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Abstract

We monitor the trading behavior of millions of 401(k) plan participants both before and during the recent financial turmoil. We find that 401(k) investors panic and flee to safety, but the amounts moved from equity to fixed income assets are not substantial. Compared to ‘normal’ times, when traders are mostly older, affluent, men with web access, novice traders who begin to trade during the crisis are lower paid and more likely to be female. Determinants of trading flows are identified: people trade to rebalance; they react to past market returns; and they start to respond to market shock and financial report in financial turmoil. Although both continuing and novice traders change their trading behavior from normal times, continuing traders stay calmer than novice ones in the tumultuous financial market. Last, we conclude that people don’t trade to improve their portfolio performance, and certain trading strategy could cause up to 45% loss in final retirement wealth in a span of 20 years.

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The recent financial turmoil of 2008-09 has taken a painful toll on American's wealth, with housing values dropping 20-30% (or more in some areas) and the stock market plummeting by more than 40%. Retirement assets have likewise felt the pain, tumbling from \$10.3 trillion in 2006 to \$8 trillion (Altman, 2009), and defined contribution pensions have lost about 30% in value in 2008 alone (Vanguard, 2009). In this paper we ask how 401(k) pension plan participants who manage their own pension portfolios have fared, against this gloomy financial backdrop. Specifically, we examine how workers managed their 401(k) portfolios during the worst financial shock since the Great Depression, and how these patterns compared to what happened during more 'normal' times. Not only do we compare the probability of trading and characteristics of participants who trade, but we also examine whether trading decisions differ for experienced continuing traders versus novice traders spurred to take action by the financial shocks. Our results are informative for plan sponsors and policymakers seeking to fashion better pension systems for employees seeking to accumulate retirement saving.

In what follows, we first provide an overview of aggregate 401(k) trading patterns both before and during the financial turmoil. We then identify characteristics of people who trade during normal times, and highlight how these characteristics change in times of turmoil. Hypotheses regarding how trading decisions shape asset flows are compared in normal with that in volatile times, and we explore differential reactions of experienced versus novice traders. Last, we evaluate the potential effects of observed trading on eventual retirement income.

Prior literature has proposed a wide range of views on why investors might trade or alter their investment portfolios. Early theoretical models suggest that barring new information, people should not rationally be anticipated to alter their portfolios (Aumann 1976; Milgrom and Stokey 1982). Subsequently, however, various authors have shown that trading may be rationally driven by portfolio rebalancing, tax losses, search costs, and life-cycle considerations (Grinblatt and Keloharju, 2001; Sirri and Tufano, 1998; Bergstresser and Poterba, 2001). A spate of subsequent papers propose alternative ‘behavioral’ explanations for trading, including loss aversion that translates into unwillingness to sell losers (disposition effect); overconfidence leading to excess turnover; and inability to understand trading costs.¹

Because theoretical models tend not to provide clear predictions regarding the rationale and motivations for portfolio trading, a wide range of empirical trading studies have explored trading patterns for individuals holding discount brokerage accounts (Odean, 1999; Barber and Odean, 2000, 2001) or institutional managers (Badrinath and Wahal, 2002; Lakonishok, Shleifer, and Vishny, 1992; Grinblatt, Titman and Wermers, 1995; Nofsinger and Sias, 1999; and Gompers and Metrick, 2001). Interestingly, relatively few analyses have studied how *average* employees invest their money, even though it is likely that many 401(k) traders are unsophisticated and thus could have exhibited different investment objectives from more highly seasoned investors. In a study of a single 401(k) plan, Agnew (2004) report that workers tend not to chase returns when they trade, in contrast to the more complex patterns of institutional and active traders mentioned above. Two other studies on 401(k) trading patterns during calmer market conditions find limited trading in 401(k) plans (Mitchell, Mottola, Utkus and Yamaguchi, 2006; and Agnew, Balduzzi and Sunden, 2003).

¹ An illustrative list includes Choi, Laibson, Madrian and Metrick (2009), Odean (1999), and Odean (1998).

Because so much of household wealth is held in 401(k) plan accounts, it is of substantial interest to learn more about what drives their trading patterns overall. In addition, the special topic on which we focus here is how 401(k) investors may have altered their behavior when confronted with particularly tumultuous financial markets. On the one hand, monitoring and search costs that can discourage trading during normal times (Johnson 2006; and Sirri and Tuffano 1998) could have eroded in the face of enormous media attention devoted to financial markets during a crisis. Early studies in non-401(k) areas have found that trading volumes increase with high market volatility (Epps and Epps, 1976; Karpoff, 1987; and Cornell, 1981). On the other hand, employees are unlikely to react strongly to market shocks, given their tendency to inertia; for instance, Agnew (2004) concludes that extreme negative returns are needed before 401(k) plan participants change their behavior.

Of course extreme negative returns are exactly what prevailed during the recent period of financial turmoil in late 2008 and early 2009, producing deep losses in equity portfolios. So to preview our findings, we conclude that prior to the crisis, few people trade in their 401(k) accounts, and the rate trends up only slightly during the turmoil. Nevertheless, there is some element of panic and flight to safety, though amounts transferred are small. During normal times, the handful of 401(k) traders are older, more affluent, men, whereas the novice traders who respond during the crisis are more likely to be less wealthy females. We also find that financial statements delivered by the fund management firm prompt trading and the impact is stronger during the crisis. The analysis also shows that people trade for several reasons: to rebalance their accounts, in reaction to past returns, and to respond to market shock and financial statement in the turmoil time. Finally, we show traders do not enhance their pension plan's portfolio

performance during crisis; anticipated losses as a result of their trading strategy could reduce their eventual retirement accounts by 45% over a twenty year period.

In what follows, we first describe our data and provide descriptive statistics on aggregate trading patterns. Next we investigate who trades during normal times and how the subset of traders changes when financial shocks occur. Then we identify determinants of trading flows before and after the market shocks and how continuing and novice trader behave differently in financial turmoil. Finally we evaluate the effects of trading on portfolio performance. A final section concludes.

Data and Descriptive Evidence

To explore the questions above, we undertake an empirical analysis of portfolio trading patterns in 401(k) plans over the period of 2006/01 to 2009/03, relying on participant data provided by Vanguard, a mutual fund company managing 401(k) plans on behalf of a wide range of plan sponsors. First we trace the overall trading patterns in the data, comparing the percentage of participants electing to trade prior to the financial crisis, versus afterwards. Next we evaluate trading flows to determine patterns on flight to safety and investment in equities before and after the financial market shock was felt. In particular, we investigate the flow patterns among different groups of traders.

In this paper we define the onset of the financial shock as September 2008. Accordingly, in our data, the period from 2006/01 to 2008/08 is defined as pre-shock, and the turmoil period is from 2008/09 to 2009/03. Figure 1 shows the S&P 500 Index daily returns over this period, and it confirms that, in our data period, daily returns grow very volatile from 2008/09.²

² We confirm this definition by checking whether the daily S&P 500 returns are within one standard deviation of the mean and the monthly S&P 500 volatilities are within one standard deviation of the monthly volatility mean, using S&P 500 daily return data from 2006/01-2009/03. Over this period, the only eight months with more than 50% of

[Figure1 here]

Our participant sample consists of 97,595,207 observations (person*months) on active 401(k) plan participants over the period of 2006/01 to 2009/03. These observations include both traders and non-traders. For this group there are 2,326,576 daily trading observations (person*days). We have for these participants information on their trading dates as well as the amount, source, and destination of funds traded on a daily basis.³ We also know participants' account balances, whether they have web access to their pension accounts, and some sociodemographic information including age, sex, and proxies for household income, non-retirement wealth, and homeownership.⁴ In addition, we have access to return files on the monthly total returns on funds held by the participants. Plan-level data include dummies for industry.⁵

To review the aggregate trading patterns in 401(k) plans, we first evaluate how many participants elect to trade as a percent of active participants each period. There is little change in the *annual* fraction of participants trading in their retirement accounts over our period (15.3% in 2008 vs. 14.5% in 2007 and 14.3% in 2006),⁶ consistent with prior studies on pension investors conducted for earlier periods. For instance 80-90% of 401(k) participants initiated no trading over a 1-2 year period in 2002-4 (Mitchell, Mottola, Utkus and Yamaguchi, 2006; and Agnew, Balduzzi and Sunden 2003). The observed inertia in 401(k) plans differs markedly from discount

daily returns and monthly volatility outside the one standard deviation ranges are 2008/09-2009/03 except for the 2009/02. For this reason we model this period as the period of financial turmoil.

³ This paper focuses on participant-driven changes in their balances across funds included in their plan investment menu. We do not examine future contributions as these are relatively small amounts compared to the plan asset balances.

⁴ The household income data is imputed by Claritas using participant ZIP codes; data from IXI Corporation is used to impute non-retirement household financial wealth and house ownership indicator.

⁵ Industry the plan is in is categorized in to Agriculture/Mining/Construction; Transportation/Communication/Utilities; Manufacturing; Media/Entertainment/Leisure; Wholesale/Retail trade; Finance/Insurance/Real Estate; Professional /Non-profit services; Education /health; and Government.

⁶ This is consistent with the client reports provided by Vanguard (2009).

brokerage account holders (Odean, 1999 and Barber and Odean, 2000). But there is a bit more evidence of behavioral change in Figure 2, which displays *monthly* statistics: here 2.5% of participants trade each month from 2006/01 to 2009/03 on average, but there is a bump-up when the financial shock sets in with monthly trading rising from 2.4% prior to 2008 to a peak of 4.6% in 2008/10. Thus inertia still dominates most 401(k) accounts during the financial turmoil, but there is a slight increase in trading when the market was at its worst.

[Figure 2 here]

Next, we summarize the demographic characteristics of 401(k) traders. As demonstrated in Figure 3, we define three types of traders from 2006/01 to 2009/03: *continuing traders* are those who traded both before and during financial turmoil (259,150 participants), *leavers* are traders who traded in normal times but stopped trading in financial turmoil (667,653 participants) and *novice traders* are those who initiated trading only when the crisis hit (161,856 participants). Table 1 compares characteristics of the continuing traders, the reference group, versus novice traders and leavers as of 2008/09. On average, traders during normal times are around age 47, having \$85,000 in non-retirement wealth, \$85,000 in household income; two thirds of them are men, three quarters own their homes, and most (88%) have web access to their retirement accounts. By comparison, the novice traders are females, younger, less wealthy, less likely to own a home, and less likely to have web access. To the extent that these traits are also characteristics of those with less financial literacy (Lusardi and Mitchell 2009), it would be reasonable to conclude that novices who enter the market in response to the crisis are also less financially adept. Turning to the leavers, those who stop trading in the crisis, they are younger wealthier women.

[Figure 3 here] [Table 1 here]

Next we explore what traders do when trading to determine whether they panic and move their assets into safer funds during the crisis. Accordingly we categorize participants' trades into two types: trades into fixed income, versus trades into equity.⁷ If a trader's *net* flow amount that day is toward fixed income assets, we classify it as the first type of trade; if the *net* flow is toward equity assets, it is the second type.⁸ Figure 4, Panel A, shows the monthly percentage for the first trade type while Panel B shows the second type. Since early 2008, the overall pattern reveals more 'flight to safety', with less money flowing into equity. The trend is stronger during the crisis: where the first (second) type trade rises (falls) from 40% (42%) during normal times to 60% (32%) during the tumultuous period.⁹ That is to say, trades to safety rise by about 50% and net flows to equity fall by 24% during the crisis, thus traders do panic. Yet we note that some traders continue to trade equities even during the crisis. In addition, looking at the trading patterns among different groups of traders, we find that novice traders and leavers are more likely to flee to safety and they are affected more by market shocks.

[Figure 4 here]

Figure 5 shows the average turnover rate of two types of trades, calculated as the ratio of net flow into fixed income and equities, divided by each individuals' last month balances. Panel A shows that there is no significant increase in the net amounts flowing to safety during the crisis (average turnover rates are 42% in normal times vs. 50% in the turmoil period). Panel B shows a similar story, in that the flows to equities remain stable as well (43% in normal times vs. 35% in financial turmoil) except for a bump up in 2008/05. Since turnover rates in both types of flows

⁷ Equity assets include both domestic and international funds and company stocks. Fixed-income assets include bond funds, money-market funds and contract funds.

⁸ The classification is justified by the conclusion in Agnew (2004) showing that most trades in a single 401(k) plan were from equities to risk-free assets, or vice versa in a much more tranquil time. Our data shows the similar result: 42% of trades are between fixed-income and equity funds. Therefore, the two types of trades represent the majority of trades in 401(k) plans.

⁹ The total percentages of two types of trades do not add up to one as there are other trades with equities or fixed-income funds only.

do not increase substantially during the crisis and remain below 50%, it is reasonable to conclude that some people do panic by fleeing to safety but they do not totally abandon equities. Nevertheless, different traders behave differently: turnover for continuing traders remain relatively low and stable, while novice traders and market leavers do trade a higher fraction of their accounts. In particular, novice traders' turnover into fixed-income assets rises to 73% in the crisis, while overall average for continuing traders is only 39% in the same time span. Therefore the more seasoned traders are less likely to go to extremes than others, especially in the financial crisis.

[Figure 5 here]

Multivariate Analysis: Who Chooses to Trade

To add to our evaluation of trading patterns in normal and troubled times, we turn next to a multivariate analysis of 401(k) trading patterns. We model an individual 401(k) participant as first deciding whether to trade in his account, and then, if so, how to trade. This section focuses on the first decision to see who trades and how this changes, if at all, in times of turmoil.

We posit that the individual employee's decision to trade can be cast in the following multivariate format suitable for Probit estimation:

$$Y_{i,t} = \alpha + \beta_1 X_{i,t} + \beta_2 (Turmoil_t * X_{i,t}) + \varepsilon_{i,t} \quad (1),$$

where $Y_{i,t}$ takes on the value of one if participant i elects to trade in his portfolio at time t (0 otherwise).¹⁰ The vector $X_{i,t}$ includes individual controls indicating whether the participant is registered for web access to his account as well as his age, sex, and proxies for his income, non-retirement wealth dummies and home ownership.¹¹ We also know the month in which the

¹⁰ This formulation follows Mitchell, Mottola, Utkus and Yamaguchi (2006).

¹¹ High wealth dummy indicates if wealth is greater or equal to \$61,289; medium wealth dummy indicates if wealth is between \$7,280 and \$61,289; poor Wealth (reference group) indicates if wealth is less than \$7,280.

participants receive a statement indicating how his account performed in the last quarter (“report month”) which permits us to test whether 401(k) trading jumps when people receive this information about performance. To test whether participant trading propensities change pre/post the shock, we also include an indicator variable $Turmoil_t$, set equal to one for the period 2008/09-2009/03 (and 0 else). This term is interacted with all other explanatory variables so the vector β_2 permits a test that trading patterns shifted for participants in times of financial turmoil compared to normal times.¹²

The left-most column in Table 2 indicates how trading patterns vary across participants in the pre-turmoil period. What we see, consistent with results from earlier periods, is that more affluent older men having web access to their 401(k) accounts are most likely to trade (Mitchell, Mottola, Utkus and Yamaguchi, 2006). These patterns are reminiscent of Barber and Odean’s (2001) finding that men are more active traders than women, though the low percent of trading instance here -- well under 3% -- stands in sharp contrast to their more actively self-selected group in discount brokerage account. In our file, those participants having web access to their accounts are also more active traders, being 3% more likely to trade than their less technologically linked counterparts. Last, it is intriguing that participants are 0.5% more likely to trade in the month when they receive their plan statements, a sizable jump from the 2.4% monthly average. It seems that receiving the statement lowers some participants’ search costs and prods them out of their inertia state.

[Table 2 here]

The second column of Table 2 provides the values of the interaction effects, which indicate the differential impact of factors driving trading probabilities during the crisis. Evidently

¹² All regressions also include year and industry controls as well.

the probability of trading rises from 2.4% to 2.9%, and traders' characteristics change rather significantly. Specifically more women trade in their pension accounts during the crisis period, along with the less wealthy and those less likely to have web registered. Even more strikingly, receive the account financial report drives 40% more trading (0.21%/0.5%) during the crisis period compared to the previous pattern.

Determinants of Trading Flows

Next we perform a multivariate analysis on trading flows to study participants' second decision on how to trade. Here we are particularly interested to learn how 401(k) participants reallocate between equity and fixed-income assets prior to and during the shock. Accordingly we focus on flows to fixed income assets which we term the "flight to safety" decision, as well as on flows to equities which indicates a willingness to take risk. These two trading flow patterns are evaluated using two multivariate regression equations:

$$Flow1_{i,t} = \alpha + \gamma_1 X_{i,t} + \gamma_2 (Turmoil_t * X_{i,t}) + \varepsilon_{i,t} \quad (2)$$

$$Flow2_{i,t} = \alpha + \lambda_1 X_{i,t} + \lambda_2 (Turmoil_t * X_{i,t}) + \varepsilon_{i,t} \quad (3)$$

where the dependent variable $Flow1_{i,t}$ denotes participant i's daily net flows into fixed income, and $Flow2_{i,t}$ is the daily net flow into equity assets, both scaled by the participant's last month's account balance.

Our interest is in testing four hypotheses regarding the determinants of flows to fixed income assets and equities, namely rebalancing, feedback trading, market shock, and report effect. The model also permits us to test whether these effects change during the crisis. We say more about each in turn.

Hypothesis 1: Rebalancing. One factor driving trading behavior might be to return to the investor's targeted risk share after a market movement.¹³ To test this we measure the participant's change in risk share in the previous month; if the investor is seeking to rebalance, then in times of rising past risk exposure, we would expect more flows to fixed income assets and less flows to equities.

Hypothesis 2: Feedback Trading. Prior analysts have sought to determine whether investors are mainly momentum (buy winners and sell losers) or contrarian traders (buy losers and sell winners). Evidence to date on this point is mixed: for example, Grinblatt and Keloharju (2001) conclude that Finnish households are contrarian in their sell decisions, while Agnew, Balduzzi and Sunden (2003) suggest 401(k) participants are momentum traders. Also investors appear to react differently to positive versus negative returns (Grinblatt and Keloharju, 2001; and Sirri Tufano, 1988). Accordingly we distinguish positive from negative equity spreads in terms of their effects on 401(k) participant trading decisions. Here the *equity spread* is defined as the difference between the S&P 500 index return and the Barclays US Aggregate return series. We have positive and negative return spreads over non-overlapping trading horizons: the current day (day 0), three days prior (day -1, -2, -3), and two months prior (month -1,-2). We expect negative signs on flows to fixed-income assets and positive signs on flows to equities under momentum trading hypothesis and the opposite for contrarian trading.

Hypothesis 3: Market Shock. Some have argued that market volatility induces trading; for instance Agnew (2004) suggest for a single 401(k) plan that extremely negative returns appear to produce higher levels of trading; and in other settings, Epps and Epps (1976), Karpoff (1987), and Cornell (1981) concur that trading volume rises with market volatility. We therefore include

¹³ Barber and Odean (2000, 2001) consider rebalancing as a rational reason for trading, but find little evidence of rebalancing among traders with discount brokerage accounts.

two indicators to show whether yesterday's equity spread hit the past 30-day high or low, and we also control for the standard deviation of last month's S&P 500 index daily returns. We would expect 401(k) traders reduce flows to equities and increase flows to fixed income assets when facing extremely negative returns and do the opposite for extremely positive returns; and traders take positive action to high market volatility

Hypothesis 4: Report Effect. As shown above, retirement plan participants are more likely to trade in months they receive their financial statements about their portfolios. Accordingly we seek to determine how 401(k) traders change their asset allocation to fixed income or equities when given more information about their plan balances. We expect positive report effects. That is, people will reallocate a larger amount of their assets when giving more information.

Empirical Results Table 3 provides regression results for the determinants of net inflows into fixed-income assets (column 1) and net inflow into equities (column 2), scaled by the participant's last month account balance. Both regressions control for the factors identified above as well as interaction effects for the shock period. Panel A shows results for the *rebalancing* hypothesis, where we see that in normal times, 401(k) investors actively rebalance their portfolios. Specifically, a 1% rise in the past month's risk share induces participants to boost their fixed income share by 0.32% of assets and decrease by 0.44% their equity fraction. During the shock, investors still rebalance but they do so less than before. This might be explained by decreasing risk preference associated with their drop in wealth (Wachter and Yogo, 2008).

[Table 3 here]

Panels B and C show the effect of *feedback trading* to past positive and negative equity spreads. During the pre-shock period, people make flight to safety decisions based on past daily returns and investment in equities decisions on past monthly returns. The directions of feedback

trading are mixed, and the magnitude remained at a low level.¹⁴ During the shock, traders' reaction to past return changes dramatically: thus a 1% increase in last month's positive return spread prompts traders to reallocate up to 38% more of their assets into fixed income assets, and 32% more in equities than in normal times. Also positive returns in the second to last month have a similar large positive effect on flow to fixed income. In the next section, we will further investigate if this dramatic change occurs because continuing traders change their trading strategies, or whether this occurs because of the inflow of novice traders.

Panel D shows the effect of *market shock*. In normal times, market shocks do not affect traders' flow decisions, but during the turmoil, traders start to react to extreme past returns and high market volatility. Panel E on *report effect* shows that when traders receive their account statements, they invest 10% more in equities during the turmoil period.

How Continuing and Novice Traders React Differently in Financial Turmoil Before concluding the discussion of trading flows, we ask whether observed changes in behavior are due to the change in the trading behavior of continuing traders or it is caused by the entrance of novice traders. To do so, we define continuing traders during the pre-shock period as the reference group, and define a dummy indicating whether the trader is a novice or continuing trader in turmoil time. Table 4 shows the results.

Panel A shows that novice traders rebalance more. That is, during normal times, a rise of 1% in last month's risk exposure prompts novice traders to reallocate 0.58% more assets into fixed income than continuing traders do in normal times. Further, Panel B indicates that both novice and continuing traders react more strongly to past returns during the shock, but the novice traders react more powerfully. For example, with a 1% rise in last month's return spread during

¹⁴ I.e. under 5.8% on a base turnover rate of 41% in flow to fixed income and 38% in flow to equities, except for the coefficient of 7.85% from yesterday's negative spread on flows to fixed-income assets.

the crisis, novice traders would raise their allocation to fixed income assets to 110% of their last month's balance, while continuing traders have a response of only half that magnitude (53%). Similar results are found in flows to equities. Results in Panel D shows that both exiting and novice traders react to extreme returns and market volatility during the turmoil but they used to keep silence in normal times. Last, it is intriguing to look at Panel E results on the impact of people receiving the plan's financial report. When provided with financial information on their portfolio performance during the crisis, continuing traders decrease their investment in fixed-income assets and increase their equity holdings. So do novice traders, who put 17% more assets into equities in financial report months. Perhaps the plan statement builds up investors' confidence in equities and both continuing and especially novice traders act on it.

[Table 4 here]

Abnormal Returns from Trading

Next we evaluate whether traders are anticipated to benefit from trading, and if so, which trading strategies enhance their outcomes. Prior studies have suggested that discount brokerage account holders do poorly when they trade (Barber and Odean, 2000), and in the 401(k) arena, similar patterns are suggested by Yamaguchi, Mitchell, Mottola and Utkus (2007) and Agnew, Balduzzi and Sunden (2003). In what follows, we evaluate whether continuing as well as novice traders enhance their portfolio performance when they trade, and also we assess the size of abnormal returns from different trading strategies.

To do so, we use the own-benchmark abnormal return approach advocated by Barber and Odean (2000). This requires that we first calculate the gross monthly return on a trader's portfolio as

$$R_{j,t} = \sum_{i=1}^{S_{j,t}} p_{i,t} R_{i,t} \quad (4),$$

where $p_{i,t}$ is the beginning-of-month share invested in fund i of individual j out of the total balance amount. $R_{i,t}$ is the monthly total return of fund i in month t . $S_{j,t}$ is the total number of funds individual j hold at the beginning of the month. Therefore the monthly portfolio return $R_{j,t}$ of individual j in month t is calculated as the value weighted average returns of funds in his portfolio.¹⁵ Next we compute the average individual traders' monthly portfolio return as:

$$R_t = \frac{1}{n_t} \sum_{j=1}^{n_t} R_{j,t} \quad (5),$$

where n_t is the total number of traders in that month, and $R_{j,t}$ is the monthly return on trader j 's portfolio calculate in equation (4).

The own-benchmark abnormal returns is defined as the difference between the trader's actual monthly realized return and the hypothetical return he would have earned that month if he had retained his initial allocation. It is shown in Table 5 that neither continuing nor novice traders has significant abnormal returns in financial turmoil. They do not benefit from the trading activity in financial turmoil. However, it is interesting to find that new traders who might be less financially sophisticated obtained higher abnormal returns from trading than continuing traders in all turmoil periods except 2009/03. That could be due to the fact that novice traders' allocations prior to the shock are less efficient.¹⁶

[Table 5 here]

¹⁵ This assumes (as do Barber and Odean, 2000) that all trading occurs at the end of each month.

¹⁶ For an analysis of efficiency outcomes see Tang et al (2009).

To investigate in greater detail how portfolio performances are affected by trading strategies, we follow Barber and Odean (2000) to examine risk-adjusted abnormal returns under the CAPM model with the following formulation:

$$R_t - R_{f,t} = \alpha_i + \beta_i(Equity_t - R_{f,t}) + \lambda_i(Bond_t - R_{f,t}) + \gamma_i(Eafe_t - R_{f,t}) + \varepsilon_{i,t} \quad (6),$$

where $R_t - R_{f,t}$ is the average excess monthly return and R_t is calculated from equation (5); we use monthly excess returns of S&P 500 index ($Equity_t - R_{f,t}$), Barclays US Aggregate index ($Bond_t - R_{f,t}$) and MSCI EAFE ($Eafe_t - R_{f,t}$) to capture the risk factors. Then Jensen's alpha α_i is the risk-adjusted abnormal return of the portfolio.

Trading patterns are divided into groups that appears to follow a specific trading strategy, and a different group that do not. For example, those with the highest positive correlation between flow into equities and the last month's return are classified as *momentum traders regarding equities*; conversely, those with the lowest negative correlation coefficients are regarded as *contrarian traders*. Traders with the lowest absolute correlation coefficients are treated as the reference group (those who follow neither a momentum nor a contrarian strategy). To implement this test we select 2000 traders for each group and compare abnormal returns among those who exhibit a clear strategy with those who do not (reference group).

Results appear in Table 6. If we compare portfolio abnormal returns for those pursuing a specific trading strategies with the reference group, we see that trading strategies identified here are not successful in helping traders achieve better portfolio performance and some strategies even backfire. For example, a strategy of negative feedback trading to 30-day high is associated with a monthly loss of 0.25%, compared to the no negative feedback approach. To put this estimate into context, if we assumed that the monthly portfolio return to be 0.5%, a monthly loss

due to this strategy could result in 45% less retirement wealth after 20 years.¹⁷ Thus we generalize the single-company results of Agnew, Balduzzi and Sunden (2003), in that “successful” 401(k) participants with higher portfolio investment performance do not achieve this outcome by savvy trading.

[Table 6 here]

Conclusions

This paper has investigated how the financial shock of 2008-9 shapes trading patterns of 401(k) pension plan participants. Prior to the crisis, few participants does much trading in their 401(k) plan accounts, in sharp contrast to the much more active behavior seen among institutional traders and owners of discount brokerage accounts. Prior to the crisis, those who trade are more likely to be male, more affluent, and older, and have web access to their 401(k) accounts; there is also some positive response to receiving the plan’s financial quarterly statement. We also find that participants trade to rebalance and react to past returns, but at least during non-turmoil periods, trading flows do not respond to market shocks or to the receipt of the financial statement. And the trading is not beneficial, inasmuch as certain trading strategies could produce losses of 45% in retirement wealth over a 20-year period.

Several things changed when the financial crisis hit. First, more people trade in their accounts, but overall probabilities still remain well under 3% per month. People panic when confronted with the tumultuous market and flee to safety, but the panic is not extreme in the sense that the amount transferred to safer assets is insubstantial. Novice traders who start trading during the shock are more likely to be female and lower-wealth employees, and those who lack web access. For determinants of trading flows, we find people continue to trade to rebalance in

¹⁷ That is $(1.005)^{240}$ versus the lower return of $(1.005 - 0.0025)^{240}$ after 20 years. Results using the Fama-French model (not reported here) are similar.

turmoil time; they react more strongly to past monthly returns; market shocks and financial report start to affect flow decisions. These observed changes in trading behavior are attributable to changes in behavior of continuing traders, as well as the influx of novice traders. Nonetheless, continuing traders remain calmer than do the novices when facing financial shocks. And finally, we find that neither continuing nor novice traders benefits from trading in financial turmoil.

Additional research will be needed to determine whether changes in the trading behaviors prompted by the recent market collapse are attenuated after the crisis passes into history. In any event, the knowledge we gained in this paper about the composition of traders today in 401(k) accounts, how they make their trading decisions in the gloomy market and our evaluation of the potential losses due to trading patterns should be of interest to both plan sponsors and policymakers. Employers take on a fiduciary role when they offer 401(k) plans to their employees, and our estimates of possible reductions in peoples' retirement accounts suggests that employers should devote more attention to plan design and financial literacy education – and quite possibly, to deterring certain inappropriate employee trading behavior in 401(k) plans. Policymakers also have an interest in retirement plan structure, to the extent that the government may be called on to supplement shortfalls of the private retirement system.

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Table 1. Demographic Statistics on Different Groups of Traders as of 2008/09

| Male | Age | Non-retirement wealth | Household income | House ownership | Web access |
|---|-------|-----------------------|------------------|-----------------|------------|
| Continuing traders (benchmark group) | | | | | |
| 65.96% | 47.25 | 84740 | 84651 | 76.00% | 88.02% |
| Difference in novice traders | | | | | |
| -8.55% | -2.00 | -14922 | -3490 | -13.50% | -11.92% |
| *** | *** | *** | *** | *** | *** |
| Difference in leavers | | | | | |
| -2.87% | -1.41 | 3830.4 | 93.6 | -0.01 | -1.03% |
| *** | *** | *** | | *** | *** |

Note: The table shows the demographic statistics of continuing traders (as benchmark) as well as difference in novice traders and leavers as of 2008/09. *, **, *** denote statistically different at 10%, 5%, and 1% significance levels separately.

Table 2. Determinants of the Probability of Trading During Normal versus Financial Turmoil Period: Marginal Effects (in %) from Probit Model

| | Pr (trade=1) | | |
|-------------------------|----------------------------------|-------------|---|
| | (1) Normal times (mean=2.37%) | | (2) Difference in turmoil (mean=2.89%) |
| | Mean | Coefficient | Coefficient |
| Male (%) | 53.40 | 0.68 *** | -0.22 *** |
| Age | 43.76 | 0.41 *** | 0.09 *** |
| Medium wealth dummy (%) | 34.99 | 0.14 *** | -0.10 *** |
| High wealth dummy (%) | 22.33 | 0.31 *** | -0.19 *** |
| Household income (\$k) | 82.38 | 0.00 *** | 0.11 *** |
| House ownership (%) | 63.09 | 0.01 | 0.15 *** |
| Web access (%) | 55.62 | 2.89 *** | -0.08 *** |
| Report month (%) | 34.31 | 0.50 *** | 0.21 *** |
| R-square | 0.0154 | | |

Notes: The table shows marginal effects from a Probit regression on 97,595,207 observations; 78,658,373 are observations prior to the shock and 18,036,834 are from the financial turmoil period. Controls include dummy variables indicating years, industry, and missing values. Column (1) shows the effect of independent variables on trading probability in normal times; column (2) indicates additional effect of independent variables on trading probabilities in financial turmoil compared with normal times. *, **, *** denote 10%, 5%, and 1% significance level respectively.

Table 3. Multivariate Model of Determinants of Net Flows to Fixed-Income and Equity Assets (Normal vs. turmoil periods)

| | (1) Net flow into fixed-income assets | | | (2) Net flow into equity assets | | |
|---|---------------------------------------|-------------|-------------------|---------------------------------|-------------|-------------------|
| | Normal times | | Financial turmoil | Normal times | | Financial turmoil |
| | Mean | Coefficient | Coefficient | Mean | Coefficient | Coefficient |
| | 40.96% | | 48.68% | 38.26% | | 33.51% |
| Panel A: Change in risk exposure | | | | | | |
| Risk share change last month (%) | -0.10 | 0.32 *** | 0.18 | 0.76 | -0.44 *** | 0.09 *** |
| Panel B. Max [0, equity spread] | | | | | | |
| Daily return with lag 0 (%) | 4.70 | 1.25 *** | 0.35 | 0.38 | -3.44 | 4.41 |
| 1 | 0.43 | -3.04 *** | 2.60 *** | 0.41 | -3.75 | 4.76 |
| 2 | 0.37 | 2.71 *** | -2.93 *** | 0.35 | 0.87 | -1.43 |
| 3 | 0.33 | -3.71 *** | 2.55 ** | 0.33 | -3.60 | 3.64 |
| Monthly return with lag 1 | 1.03 | 0.75 | 38.26 *** | 1.18 | 3.57 | 32.03 *** |
| 2 | 1.19 | -1.32 | 30.60 ** | 1.33 | -2.16 * | 5.93 |
| Panel C. Min [0, equity spread] | | | | | | |
| Daily return with lag 0 (%) | -0.42 | -3.01 *** | 2.20 *** | -0.43 | 3.96 | -3.43 |
| 1 | -0.47 | -7.85 *** | 4.02 | -0.38 | 4.57 | -4.11 |
| 2 | -0.46 | -5.75 *** | 6.87 *** | -0.41 | -0.06 | 1.79 ** |
| 3 | -0.51 | 0.10 | -0.83 | -0.43 | 2.58 | -2.46 |
| Monthly return with lag 1 | -1.51 | -0.21 | 0.17 | -1.21 | 2.28 * | -3.80 *** |
| 2 | -1.59 | 0.55 | 0.03 | -1.17 | 2.95 * | -3.26 * |
| Panel D: Market shock | | | | | | |
| Top performance (%) | 5.01 | 0.15 | -6.37 *** | 0.05 | 5.40 | -3.28 |
| Bottom performance (%) | 5.08 | -4.88 | -10.00 | 0.05 | 8.21 | -10.04 * |
| Equity market volatility last month (%) | 0.94 | 7.27 | -4.27 | 0.86 | 16.54 | -18.63 * |
| Panel E: Report effect | | | | | | |
| Report month (yes=1, no=0, %) | 40.30 | 0.50 | -4.19 | 38.82 | -1.26 | 9.69 *** |
| R-Square | 0.0004 | | | 0.0001 | | |

Note: Column (1) shows the results of OLS regressions on net flows to fixed-income assets as a percent of the individual's previous monthly balance, for 1,209,257 observations including 839,129 observations in normal times and 370,128 observations during the financial turmoil period. Column (2) shows the results of OLS regressions on net flows to equity assets as a percent of the same denominator for 1,117,319 observations including 906,717 observations in normal times and 210,602 observations during the turmoil period. Controls include individual characteristics and dummy variables indicating year, industry sector, and missing values. Coefficients in "Normal Times" shows the effect of independent variables on trading flows in normal times, column "Financial Turmoil" indicates additional effects of independent variables on flows during the turmoil compared to normal times. *, **, *** denote 10%, 5%, and 1% significance level respectively.

Table 4. Determinants of Net Flow to Fixed-Income and Equity Assets among Different Groups of Traders

| | (1) Net flows to fixed-income assets | | | (2) Net flows to equity assets | | |
|---|--------------------------------------|-------------------------------|----------------|------------------------------------|-------------------------------|----------------|
| | Benchmark | Difference in | | Benchmark | Difference in | |
| | Continuing traders in normal times | Continuing traders in turmoil | Novice traders | Continuing traders in normal times | Continuing traders in turmoil | Novice traders |
| | 35.16% | 39.06% | 69.37% | 33.31% | 30.41% | 43.90% |
| Panel A: Change in risk exposure | | | | | | |
| Risk share change last month (%) | 0.36 *** | 0.03 | 0.58 *** | -0.37 *** | 0.02 | 0.06 |
| Panel B. Max [0, equity spread] | | | | | | |
| Daily return with lag 0 (%) | 1.70 *** | -0.24 | -0.47 | -5.00 | 6.03 | 5.82 |
| 1 | -2.58 *** | 2.38 *** | 1.58 *** | -5.79 | 6.35 | 7.39 |
| 2 | 3.28 *** | -3.67 *** | -3.30 *** | -1.68 | 1.10 | 1.89 |
| 3 | -2.57 *** | 1.96 *** | 1.34 ** | -6.38 | 6.44 | 5.97 |
| Monthly return with lag 1 | 1.96 | 53.14 ** | 109.72 *** | 6.32 | 44.50 *** | 109.30 ** |
| 2 | -2.47 | 58.44 * | 52.88 * | -3.29 | 31.01 | 44.97 |
| Panel C. Min [0, equity spread] | | | | | | |
| Daily return with lag 0 (%) | -3.2 *** | 2.24 *** | 2.93 *** | 6.17 | -5.70 | -6.13 |
| 1 | -10.71 ** | 7.05 | 8.13 * | 6.67 | -5.86 | -8.04 |
| 2 | -7.02 * | 8.38 ** | 6.77 * | 0.36 | 1.14 | 1.54 * |
| 3 | -1.68 | 0.81 | 1.11 | 5.43 | -5.49 | -4.25 |
| Monthly return with lag 1 | -0.04 | 0.52 | -0.69 | 2.31 | -3.20 ** | -4.94 *** |
| 2 | 1.69 | -1.84 | -0.83 | 3.21 | -3.74 | -4.07 |
| Panel D: Market shock | | | | | | |
| Top performance (%) | 1.23 | 3.94 ** | -11.63 *** | 11.16 | -5.97 | -17.11 |
| Bottom performance (%) | -11.81 | -2.95 | 1.54 | 12.45 | -14.30 | -13.75 |
| Equity market volatility last month (%) | 2.34 | 2.98 ** | 8.04 *** | 20.61 | -18.82 | -19.02 |
| Panel E: Report effect | | | | | | |
| Report month (yes=1, no=0, %) | -0.57 | -9.99 ** | -2.28 | -6.82 | 7.70 ** | 17.23 * |
| R-Square | 0.0003 | 0.0004 | 0.0006 | 0.0002 | 0.0001 | 0.0002 |

Note: The table shows regression results on flows to fixed income assets (column 1) and flow to equities (column 2). Under each column, there are three regressions: the first regression is among continuing traders in normal times (benchmark group), the second regression shows additional effects among continuing traders in turmoil compared with the benchmark, and third regression indicates addition effects among novice traders. Control variables include individual demographic variables and dummy variables indicating years, industry sectors and missing values. *, **, *** denote 10%, 5%, and 1% significance level separately.

Table 5. Own-benchmark Abnormal Returns of Novice and Continuing Traders in Financial Turmoil (in %)

| | (1) Novice Traders | (2) Continuing traders in financial turmoil | (1)-(2) |
|---------|--------------------|---|-----------|
| 2008/10 | 4.21 | 2.44 | 1.77 *** |
| 2008/11 | 2.57 | 1.26 | 1.31 *** |
| 2008/12 | -0.34 | -0.40 | 0.06 * |
| 2009/01 | 0.89 | 0.83 | 0.06 * |
| 2009/02 | 2.75 | 1.40 | 1.35 *** |
| 2009/03 | -2.68 | -1.56 | -1.11 *** |
| Turmoil | 1.48 | 0.82 | 0.66 *** |

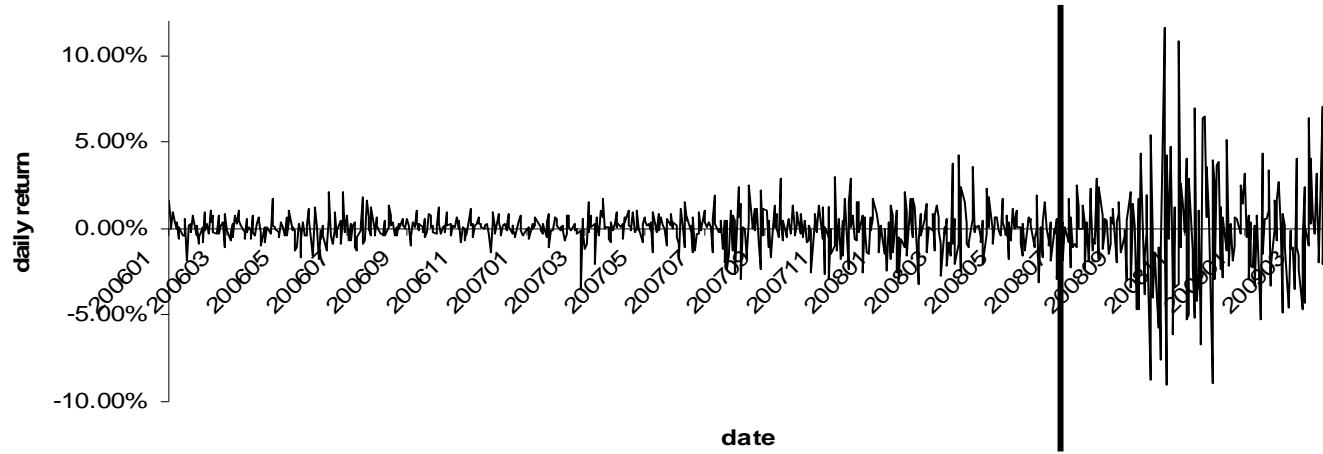
Note: *, **, *** denote 10%, 5%, and 1% significance level separately.

Table 6. Abnormal Returns from Different Trading Strategies (in %)

| | (i) | (ii) | (iii) | (i)-(iii) | (ii)-(iii) |
|--|--------------------------|--------------------------|-------------|-----------|------------|
| (1) Flow to fixed income assets | | | | | |
| | rebalance | | none | | |
| Risk share change last month | 0.05 | | 0.12 | -0.07 ** | |
| | momentum | contrarian | none | | |
| Daily return with lag 1 | 0.05 | -0.05 | 0.08 | -0.03 | -0.13 *** |
| Monthly return with lag 1 | 0.06 | 0.05 | 0.09 | -0.03 | -0.05 * |
| | negative feedback | positive feedback | none | | |
| Top performance | -0.11 | 0.03 | 0.13 | -0.25 *** | -0.10 *** |
| Bottom Performance | 0.05 | 0.14 | 0.11 | -0.06 * | 0.03 |
| Equity market volatility last month | 0.01 | 0.02 | 0.05 | -0.04 | -0.03 |
| (2) Flow to equity assets | | | | | |
| | rebalance | | none | | |
| Risk share change last month | -0.07 | | -0.03 | -0.03 | |
| | momentum | contrarian | none | | |
| Daily return with lag 1 | 0.09 | 0.00 | 0.05 | 0.04 | -0.05 |
| Monthly return with lag 1 | -0.03 | 0.05 | 0.16 | -0.19 *** | -0.11 *** |
| | negative feedback | positive feedback | none | | |
| Top performance | -0.12 | 0.00 | 0.03 | -0.15 *** | -0.03 |
| Bottom Performance | -0.02 | -0.02 | 0.13 | -0.15 *** | -0.15 *** |
| Equity market volatility last month | -0.11 | 0.03 | 0.12 | -0.23 *** | -0.09 *** |

Note: The table shows the abnormal returns by following different trading strategies (column i and ii) vs. by not following the strategies (column iii), and the difference between them (column i-iii and ii-iii). Panel (1) and (2) contain results for flows to fixed income assets and equities respectively. *, **, *** denote 10%, 5%, and 1% significance level separately.

Figure 1. Daily S&P 500 Index Returns from 2006/01-2009/03



Source: WRDS.

Figure 2. Monthly Proportion of Participants Trading

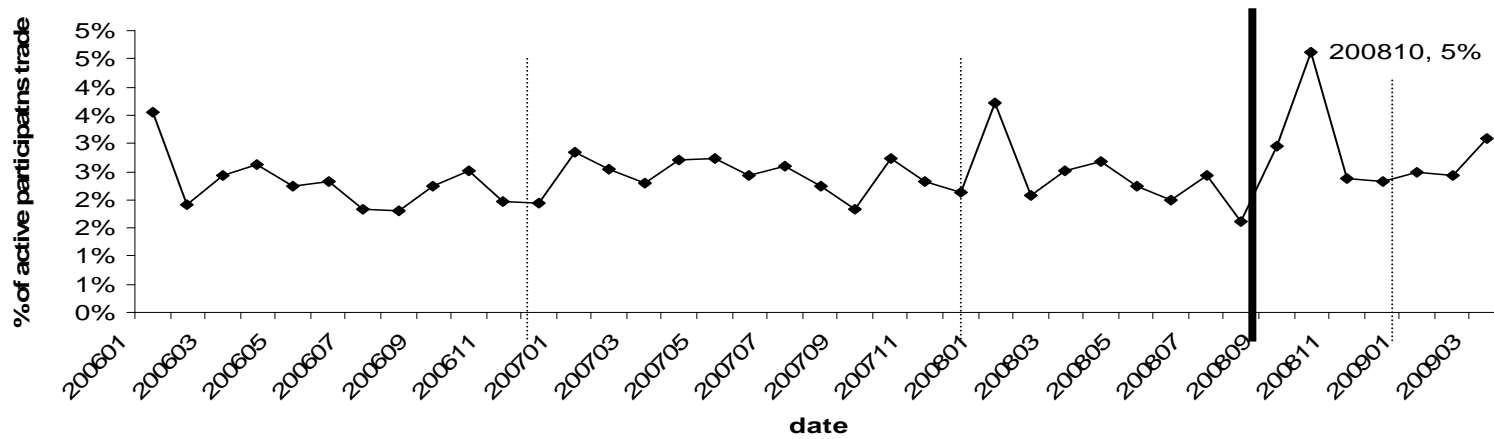


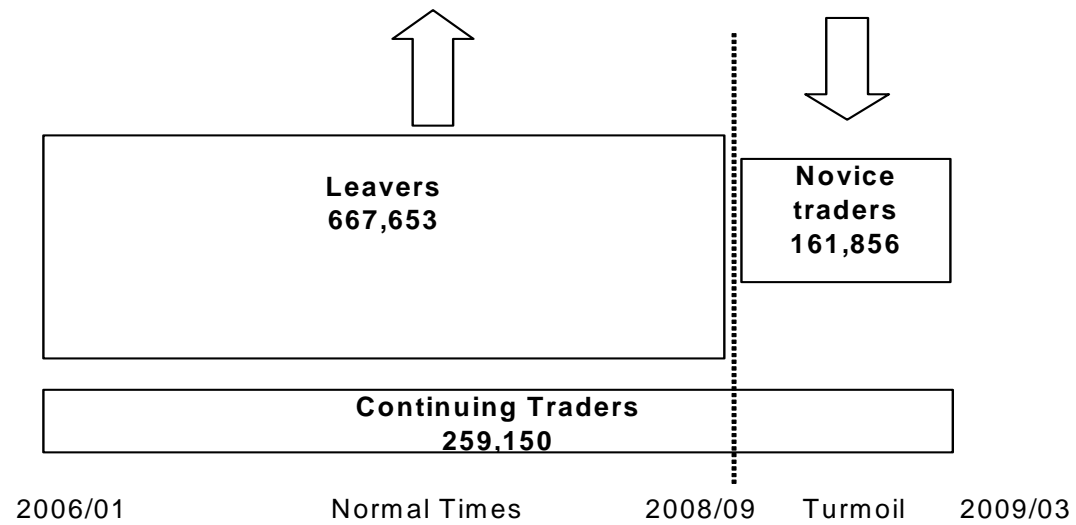
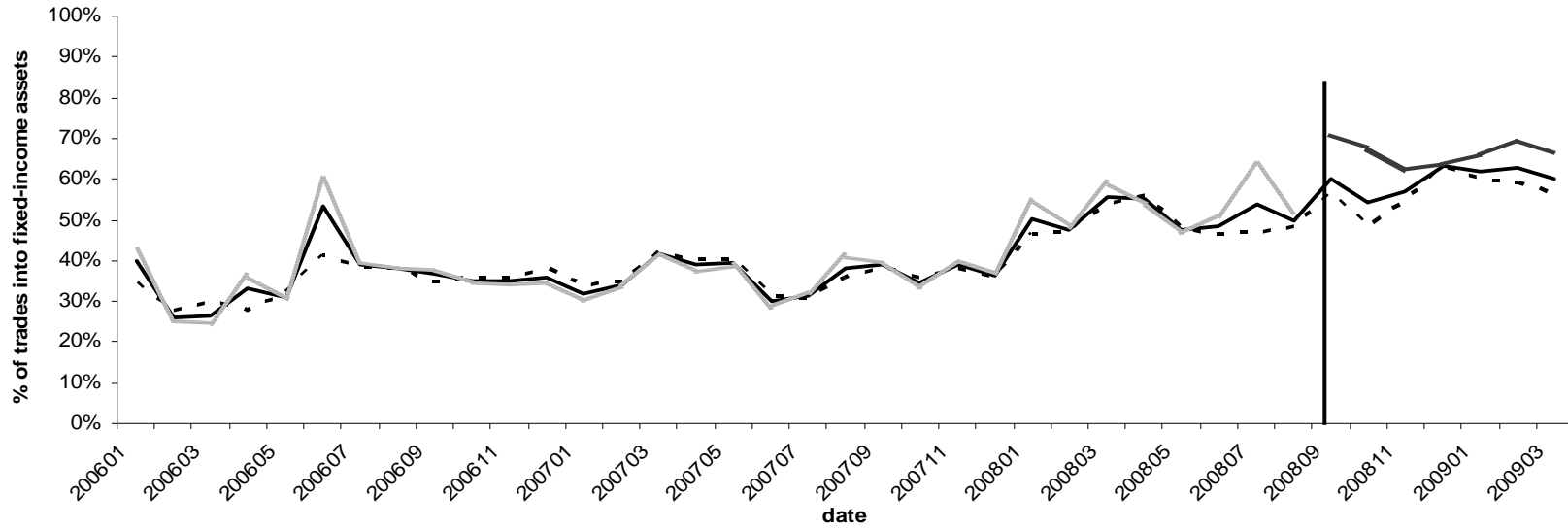
Figure 3. Composition of Trading Pool over Time

Figure 4. Percentage of Trades into Fixed-Income Assets and Equities by Different Trader Groups

Panel A. Flow to Fixed-income Assets



Panel B. Flow to Equities

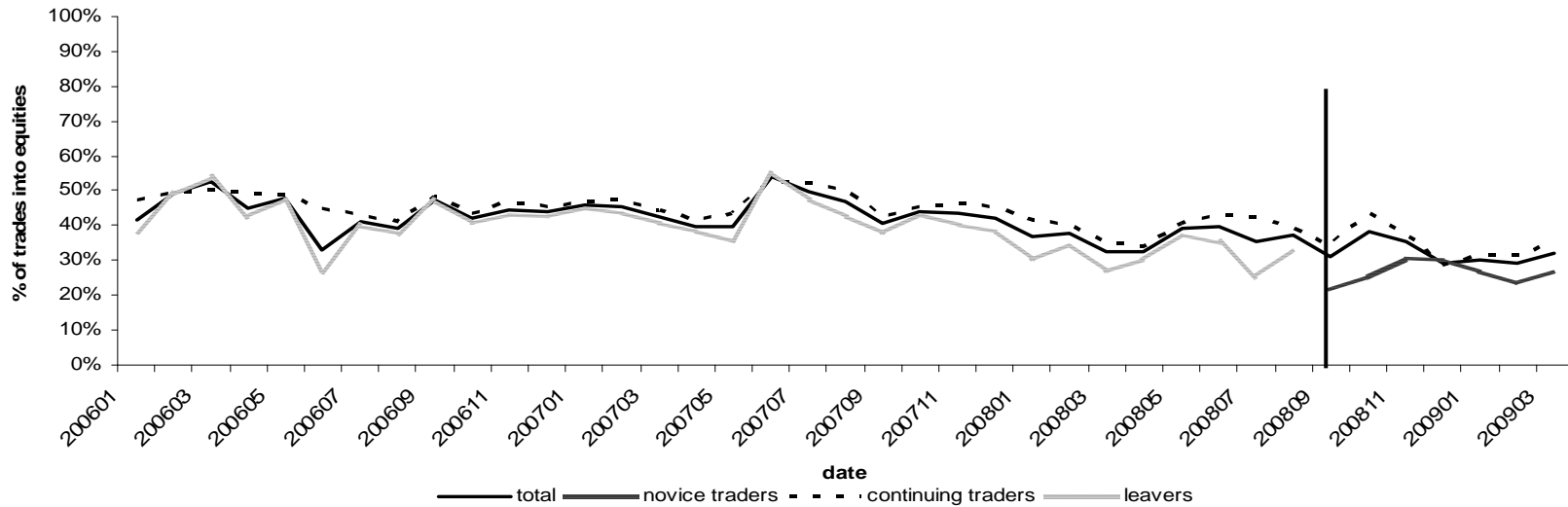
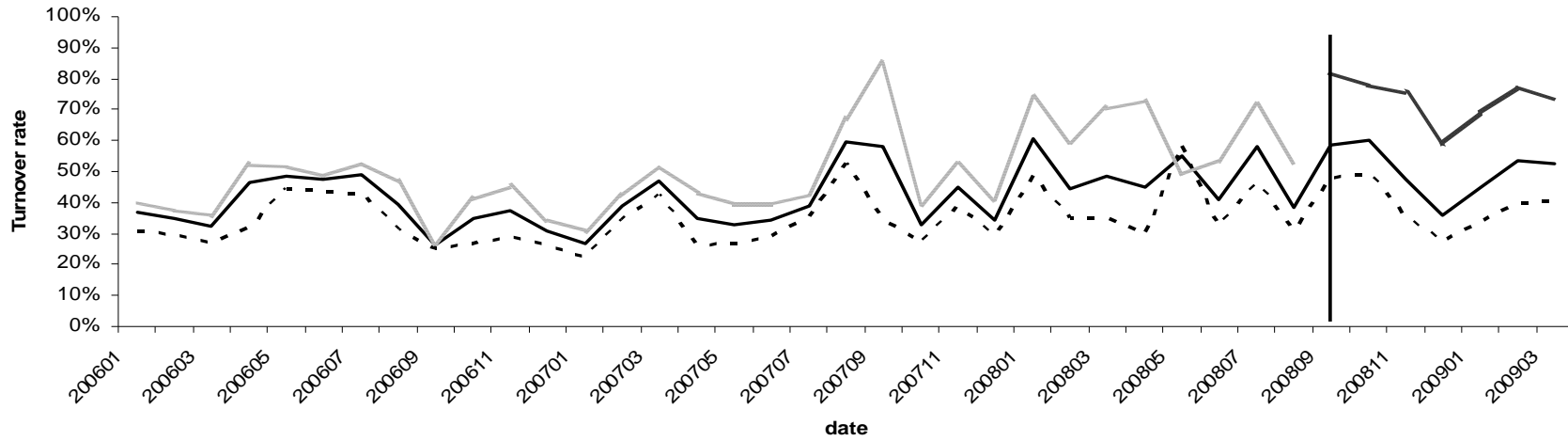
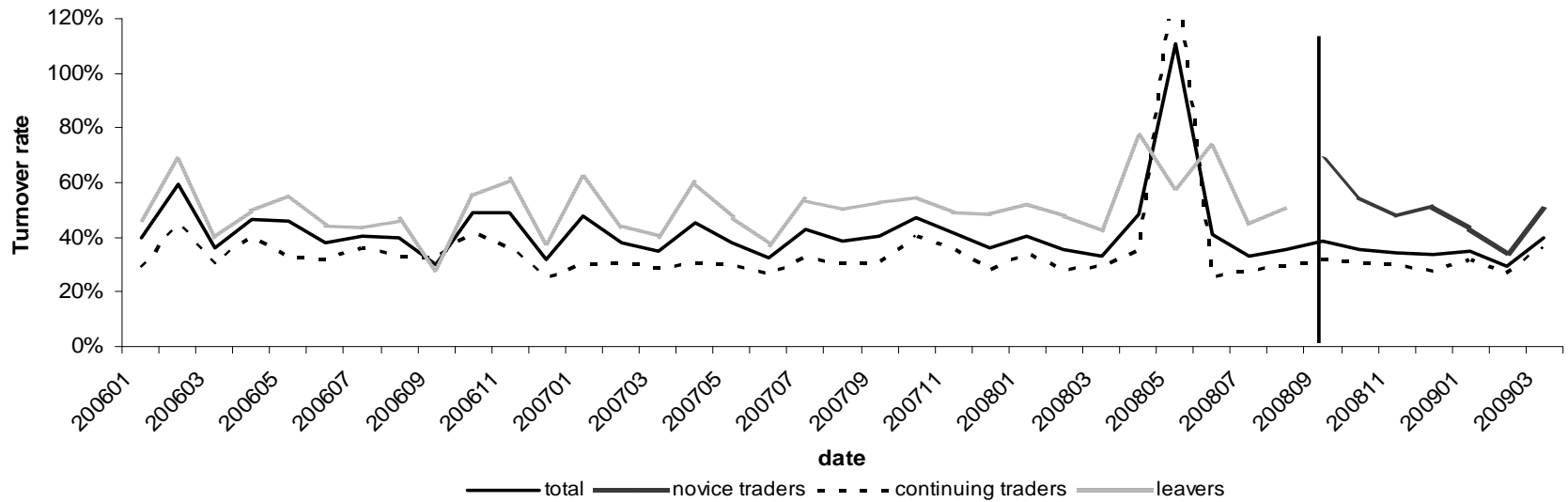


Figure 5. Turnover Rates of Trades into Fixed-income Assets and Equities by Different Trader Groups
Panel A. Flow to Fixed-income Assets



Panel B. Flow to Equities



— total — novice traders - - - continuing traders . . . leavers