are almost always zero, and hence are not informative.

[14] Investors cannot take short positions within the plan.

[15] The cumulative return on the S&P 500 index for that period was 137%.

[16] We test the equality of means by regressing observations on a constant and one or more dummies. The coefficient(s) on the dummies capture the difference in means. Statistics in all tests in the paper are adjusted for serial correlation and heteroskedasticity. The serial-correlation adjustment allows for correlation of moving-average form in the yearly observations from the same participant. By (marginally)

married participants is 42.88%, while the average for single participants is 36.52%. One possible explanation for this pattern has to do with idiosyncratic labor-income shocks. Couples with dual earners enjoy some diversification of these shocks. This makes a married individual's non-financial income less risky and should induce more aggressive asset allocations relative to single investors. A second possible explanation has to do with the stronger bequest motive for married couples.[18] The bequest motive lengthens an investor's horizon beyond his lifespan and, as argued below, models of optimal portfolio choice predict a higher allocation to equities the longer the time horizon.

Third, a marked variation of allocations exists by salary group. We expect a positive correlation between salary and equity allocation because higher annual earnings translate into a higher stock of human capital. For most individuals, labor income is either risk-free or is dominated by person-specific risk that is only weakly correlated with stock returns. Hence, human capital is a relatively safe investment and investors should compensate for the higher stock of human capital with a higher investment in risky assets, i.e. stocks. A higher annual salary may also be interpreted as a proxy for education and financial sophistication, both of which should correlate positively with the allocation to equities. All these elements predict a positive correlation between salary and equity allocation. This positive correlation arises for all salary ranges, with the exception of the $50,000-$74,999 range. Overall, we have an increase of equity allocations from 30.23% (Under $25,000) to 57.76% ($100,000+).

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significant, we denote a coefficient significantly different from zero at the (5%) 1% level in a two-sided test.

[17] Sundén and Surette (1998) suggest that the interaction between gender and marital status may also play a role. This hypothesis is investigated later on in the regression analysis, where we use as an explanatory variable an interaction dummy for plan participants who are male and married.

[18] We thank Ed Kane for suggesting this point.

Fourth, participants who entered the plan before 1994 tend to allocate significantly less to equities than later entries: 39.97% as opposed to 47.04%. Since participants who entered the plan before were assigned a 100% allocation to the GIC fund by default, this is consistent with some inertia in their revision of asset allocations.[19]

We next investigate how asset allocations vary according to age. Mean allocations initially increase as a function of age and then tend to decrease. Average allocations equal 37.50%, 42.50%, and 44.01% for the participants under 35, 35 to 44, and 45 to 54. For the 55 to 64 group the average allocation declines to 37.85%; while the 65 and older group allocates an average of 4.75% to stocks. This pattern is roughly consistent with the findings of Ameriks and Zeldes (2000). Based on an examination of TIAA-CREF data covering the 1987-1996 period, they show that equity shares in financial assets have a hump-shape pattern with age.[20]

The declining portion of the hump-shape pattern is consistent with models of optimal portfolio choice. As shown by Balduzzi and Lynch (1999) and Lynch and Balduzzi (2000), the time-series properties of U.S. stock returns are such that an investor with long-term objectives tends to allocate a larger fraction of his wealth to stocks than a short-term investor. The positive hedging demand for equity decreases as the investor ages. In addition, asset allocations should change over the life-cycle as a function of the stock of non-tradable human wealth. As argued by Jagannathan and Kocherlachota (1996), when investors are young, they have a long stream of future income. As they age, this stream shortens, so the value of their human capital falls. The best way for investors to respond to this situation is to shift the risk composition of their financial

[19] This is consistent with the findings of Hinz et al. (1997).
[20] This is based on a specification that includes age and time effects, excluding cohort effects.

wealth in order to offset the decline in the value of their human capital. So, most investors need to shift their financial wealth toward bonds and away from stocks as they age to make up for the loss in human capital. In addition, Bodie, Merton, and Samuelson (1992) note that individuals have some ability to change their supply of labor in response to realized returns on their assets: a low return on financial wealth can be partially "hedged" by increasing labor supply. It is reasonable to hypothesize that, for most individuals, the degree of labor flexibility diminishes over the life cycle. For this reason, the effective human capital on which the individual can draw also declines, leading to more conservative investment behavior as retirement nears.

Finally, we investigate the association between tenure on the job and equity allocations. Average equity allocations for employees who were with the company five years or less average at 30.86%. Average equity allocations then steadily increase, to reach 62.34% for participants who were with the company 16 to 20 years. This pattern is consistent with the notion that as seniority increases, so does job security. This makes human capital less risky, which makes it optimal to increase financial exposure to the riskier assets.

When interpreting the allocation decisions, it is important to bear in mind that the 401(k) plan is just one of the assets in a household's overall portfolio. The question is how the allocation of retirement assets compares to the allocation of the non-retirement portfolio. Uccello (2000) uses information from the 1998 SCF and concludes that families tend to invest their retirement saving in a very similar fashion to their non-pension assets. That is, if a participant holds mostly equities in their 401(k) plan, he or she is also likely to hold a similar share of equities in the non-retirement part of the portfolio.

3.2 Trading Activity

Table 5 measures trading activity by the number of times a participant changes portfolio allocations every year. These trades include any reallocations among the eight funds available for investment: the four basic funds and four balanced portfolios.[21]

Since employees who joined the plan before April 1994 started with a 100% allocation to the GIC fund, these participants had to adjust their allocations to invest in equities. Hence, this first trade is very different in nature from all other trades and it is excluded from all measures of trading activity.

About 88% of the annual number of trades are zero: that is no trades. Roughly 6% of the observations are of one trade per year and only 0.19% observations exceed 10 trades per year. Overall, the average number of trades per year is 0.26, or one trade every 3.85 years. These statistics indicate very limited trading activity on the part of the participants in the sample.[22]

Theory tells us that, in the absence of transaction costs, it is optimal for an investor to rebalance his portfolio continuously. On the other hand, fixed transaction costs lead to infrequent rebalancing by discrete amounts. Since no explicit fee is charged when investors in our sample change allocations,[23] the type of transaction costs they face

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[21] Number of trades and turnover for 1994 and 1998, which are not full years, are annualized.

[22] Ameriks and Zeldes (2000) confirm our evidence of limited trading in 401(k) plans. They find that almost half of the investors in a sample of TIAA-CREF accounts made no changes to their allocations during the 1987-1996 period.

[23] Plan fees are charged against the aggregate account balance of participants.

must be *implicit*: the opportunity cost of spending time considering one's portfolio choices, for example.

Hence, it is interesting to ask what number of trades per year is optimal for an investor facing realistic fixed transaction costs. Lynch and Balduzzi (2000) perform this type of exercise. They consider an investor choosing between U.S. stocks and a risk-free asset. The investor has to pay a fixed fee of either 0.01% or 0.1% of the portfolio value ($10 and $100 for a $100,000 portfolio, respectively) for every trade. Lynch and Balduzzi predict that an investor with a 10-year investment horizon who uses the *unconditional* distribution of U.S. stock returns averages 0.37 and 0.16 trades per year, depending on the fee. Hence, the average number of annual trades realized by our investors, 0.26, falls squarely within the range calculated in their paper. Interestingly, they also predict that an investor using the *conditional* distribution of stock returns, hence being aware of predictability, rebalances much more frequently: on average 1.8 and 0.63 times per year. Hence, our sample also provides an indirect indication that investors do not try to time the market, and make rebalancing decisions with the long-run properties of asset returns in mind.

Our evidence on trading frequency seems to contrast with the evidence on discount brokerage accounts reported by Odean (1999). Odean examines trading activity in 10,000 accounts from January 1987 through December 1993, finding that investors trade on average 1.44 times per year, which is 5.5 times higher than in our sample. As argued earlier, this difference might be due to several factors, including sample-selection, and the limited range of investment choices offered in our 401(k) plan.

Trading activity in our sample varies over time with an overall positive trend. While in 1994 there were only an average of 0.16 trades per year, this average grows to 0.34 by 1997, to stabilize at 0.30 in 1998.

We then investigate patterns of trading activity according to participants' characteristics. Males trade a significant 55% more than females, where the average number of annual trades is 0.28 for males and 0.18 for females. Marital status also is significant. Married investors trade significantly more than single investors: an average of 0.28 times a year, as opposed to 0.21 times for their single colleagues.

Trading activity increases with salary. Participants earning less than $25,000 average 0.11 annual trades, while participants with salary in excess of $100,000 average 0.66 trades per year. Presumably, participants earning a higher salary manage a larger portfolio, for which the benefits of rebalancing are more substantial. As argued earlier, salary may also proxy for financial sophistication, which is likely to be positively correlated with trading activity.

Trading activity also increases with age. While participants below age 35 trade on average of 0.17 time per year, participants in the 55-64 age group trade an average of 0.60 times. The exception to this pattern is trading among participants 65 and older, who average only 0.03 trades per year. This higher trading activity among participants closer to retirement is consistent with the notion that as investors age, the investors' financial wealth increases relative to their human capital. This makes the need of an efficient allocation more pressing, hence inducing higher trading activity. The lower trading activity among the oldest plan participants can also be rationalized: these investors are mainly invested (95% on average) in the GIC fund, which is the safest investment option. This makes further trading towards the safe asset unlikely.

Average annual trades tend to increase with job seniority. Employees who are with the company up to 5 years average 0.14 trades per year. In contrast, employees who are with the company for 16 to 20 years average 0.64 trades per year. This pattern is consistent with the notion that higher job security, associated with tenure on the job, leads to more aggressive investing both in terms of the investment choices and rebalancing activity.

Table 6 reports statistics on trading activity as measured by annual portfolio turnover. Portfolio turnover is the total percentage change in a participant's actual allocations during each year in the plan.[24] As with the number of trades, we find evidence of moderate trading activity: most observations, 67.14%, have zero annual turnover and only 5.88% of the observations have more than 100% annual turnover. Average annual turnover for the sample is 18.51%. This figure is about one-fourth of the average annual turnovers reported by Barber and Odean (2000) for their discount brokerage accounts sample, in which turnovers averaged 6 to 7%.

Since turnover correlates strongly with the number of trades, patterns in turnover over time and according to participants' characteristics closely mirror those documented for the number of trades. Turnover increases steadily during the four years of the sample, from 10.42% in 1994 to 24.76% in 1997, and then flattens to 23.86% in 1998. Men rebalance significantly more than women (19.89% *vs* 13.31%) and married participants rebalance significantly more than single participants (19.75% *vs* 15.95%). Interestingly, our evidence on portfolio turnover by gender is very similar to the results of Barber and Odean (1998). They find that average share turnover is 43% higher for men than it is for women in their sample from a large brokerage firm. In our sample, portfolio turnover is 49% higher for men than it is for women. We find that turnover increases with a participant's salary. Turnover also increases with age, with the exception of the 65+ group, and with job seniority.

3.3 Equity Portfolio Performance

Next, we examine the performance of the equity portion of investors' portfolios. We focus on this portfolio, rather than the entire 401(k) portfolio, because the performance of the entire portfolio follows directly from the choice of equity allocations, plus the fact that stocks outperformed GICs for most of the sample period. Hence, by focussing on the returns on the equity portion of an investor's portfolio, we can study portfolio performance after accounting for equity exposure.

Equity portfolio performance is measured in two ways. We calculate continuously-compounded annual returns on equity portfolios for each year/participant.[25] We also calculate Sharpe ratios, which are obtained by dividing the average monthly return, in excess of the average one-month T-bill rate, by the standard deviation of monthly returns for that year/participant.

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[24] In practice, we calculate individual turnover as follows. We sum up of the absolute values of the changes in allocations across all funds for each trade and we divide this sum by two. The change is calculated with respect to the *actual* allocations before the trade.

[25] Equity returns are calculated based on the *actual* equity allocations. Equity returns for 1994 and 1998 are annualized.

Table 7 presents summary statistics for annual equity portfolio returns. The frequency distribution shows a substantial variation in annual equity returns. This variation results both from variation of returns over time, and variation of allocations across investors.

Two patterns of returns emerge from the table. First, with the exception of the Under $25,000 group, higher-earning investors tend to realize higher returns: participants with salary between $25,000 and $49,999 realize an average return of 4.59%, while participants with salary above $100,000 realize average returns in excess of 9%. Second, participants who entered the plan before April 1994 tend to earn higher returns than later entries: 9.21% compared to 5.15%. Hence, the ability to invest in equities seems to improve with salary and familiarity with the plan. Since these two characteristics are likely to be correlated, we must wait for the regression analysis of the next section to draw any conclusions.

Table 8 presents summary statistics for equity portfolio Sharpe ratios. The average Sharpe ratio is 20.08% with a standard deviation within the sample of 37.49%. The patterns in Sharpe ratios largely mirror those in average returns: Sharpe ratios tend to increase with salary and early entry in the plan. In addition, married investors realized better Sharpe ratios than single participants: 20.54% as opposed to 17.90%.

4. Regression Analysis

The regression analysis relates asset allocation choices and trading activity to common effects and participants' characteristics. The constant and time-varying common effects are captured by a constant and by four year dummies for the years 1995, 1996, 1997, and

1998 (these are indicator variables that for each participant equal one in a particular year, zero otherwise). We then consider demographic and earnings characteristics. The following participant's characteristics are constant over time:

- "Male:" indicator variable equal to one if the participant is male, zero otherwise;
- "Married:" indicator variable equal to one if the participant is married, zero otherwise, as of August 1998;
- "Married*Male:" indicator variable equal to one if the participant is married *and* male, zero otherwise;
- "Salary:" 1997 annual salary, as of October 1997 (unit: ten thousand dollars);
- "Pre-94:" indicator variable equal to one if the participant was in the plan before April 1994, zero otherwise.

A second set of participants' characteristics varies over time:

- "Age:" age of the participant as of year of observation (unit: years);
- "Time Employed:" time the participant has been with the company as of year of the observation (unit: years).

The explanatory variables above essentially correspond to the criteria used to sort observations in the panel data set in the previous section. Note that since some observations for some of the explanatory variables are missing, we have to further reduce our sample. For the equity allocation and trading regressions, we follow 6,023 participants (N) for an average of 4.4 years (T-bar), for a total of 26,722 observations. For the equity portfolio return regressions, we follow 3,802 (N) participants for an average of 3.2 years (T-bar), for a total of 12,143 observations.

4.1 Average Equity Allocations

We relate average annual equity allocations to the explanatory variables listed above. Since equity allocations are restricted to be between zero and one, we use a *censored regression* model. Let s_{it} denote the percentage allocation to equities. We assume

$$
\begin{aligned}
s_{it} &= x_t\beta + y_i\gamma + z_{it}\delta + \varepsilon_{it}, \text{ if } 0 < s_{it} < 1; \\
s_{it} &= 0, \text{ if } x_t\beta + y_i\gamma + z_{it}\delta + \varepsilon_{it} \le 0; \qquad (1) \\
s_{it} &= 1, \text{ if } x_t\beta + y_i\gamma + z_{it}\delta + \varepsilon_{it} \ge 1 .
\end{aligned}
$$

x_t is the row vector of realizations of the explanatory variables which are common to all participants (constant and year dummies); y_i is the row vector of *constant* participants' characteristics (gender, marital status, salary, time of entry); z_t is the row vector of realizations of *time-varying* participants' characteristics (age and seniority); β, γ, and δ are conforming column vectors of coefficients; ε_{it} is a normally-distributed error term.

Note that our approach in estimating the demand function for equities differs from that of Ameriks and Zeldes (2000) in several respects. First, Ameriks and Zeldes estimate two separate demand function models: A probit selection model describes the probability of equity ownership, while a linear model describes equity shares conditional on ownership. In our approach, we model jointly the decision of holding equities and the decision of how much equity to hold. This seems more appropriate since the same variables determine whether to hold equities and how much equities to hold. Second, Ameriks and Zeldes estimate fixed-effects models, hence leaving the constant heterogeneity across participants unexplained. Since our data set has information on participants' characteristics in addition to age, we explicitly model the heterogeneity in terms of the variables y_i. Third, the two panel data sets considered by Ameriks and Zeldes cover longer time periods than our sample. This creates an identification problem between cohort and time effects, and hence creates the need to separately estimate a model with age and time effects and a model with age and cohort effects. Since our panel covers only a period of roughly four years, cohort effects are unlikely to be relevant, and we estimate models with age and time effects only.

Results of the regressions are presented in Table 9. The model shows a low pseudo R-squared of 4.19%, but the joint significance of the explanatory variables is high. The high number of censored observations (roughly twelve-thousand left censored and six thousand right-censored) confirms the appropriateness of the censored-regression model. In the following, we discuss the significant effects that we document.[26]

The year dummies, all significant, show an upward trend in equity allocations, confirming the findings of Table 4. Male participants invest more in equities than their female counterparts: 19.13% more. This effect is consistent with the summary-statistics evidence in Table 4 and confirms the results of other authors. Hinz, McCarthy, and Turner (1997), for example, find that women invest more conservatively than men, after controlling for other demographic characteristics, using data from the Federal Government's Thrift Savings Plan. Similar findings are noted by Baijtelsmit and VanDerhei (1997), who use data from one large 401(k) plan, and by Sundén and Surette (1998), who use data from the 1992 and 1995 SCF.[27] Married participants also invest more in equities: the difference in allocations relative to their single counterparts is

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[26] By (marginally) significant we denote a coefficient different from zero at the (5%) 1% level in a two-sided test. This corresponds to a critical value of $(\pm 1.96) \pm 2.58$ for the t-ratio.

14.44%. Salary increases the equity allocation by 1.77% for each $10,000 of extra income. This effect confirms the pattern documented by Bodie and Crane (1997) on the basis of summary statistics for different net-wealth groups.

Having entered the plan before April 1994 reduces the equity allocation by 31.92%. As we noted earlier, participants who were in the plan before April 1994 maintained their all-GIC allocation unless they submitted a trade to change it. Hence, the pre-94 effect hints at a substantial inertia in revising asset allocations.

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.[28] This is remarkably close to the practitioners' rule of thumb of decreasing one's equity exposure by 1% for each additional year of age. Seniority on the job has a separate and opposite effect relative to age: one more year with the company leads to an extra 5.27% allocated to equities. This is consistent with the notion that higher job security makes an investor's human capital safer, and this can be compensated for by a higher allocation to equities.

4.2 Annual Number of Trades

Let n_{it} denote the number of annual trades by the individual i in year t. Since this dependent variable is a count variable, we implement a negative-binomial regression model. The negative binomial model is a variation of the Poisson model, where the Poisson parameter is assumed to be itself drawn from a Gamma distribution. The

[27] Lewellen, Lease, and Schlarbaum (1997) report similar results for a sample of brokerage accounts.

[28] We also estimated a specification including both age and age squared, to capture possible non-monotonicities in the relation between equity allocations and age. The coefficients on the two terms, both significant, are such that the equity allocation implied by the model peaks very early, at 32.5 years of age. Hence, the overall negative association between equity allocations and age from the linear model is confirmed by a nonlinear specification.

negative binomial model encompasses the Poisson model as a special case, and allows for more dispersion than the Poisson distribution. Specifically, we have

$$pr(n_{it}) = \int_0^\infty \frac{1}{n_{it}!} e^{-\lambda_{it}} \lambda_{it} dF(\lambda_{it}; \phi_{it}, \eta). \tag{2}$$

Hence, the probability density of observing n_{it} annual trades equals the expectation of a Poisson density with parameter λ_{it}, where the parameter λ_{it} is distributed following a Gamma distribution $F(\lambda_{it}; \phi_{it}, \eta)$. The first parameter of the Gamma distribution is modeled as a function of the explanatory variables x_t, y_i, and z_{it}. In particular, we have

$$\phi_{it} = e^{x_t\beta + y_i\gamma + z_{it}\delta}. \tag{3}$$

Hence, the Poisson parameter λ_{it} has expectation $E(\lambda_{it}) = \phi_{it} / \eta$ and variance $V(\lambda_{it}) = \phi_{it} / \eta^2$, while the annual number of trades has expectation $E(n_{it}) = \phi_{it} / \eta$ and variance $V(n_{it}) = \phi_{it}(1+\eta)/\eta^2$. Therefore, the variance-to-mean ratio of the negative binomial equals $(1+\eta)/\eta$: the negative binomial specification allows for over-dispersion, with the original Poisson a limiting case as $\eta \to \infty$. The parameters β, γ, and δ are the partial derivatives of the log of the number of trades predicted by the model with respect to the explanatory variables. For further discussion of the negative binomial model, see Hausman, Hall, and Griliches (1984).[29]

Results of the negative binomial regression are presented in Table 10. While the fit of the regression is a low 2.80% pseudo R-squared, the explanatory variables are strongly jointly significant. The regression model shows an overall positive trend in

[29] We also estimated a Poisson regression model, although the null of a Poisson distribution is strongly rejected in our sample. The estimates from the Poisson models are very close to those obtained with the negative binomial model, both in magnitude and significance.

trading activity over the years, confirming the summary-statistics evidence of Table 5. In addition, being male has a (marginally) significant and positive effect on the number of trades. A single male participant trades 28.27% more than a single female participant. Salary has a small, but significant impact on trading activity: a salary increase of $10,000 increases trading by 2.25%. Age has a small but significant effect: one more year of age increases trading by 1.42%. Finally, time employed stronger and significant effect. One more year of employment increases trading by 6.93%.

The effects documented above qualify and complement the patterns identified in the discussion of the summary statistics. In particular, we find that being married, while still having a positive impact, is now insignificant.

4.3 Annual Portfolio Turnover

Let v_{it} denote the annual turnover of participant *i* in year *t*. We model turnover as a linear function of the explanatory variables, as long as turnover is strictly positive. This is again a censored regression model where

$$v_{it} = x_t\beta + y_i\gamma + z_{it}\delta + \varepsilon_{it} \text{ if } v_{it} > 0 \text{, and } v_{it} = 0 \text{ otherwise.} \quad (4)$$

The error term is normally distributed. Table 11 presents estimation results for the model in (4).

The pseudo R-squared is 3.19% and the explanatory variables are strongly jointly significant. As with the number of trades, we find evidence of an overall increase in trading activity over the five years of our sample. Male now has both a positive and significant effect: annual turnover is higher by 28% for males than it is for females. Being married also affects turnover positively, by 18.25%, although the effect is only marginally significant. An increase in salary by $10,000, increases turnover by 5.11%. As with number of trades, having entered the plan before April 1994 reduces trading activity. In this case the effect is quite strong: -39.85%. Finally, seniority on the job increases turnover by 5.55% for each additional year on the job.

4.3 Equity Portfolio Performance

Let r_{it} denote the annual return on the equity portfolio of participant *i* in year *t*. We model returns as a linear function of the explanatory variables,

$$r_{it} = x_t \beta + y_i \gamma + z_{it} \delta + \varepsilon_{it} . \qquad (5)$$

Table 12 presents results of a standard least-squares regression. We find several significant effects and the fit of the regression model is quite good: 88.70%. As one would expect, the year dummies are strongly significant and capture most of the variability of annual returns.

Being male affects annual returns negatively, with a marginally significant effect: 42 basis less than female counterparts. Salary has a smaller but more significantly negative effect on returns: a $10,000 increase in annual salary reduces annual returns by two basis points. From tables 10 and 11 we know that males and higher earners tend to trade more frequently and by larger amounts. Hence, this evidence seems to confirm the notion that trading has a negative impact on portfolio performance, as shown by Barber and Odean (2000) in the context of discount brokerage accounts. Finally, age has a positive, small, but significant effect: an increase of 2 basis points in annual return for each additional year of age. Hence, it appears that older investors are better managers of their equity portfolios.

Relative to the summary statistics of Table 7, the regression results show a significant difference between the performance of males and females. Moreover, after controlling for age, salary has a *negative*, rather than positive effect on returns.

Let SR_{it} denote the Sharpe ratio of the equity portfolio of participant *i* in year *t*. As with returns, we model Sharpe ratios as a linear function of the explanatory variables,

$$SR_{it} = x_t \beta + y_i \gamma + z_{it} \delta + \varepsilon_{it} . \tag{6}$$

Table 13 presents the results of least-squares regression. The fit of the model is again extremely good, 90.83%, mainly driven by the year dummies.

The effects of participants' characteristics are similar to those documented for raw returns. Salary reduces Sharpe ratios by 12 basis points, while early entry in the plan reduces Sharpe ratios by 1.29%. Age, on the other hand, increases Sharpe ratios by 8 basis points. Hence, it appears that older participants are indeed better managers of their equity portfolios, even after adjusting for risk.

Being male has now an insignificant negative effect, -1.28%. This measure is interesting, though, because it is remarkably close to what was found by Barber and Odean (1998). In their sample, men, who trade more than women, realize Sharpe ratios which are 1.4% less than those earned by women.

5. The Timing of Changes in Equity Allocations

In this section, we study the timing of changes in equity allocations, to determine whether the investors in our sample were reacting to contemporaneous and lagged returns on their equity portfolios (feedback trading), and whether they were able to successfully anticipate future market movements (market timing). In particular, we want to determine whether investors took advantage of the wildcard option in mutual-fund shares (explained later in this section), documented by Chalmers, Edelen, and Kadlec (1999).

To perform this analysis we construct a daily data set of changes in equity allocations and returns on equity portfolios. To measure the overall flows of funds in and out the equity funds, we calculate the change in the *average* desired allocation to equities among all the individuals in the plan on a given day. The daily equity return is the weighted average of the returns on the three basic equity funds, where the weights are the average percentage allocations across plan participants at the beginning of the month. This data set contains 1,152 daily observations for the April 1994-August 1998 period.

Let $\Delta\bar{s}_t^*$ denote the change in the average desired equity allocation between day $t-1$ and day t, and let $\bar{r}_t$ denote the average return on the participants' equity portfolio during the same period. We calculate autocorrelation coefficients, $\rho(\Delta\bar{s}_t^*, \Delta\bar{s}_{t-k}^*)$ and $\rho(\bar{r}_t, \bar{r}_{t-k})$, and cross-correlation coefficients $\rho(\Delta s_t^*, \bar{r}_{t-k})$. Estimates are reported in Table 14.

We find that changes in equity allocations display positive serial correlation. In particular, at a one-day lag (Lag 1) the correlation is a significant 0.27. Autocorrelation coefficients at longer lags, while still overall positive and significant, are much smaller. This persistence in allocation changes is consistent with the notion that some participants react immediately to news, while other participants react with one or more days of delay.

Average equity returns also display some positive serial correlation: the autocorrelation coefficient at the one-day lag is a significant and substantial 0.22, but correlation coefficients at all other lags are insignificant and take mainly negative values. As argued by Kadlec and Patterson (1999), more than 50% of the positive autocorrelation in portfolio returns could be due to the effect of stale pricing: fund shares are marked to market based on the closing prices of the underlying equities. Closing prices are, in turn, almost always the price of the last trade in the stock. For infrequently-traded stocks, this tends to increase the persistence in prices, and hence generate positive serial correlation in returns. This apparent persistence in prices is lost as soon as the stock is traded again and it is marked to market with the transaction. Hence the quick decay in the autocorrelation of equity-fund returns.

Note that the autocorrelation in individual stock returns induced by stale prices is essentially an illusion: attempts to trade the stale-priced stocks are likely to refresh the asset's price to its appropriate level. In the case of mutual fund shares, on the other hand, the readjustment effect associated with trading does not occur. In fact, Chalmers, Edelen, and Kadlec (1999) argue that mutual funds provide their shareholders with a valuable wildcard option. In our plan, for example, all transactions completed by 4:00 p.m. EST receive that day's closing prices.[30] If investors take advantage of this option, we should see a strong positive contemporaneous correlation between changes in equity allocations and equity returns: investors know that equity returns are positively correlated, and they should take advantage of this effect by increasing (decreasing) their equity exposure when returns are high (low).

We can test this proposition by looking at the cross-correlation coefficients between allocations and returns. The results are presented in the third panel of Table 14. We find that changes in equity allocations correlate positively with contemporaneous returns (Lag 0), but the correlation is small, 0.12, and not significant. On the other hand, there is a strong and significant correlation between allocations and returns at a one-day lag: 0.31. The correlation at a two-day lag is marginally significant and positive, 0.13. Since the autocorrelation of equity returns dies off very quickly, this lagged response of allocations to returns does not generate profits. Hence, our investors react with a lag to market developments and take only partial advantage of the wildcard option offered by mutual funds. These findings are consistent with Chalmers, Edelen, and Kadlec (1999), who study flows in over 1,000 U.S. mutual funds during the 1998-1999 period.

As a final test of the investing ability of our investors, we can look at the correlations between current equity-allocation changes and equity returns over the next few days. If our investors are successful market-timers, the correlations should be positive. The cross-correlations at lead 1 and 2 reported in Table 14 are negative, small, and insignificant. The cross-correlation at lead 3 is essentially zero. This suggests that our investors were not successful market timers.

6. Conclusions

This paper examines a new data set documenting the allocations, trading activity, and portfolio performance of a large number of participants in a 401(k) plan. Plan participants tend to cluster their equity allocations around zero and 100%, and trading activity is very modest. Some patterns of portfolio choice and trading activity by marital status, salary, and job seniority are broadly consistent with the implications of models of rational choice.

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[30] The international funds prices reflect the closing prices of the international markets but also reflect the currency conversion at 4:00 p.m. EST.

Regression analysis shows how asset allocations and trading activity vary with demographics and other participants' characteristics: Men invest more in equities and trade more frequently than women. Married investors invest more aggressively and churn their portfolios more than their single counterparts. A higher salary leads to higher equity allocations and more active trading. Age makes investors more "cautious" in their allocations. Older participants also trade more frequently than their younger counterparts.

Tests based on daily data show that investors in our sample tend to react with a one-day lag to market developments. In addition, they take only partial advantage of the wildcard option in equity-fund shares and are not able to time the market.

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Table 1. Descriptive Plan Statistics

The table describes general statistics concerning the plan participants: gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), entry and exit in and out of the plan, age (as of August 1998), and time employed (as of August 1998).

	Obs	Percent	Mean	Std.	Min	Max
Gender:						
Male	5,298	78.16				
Female	1,478	21.81				
Unknown	2	0.03				
Total	6,778	100.00				
Marital Status:						
Married	5,123	75.58				
Unmarried	1,439	21.23				
Unknown	216	3.19				
Total	6,778	100.00				
Married and Male	4,292	63.33				
Salary:	6,024		$69,389	$35,353	$13,384	$1,404,031
Entry-Exit:						
In Plan Entire Time	4,783	70.57				
Enter Plan Late	951	14.03				
Leave Plan Early	999	14.74				
Enter Late and leave Early	45	0.66				
Total	6,778	100.00				
Age:	6,699		39.94	8.32	19.88	76.84
Years Employed:	6,778		9.31	4.59	0.00	17.94

Table 2. Comparison of Age-Salary Structure for U.S. Population and 401(k) Sample

The table presents a comparison between the median salary by age group for the U.S. population at large and the 401(k) plan participants. The source for the U.S. population data is CPS 1997.

Age Range	Median 1997 Salary: U.S. Population	Median 1997 Salary: 401(k) plan
Under 35 years old	$22,846	$62,835
35-44 years old	$30,880	$64,470
45-54 years old	$33,106	$68,649
55-64 years old	$29,434	$73,450
65+ years old	$21,032	$69,813

Table 3. Returns on Equity Investment Choices

The table presents summary statistics for the returns on the three equity investment choices: large stocks, small/medium stocks, and international stocks. The table reports returns (r), volatility of monthly returns (σ**),** and Sharpe ratios (SR) for each year in the sample. All variables are in percents.

	Large Stocks			Small/Medium Stocks			International Stocks		
Year	r	σ	SR	r	σ	SR	r	σ	SR
1994	8.89	3.36	12.40	3.16	3.73	-1.65	-7.39	2.68	-35.08
1995	31.26	1.57	136.55	34.74	2.54	95.81	4.05	2.59	-4.37
1996	17.86	3.61	29.78	12.35	4.80	12.76	11.58	2.06	26.61
1997	25.82	4.36	39.58	13.50	5.73	12.20	6.89	3.43	4.33
1998	3.24	5.13	-2.89	-26.86	7.66	-34.36	-1.15	6.29	-8.12

Table 4. Equity Allocations

The table presents statistics for average annual equity allocations (in percents). In Panel a, we consider the frequency distribution of the observations in the panel. In Panel b, we sort observations by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). For each sorting, we test the null hypotheses that the mean of each sub-category equals the mean of the reference sub-category (bold). One (two) asterisk(s) denote rejection in a two-tailed test at the 5% (1%) significance level. Test statistics are adjusted for serial correlation and heteroskedasticity.

Panel a: Distribution

Range	Percent
$x = 0$	47.61
$0 < x < 20$	1.95
$20 \le x < 40$	4.00
$40 \le x < 60$	6.59
$60 \le x < 80$	11.10
$80 \le x < 100$	7.01
$x = 100$	21.73

Panel b: Statistics by Group

	Obs	Mean		Std.
All	28,755	40.54		43.08
Sort by Year:				
1994	5,782	28.07		39.52
1995	5,704	30.23	**	39.86
1996	5,857	40.68	**	42.68
1997	5,679	48.27	**	43.16
1998	5,733	55.55	**	43.60
Gender:				
Male	22,737	42.45		43.27
Female	6,008	33.37	**	41.59
Unknown	10	0.00		0.00
Marital Status:				
Married	22,237	42.88		43.15
Unmarried	5,779	36.52	**	42.72
Unknown	739	1.34		9.68
Annual Salary:				
Under $25,000	141	30.23		38.82
$25,000-$49,999	1,291	43.30	*	43.81
$50,000-$74,999	18,898	37.86		42.60
$75,000-$99,999	4,861	56.25	**	42.46
$100,000+	1,532	57.76	**	39.67
Unknown	2,032	13.83		30.94
Time of Entry:				
Pre-1994	26,438	39.97		43.00
Post-1994	2,317	47.04	**	43.42
Age:				
Under 35 years old	10,238	37.50	**	43.06
35-44 years old	12,033	42.50		43.41
45-54 years old	5,345	44.01		42.57
55-64 years old	919	37.85	*	39.79
65+ years old	54	4.75	**	18.64
Unknown	166	0.00		0.00
Time Employed:				
0-5 years	8,456	30.86	**	41.23
6-10 years	8,956	41.49	**	43.53
11-15 years	9,783	44.55		42.75
16-20 years	1,560	62.34	**	39.57

Table 5. Number of Trades

The table presents statistics on annual number of trades. In Panel a, we consider the frequency distribution of the observations in the panel. In Panel b, we sort observations by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). For each sorting, we test the null hypotheses that the mean of each sub-category equals the mean of the reference sub-category (bold). One (two) asterisk(s) denote rejection in a two-tailed test at the 5% (1%) significance level. Test statistics are adjusted for serial correlation and heteroskedasticity.

Panel a: Distribution

Range	Percent
$x = 0$	87.55
$0 < x \leq 1$	5.60
$1 < x \leq 5$	6.20
$5 < x \leq 10$	0.47
$10 < x \leq 39$	0.19

Panel b: Statistics by Group

	Obs	Mean		Std.
All	28,755	0.26		1.09
Sort by Year:				
1994	5,782	0.16		0.93
1995	5,704	0.23	**	1.22
1996	5,857	0.26	**	0.99
1997	5,679	0.34	**	1.13
1998	5,733	0.30	**	1.15
Gender:				
Male	22,737	0.28		1.17
Female	6,008	0.18	**	0.74
Unknown	10	0.00		0.00
Marital Status:				
Married	22,237	0.28		1.17
Unmarried	5,779	0.21	**	0.81
Unknown	739	0.01		0.15
Salary:				
Under $25,000	141	0.11	**	0.40
$25,000-$49,999	1,291	0.16	*	0.62
$50,000-$74,999	18,898	0.22		0.97
$75,000-$99,999	4,861	0.39	**	1.40
$100,000+	1,532	0.66	**	1.95
Unknown	2,032	0.08		0.41
Time of Entry:				
Pre-1994	26,438	0.26		1.12
Post-1994	2,317	0.22	*	0.74
Age:				
Under 35 years old	10,238	0.17	**	0.78
35-44 years old	12,033	0.27		1.16
45-54 years old	5,345	0.36	**	1.27
55-64 years old	919	0.60	**	1.82
65+ years old	54	0.03	**	0.20
Unknown	166	0.00		0.00
Time Employed:				
0-5 years	8,456	0.14	**	0.70
6-10 years	8,956	0.20	**	0.79
11-15 years	9,783	0.35		1.37
16-20 years	1,560	0.64	**	1.94

Table 6. Turnover

The table presents statistics on annual portfolio turnover (in percents). In Panel a, we consider the frequency distribution of the observations in the panel. In Panel b, we sort observations by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). For each sorting, we test the null hypotheses that the mean of each sub-category equals the mean of the reference sub-category (bold). One (two) asterisk(s) denote rejection in a two-tailed test at the 5% (1%) significance level. Test statistics are adjusted for serial correlation and heteroskedasticity.

Panel a: Distribution

Range	Percent
$x = 0$	67.14
$0 < x \leq 10$	15.58
$10 < x \leq 100$	11.40
$100 < x \leq 2{,}744$	5.88

Panel b: Statistics by Group

	Obs	Mean		Std.
All	28,755	18.51		77.55
Sort by Year:				
1994	5,782	10.42		53.45
1995	5,704	14.83	**	72.85
1996	5,857	18.77	**	70.63
1997	5,679	24.76	**	85.60
1998	5,733	23.86	**	97.50
Gender:				
Male	22,737	19.89		81.66
Female	6,008	13.31	**	59.30
Unknown	10	0.00		0.00
Marital Status:				
Married	22,237	19.75		81.89
Unmarried	5,779	15.95	*	63.66
Unknown	739	0.94		10.96
Salary:				
Under $25,000	141	9.79		35.09
$25,000-$49,999	1,291	13.12		47.93
$50,000-$74,999	18,898	16.27		67.90
$75,000-$99,999	4,861	26.38	**	95.03
$100,000+	1,532	43.36	**	151.80
Unknown	2,032	5.80		29.75
Time of Entry:				
Pre-1994	26,438	18.63		79.40
Post-1994	2,317	17.06		52.03
Age:				
Under 35 years old	10,238	12.42	**	51.41
35-44 years old	12,033	19.45		82.67
45-54 years old	5,345	25.07	**	91.17
55-64 years old	919	39.99	**	1.40
65+ years old	54	3.08	**	20.47
Unknown	166	0.00		0.00
Time Employed:				
0-5 years	8,456	10.79	**	48.17
6-10 years	8,956	14.71		52.59
11-15 years	9,783	24.09	**	92.81
16-20 years	1,560	47.05	**	1.64

Table 7. Equity Portfolio Returns

The table presents statistics on annual equity portfolio returns (in percents). In Panel a, we consider the frequency distribution of the observations in the panel. In Panel b, we sort observations by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). For each sorting, we test the null hypotheses that the mean of each sub-category equals the mean of the reference sub-category (bold). One (two) asterisk(s) denote rejection in a two-tailed test at the 5% (1%) significance level. Test statistics are adjusted for serial correlation and heteroskedasticity.

Panel a: Distribution

Range	Percent
$-26.86 < x \le -3.57$	20
$-3.57 < x \le 5.63$	20
$5.63 < x \le 14.50$	20
$14.50 < x \le 18.30$	20
$18.30 < x \le 34.74$	20

Panel b: Statistics by Group

	Obs	Mean	Std.
All	12,464	8.79	11.51
Sort by Year:			
1994	1,853	2.57 **	3.10
1995	1,967	22.84 **	5.70
1996	2,400	13.77 **	1.65
1997	2,821	16.89 **	3.05
1998	3,423	-6.09	4.69
Gender:			
Male	10,326	8.83	11.52
Female	2,138	8.58	11.49
Marital Status:			
Married	10,253	8.92	11.53
Unmarried	2,201	8.16 **	11.40
Unknown	10	9.18	14.83
Salary:			
Under $25,000	53	10.43	10.85
$25,000-$49,999	608	4.59 **	11.99
$50,000-$74,999	7,610	8.60	11.41
$75,000-$99,999	2,908	9.48 **	11.65
$100,000+	965	9.82 **	11.39
Unknown	320	11.45	10.07
Time of Entry:			
Pre-1994	11,169	9.21 **	11.48
Post-1994	1,295	5.15	11.20
Age:			
Under 35 years old	4,077	8.70	11.28
35-44 years old	5,445	8.80	11.55
45-54 years old	2,548	8.84	11.82
55-64 years old	391	9.21	11.48
65+ years old	3	9.53	8.01
Time Employed:			
0-5 years	2,940	9.27 **	10.97
6-10 years	3,856	7.21 **	11.68
11-15 years	4,637	11.07	10.99
16-20 years	1,031	3.05 **	11.85

Table 8. Sharpe Ratios of Equity Portfolios

The table presents statistics on the Sharpe ratios of the equity portfolio (in percents). In Panel a, we consider the frequency distribution of the observations in the panel. In Panel b, we sort observations by year, gender, marital status (as of August 1998), 1997 annual salary (as of October 1997), time of entry in the plan (before or after April 1994), age (as of year of the observation), and time employed (as of year of the observation). For each sorting, we test the null hypotheses that the mean of each sub-category equals the mean of the reference sub-category (bold). One (two) asterisk(s) denote rejection in a two-tailed test at the 5% (1%) significance level. Test statistics are adjusted for serial correlation and heteroskedasticity.

Panel a: Distribution

Range	Percent
$-50.15 < x \le 14.18$	20
$-14.18 < x \le 4.33$	20
$4.33 < x \le 23.32$	20
$23.32 < x \le 30.11$	20
$30.11 < x \le 167.90$	20

Panel b: Statistics by Group

	Obs	Mean		Std.
All	12,464	20.08		37.49
Sort by Year:				
1994	1,853	-3.05	**	10.62
1995	1,967	92.58	**	24.77
1996	2,400	24.08	**	4.35
1997	2,821	24.99	**	5.35
1998	3,423	-15.92		5.42
Gender:				
Male	10,326	20.24		37.58
Female	2,138	19.30		37.00
Marital Status:				
Married	10,253	20.54		37.77
Unmarried	2,201	17.90	**	36.06
Unknown	10	21.18		45.11
Salary:				
Under $25,000	53	25.47	*	39.87
$25,000-$49,999	608	9.06	**	34.95
$50,000-$74,999	7,610	19.30		36.55
$75,000-$99,999	2,908	21.99	**	38.52
$100,000+	965	22.42	**	38.09
Unknown	320	34.15		45.22
Period:				
Pre-1994	11,169	21.62		38.41
Post-1994	1,295	6.76	**	24.57
Age:				
Under 35 years old	4,077	19.88		37.08
35-44 years old	5,445	20.14		37.49
45-54 years old	2,548	20.08		37.97
55-64 years old	391	21.32		38.63
65+ years old	3	9.81		15.20
Time Employed:				
0-5 years	2,940	23.94	**	40.44
6-10 years	3,856	13.48	**	32.56
11-15 years	4,637	27.46		39.72
16-20 years	1,031	0.53	**	20.83

Table 9. Censored Regression: Equity Allocations

The table presents results of a censored regression of annual average equity allocations against time effects and participants' characteristics. "1995," "1996," "1997," and "1998" are year dummy variables. "Male" is a dummy variable equal to one if the participant is male, zero otherwise. "Married" is a dummy variable equal to one if the participant is married, zero otherwise. "Married*Male:" is a dummy variable equal to one if the participant is married *and* male, zero otherwise. "Salary" is the annual 1997 salary (unit: ten thousand dollars). "Age" is the age of the participant as of the year of the observation (unit: years). "Time Employed" is the time participant has been employed as of the year of the observation (unit: years). T-ratios, reported in parentheses, are adjusted for serial correlation and heteroskedasticity. The pseudo R-squared is the log-likelihood value on a scale from zero to one, where zero corresponds to the constant-only model and one corresponds to perfect prediction (a log-likelihood of zero).

Dependent variable:	Equity Allocations
Constant	-0.2935
	(-2.813)
1995	0.0460
	(4.759)
1996	0.2968
	(18.176)
1997	0.5021
	(23.815)
1998	0.6886
	(27.843)
Male	0.1913
	(2.737)
Married	0.1444
	(2.071)
Married*Male	-0.0255
	(-0.305)
Salary	0.0177
	(2.543)
Pre-1994	-0.3192
	(-5.726)
Age	-0.0093
	(-3.796)
Time Employed	0.0527
	(10.538)
χ^2 (11)	1,840.93
Pseudo-R^2	0.0419
Obs.	26,722
Left-censored	12,041
Uncensored	8,569
Right-censored	6,112
T-bar	4.4
N	6,023

Table 10. Negative-Binomial Regression: Number of Trades

The table presents results of a negative-binomial regression of the annual number of trades against time effects and participants' characteristics. "1995," "1996," "1997," and "1998" are year dummy variables. "Male" is a dummy variable equal to one if the participant is male, zero otherwise. "Married" is a dummy variable equal to one if the participant is married, zero otherwise. "Married*Male:" is a dummy variable equal to one if the participant is married *and* male, zero otherwise. "Salary" is the annual 1997 salary (unit: ten thousand dollars). "Age" is the age of the participant as of the year of the observation (unit: years). "Time Employed" is the time participant has been employed as of the year of the observation (unit: years). T-ratios, reported in parentheses, are adjusted for serial correlation and heteroskedasticity. The pseudo R-squared is the log-likelihood value on a scale from zero to one, where zero corresponds to the constant-only model and one corresponds to perfect prediction (a log-likelihood of zero).

Dependent variable:	Number of trades
Constant	-8.6924
	(-50.058)
1995	0.2543
	(4.673)
1996	0.3595
	(6.116)
1997	0.5195
	(8.428)
1998	0.4965
	(7.519)
Male	0.2827
	(2.359)
Married	0.1520
	(1.283)
Married*Male	-0.0844
	(-0.600)
Salary	0.0225
	(11.734)
Pre-1994	-0.5832
	(-6.748)
Age	0.0142
	(3.718)
Time Employed	0.0693
	(8.611)
χ^2 (11)	717.28
Pseudo-R^2	0.0280
Obs	26,722
T-bar	4.4
N	6,023

Table 11. Censored Regression: Portfolio Turnover

The table presents results of a censored regression of annual portfolio turnover against time effects and participants' characteristics. "1995," "1996," "1997," and "1998" are year dummy variables. "Male" is a dummy variable equal to one if the participant is male, zero otherwise. "Married" is a dummy variable equal to one if the participant is married, zero otherwise. "Married*Male:" is a dummy variable equal to one if the participant is married *and* male, zero otherwise. "Salary" is the annual 1997 salary (unit: ten thousand dollars). "Age" is the age of the participant as of the year of the observation (unit: years). "Time Employed" is the time participant has been employed as of the year of the observation (unit: years). T-ratios, reported in parentheses, are adjusted for serial correlation and heteroskedasticity. The pseudo R-squared is the log-likelihood value on a scale from zero to one, where zero corresponds to the constant-only model and one corresponds to perfect prediction (a log-likelihood of zero).

Dependent variable:	Turnover
Constant	-2.2164
	(-11.705)
1995	0.1732
	(6.297)
1996	0.3842
	(10.944)
1997	0.5817
	(12.920)
1998	0.5706
	(11.641)
Male	0.2805
	(3.156)
Married	0.1825
	(2.104)
Married*Male	-0.1355
	(-1.291)
Salary	0.0511
	(3.469)
Pre-1994	-0.3985
	(-6.008)
Age	0.0061
	(1.843)
Time Employed	0.0555
	(7.292)
χ^2 (11)	250.77
Pseudo-R^2	0.0319
Obs	26,722
Left-censored	17,513
Uncensored	9,209
T-bar	4.4
N	6,023

Table 12. OLS Regression: Equity Portfolio Returns

The table presents results of an OLS regression of annual equity portfolio returns against time effects and participants' characteristics. "1995," "1996," "1997," and "1998" are year dummy variables. "Male" is a dummy variable equal to one if the participant is male, zero otherwise. "Married" is a dummy variable equal to one if the participant is married, zero otherwise. "Married*Male:" is a dummy variable equal to one if the participant is married *and* male, zero otherwise. "Salary" is the annual 1997 salary (unit: ten thousand dollars). "Age" is the age of the participant as of the year of the observation (unit: years). "Time Employed" is the time participant has been employed as of the year of the observation (unit: years). T-ratios, reported in parentheses, are adjusted for serial correlation and heteroskedasticity.

Dependent variable:	Equity portfolio returns
Constant	0.0240
	(7.876)
1995	0.2030
	(154.616)
1996	0.1118
	(130.615)
1997	0.1425
	(150.497)
1998	-0.0874
	(-78.021)
Male	-0.0042
	(-1.993)
Married	0.0015
	(0.754)
Married*Male	0.0016
	(0.674)
Salary	-0.0002
	(-2.464)
Pre-1994	-0.0026
	(-1.634)
Age	0.0002
	(2.706)
Time Employed	-0.0000
	(-0.106)
F	5584.96
R^2	0.8870
Obs	12,143
T-bar	3.2
N	3,802

Table 13. OLS Regression: Equity Portfolio Sharpe Ratios

The table presents results of an OLS regression of the Sharpe Ratios of the equity portfolios against time effects and participants' characteristics. "1995," "1996," "1997," and "1998" are year dummy variables. "Male" is a dummy variable equal to one if the participant is male, zero otherwise. "Married" is a dummy variable equal to one if the participant is married, zero otherwise. "Married*Male:" is a dummy variable equal to one if the participant is married *and* male, zero otherwise. "Salary" is the annual 1997 salary (unit: ten thousand dollars). "Age" is the age of the participant as of the year of the observation (unit: years). "Time Employed" is the time participant has been employed as of the year of the observation (unit: years). T-ratios, reported in parentheses, are adjusted for serial correlation and heteroskedasticity.

Dependent variable:	Sharpe ratio
Constant	-0.0337
	(-3.518)
1995	0.9560
	(226.644)
1996	0.2697
	(104.419)
1997	0.2780
	(105.080)
1998	-0.1320
	(-44.933)
Male	-0.0128
	(-1.857)
Married	0.0025
	(0.399)
Married*Male	0.0076
	(0.964)
Salary	-0.0012
	(-2.715)
Pre-1994	-0.0129
	(-3.130)
Age	0.0008
	(3.225)
Time Employed	-0.0002
	(-0.375)
F	21,326.98
R^2	0.9083
Obs	12,143
T-bar	3.2
N	3,802

Table 14. Equity Allocations and Equity Portfolio Returns: Time-Series Properties

The table presents evidence of the time-series properties of changes in average equity allocations and equity returns at the daily frequency. We report the autocorrelation coefficients of the two series and the cross-correlation coefficients. T-ratios, in parentheses, are adjusted for heteroskedasticity.

Autocorrelation of allocations						
Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7
0.2722	0.0856	0.0993	0.1225	0.0924	0.0881	0.0852
(4.356)	(1.837)	(2.586)	(3.807)	(2.218)	(2.384)	(2.591)
Autocorrelation of returns						
Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	Lag 7
0.2236	-0.0391	-0.0278	-0.0065	-0.0371	0.0143	-0.0483
(4.096)	(-0.885)	(-0.658)	(-0.164)	(-0.890)	(0.385)	(-1.356)
Cross-correlation of allocations and lead and lagged returns						
Lead 3	Lead 2	Lead 1	Lead 0	Lag 1	Lag 2	Lag 3
0.0001	-0.0113	-0.0735	0.1233	0.3088	0.1341	0.0344
(0.004)	(-0.339)	(-1.769)	(1.931)	(6.369)	(2.320)	(0.817)