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Abstract

Most 401(k) participants did not trade much in their retirement accounts during the recent financial crisis. Yet the proportion of plan participants trading did rise by almost a quarter and the mean portfolio fraction shifted away from equities rose almost eightfold during the crisis. Traders' responsiveness to monthly stock market volatility also more than doubled, contributing to a sharp increase in the sale of equities. At the same time, traders' equity selling was offset by their reaction to returns. They shifted from a momentum approach pre-crisis selling equities on weak returns, to a contrarian strategy during the crisis and buying stocks 'on the dips.' Also first-time traders during the crisis reacted more negatively to volatility than did experienced traders; these inexperienced traders were nevertheless, and paradoxically, more likely to be contrarian in their return response. Finally, participant plan statements sent during the crisis encouraged net shifts into equities, thereby acting as a modest stabilizing factor.

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Defined contribution (DC) or 401(k) plans are now the dominant form of US retirement accounts. They cover over 65 million American employees and encompass some \$3 trillion in assets, with approximately two-thirds of those assets invested in equities.¹ During the financial crisis of 2008-09, retirement plan participants were confronted with one of the most dramatic downturns in stock prices, and one of the sharpest increases in market volatility, since the Great Depression. While only one-quarter of participants chose to trade in their accounts over our analysis period, in response to the crisis there was a sharp increase in the number of participants trading² and the fraction of portfolios shifted away from equities rose by nearly eight times. In this paper we trace how 401(k) plan participants as investors behaved in this exceptional market environment and identify whether and how trading patterns during the peak months of the financial crisis differed from trading during less volatile times.

This chapter considers three separate explanations for heightened portfolio trading activity during the crisis. First, we evaluate the motivation for trading—whether 401(k) plan participants acted as momentum investors, simply selling equities as markets fell, or whether they were reacting to increased volatility of returns. Second, we consider the impact of prior trading experience on behavior during the crisis, comparing first-time traders during the crisis with those who were more experienced. Third, our analysis examines whether the salience of information on retirement wealth—as represented by the receipt of quarterly statements during certain months of the crisis—has an independent effect on trading behavior.

Prior research in household finance has shown that employees in 401(k) plans (DC plans) are often characterized by inertia, rarely altering their investment portfolios during normal

market cycles. Only a minority trades at all and very active traders realize reduced returns.³ There have also been studies indicating that holders of low-cost brokerage accounts are more active traders; here too, very active traders realize lower net returns.⁴ Both sets of studies suggest the dominance of behavioral factors in driving household investment patterns: inertia broadly, with overconfidence among a small group of active traders. Yet the literature to date focuses on relatively calm financial markets. Our goal in this chapter is to examine 401(k) participant behavior from January 2006 to March 2009, to explore how retirement plan investors behaved when confronted with an extraordinary financial crisis.

Drawing on a large sample of 401(k) plans administered by Vanguard, we show that only a minority of 401(k) investors traded in their accounts, either before or during the crisis. Nevertheless, behavior did change for those who traded: the proportion of participants trading each month rose by nearly one-quarter, from 2.4 to 2.9 percent, and the mean portfolio fraction shifted away from equities rose almost eightfold during the crisis. We also show that this equity selling pattern was in part due to increased sensitivity to volatility during the crisis. For instance, pre-crisis, a two standard deviation rise in market volatility (uncertainty) was associated with a 4 percent shift away from equities, while during the crisis it induced a 10 percent shift away. Responsiveness to returns also changed: 401(k) traders shifted from a momentum strategy during the pre-crisis period, to a contrarian strategy during the turmoil. Thus a sharp market decline (measured by a two standard deviation drop in the prior month's equity-bond spread) was associated with a 5 percent momentum shift *out* of equities pre-crisis, but during the crisis it elicited a 5 percent contrarian shift *toward* equities. In effect, an anticipated increase in investor reaction to volatility during the crisis period was partly offset by a contrarian 'buy on the dips' reaction to returns.

We also discover that prior trading experience played a paradoxical role in these dynamics: the most experienced active traders were less sensitive to market volatility and least contrarian during the crisis. But the least experienced trader group, first-time traders during the crisis, reacted much more negatively to rising volatility; these individuals were also more contrarian in their reactions to returns. Moreover, first-time traders were on average younger, more likely to be female, lower-paid, and less wealthy than the experienced group, suggesting some degree of financial naiveté or illiteracy. Their tendency to react strongly to volatility fits this characterization; their tendency to act as contrarian investors during the crisis does not. These results suggest that 401(k) trading is more nuanced than previously imagined, and that 401(k) traders cannot be easily characterized as inexperienced, momentum investors. Finally, we find that making account wealth more salient during the crisis period had a surprising ameliorating effect. Prior to the crisis, participant trading patterns exhibited no measurable response when participants' quarterly statements were received from plan sponsors. In contrast, receiving such information during the turmoil led traders to independently boost equity holdings by 2 percent.

In what follows, we briefly review prior research on portfolio trading behavior. Next we describe our data including a description of participant trading patterns and characteristics. Our empirical strategy involves comparisons of trading patterns prior to and during the crisis, and we also detail how trading patterns varied by prior trading experience. A final section concludes.

Background

Prior research has offered competing views about why investors might trade in their investment portfolios. Early economic models suggested that investors would maintain constant

portfolio allocations over the life-cycle barring new information (c.f. Aumann 1976; Milgrom and Stokey 1982). Subsequently, some have proposed that trading will occur to take advantage of tax strategies and reduce search costs, as well as for life cycle reasons (c.f. Grinblatt and Keloharju, 2001; Sirri and Tufano, 1998; Bergstresser and Poterba, 2001). The neoclassical life cycle model has also been extended to take into account labor income and consumption shocks as drivers of portfolio trading (c.f. Horneff et al. 2009; Chai et al. 2010). From a less neoclassical vantage point, other researchers have proposed ‘behavioral’ explanations for trading, including the disposition effect where traders are unwilling to sell losers (c.f. Shefrin and Statman, 1985); overconfidence leading to excess turnover and an inability to understand trading costs (Odean, 1998 and 1999; Barber and Odean, 2000, 2001); and increasing trading volumes with high market volatility (c.f. Epps and Epps, 1976; Karpoff, 1987; and Cornell, 1981).

Relatively few empirical studies have examined trading in the context of DC retirement accounts. An analysis of a single large 401(k) plan found very limited trading, and what trading there was seemed to be momentum or return-chasing (Agnew, Balduzzi and Sunden, 2003). Additionally, extreme negative returns were seen as necessary to motivate plan participants to trade (Agnew, 2004). Using a much larger set of DC plans and participants, and analyzing a period of relatively calm markets, Mitchell et al. (2006) also found little evidence of portfolio churning in 401(k) accounts. Participants who did trade during those relatively calm markets were older, better-paid, and wealthier men. Moreover, as in studies on brokerage account traders, the active 401(k) traders also earned lower returns.⁵

One issue not yet examined in detail is how U.S. investors responded to the market shock of 2008-2009, whether in retirement or personal investment accounts. In what follows, we

explore whether and how 401(k) participant trading responded, and what these patterns tell us about theories of investor behavior.

An overview of trading patterns in DC pension accounts

We assess 401(k) trading activity over the period January 2006-March 2009. In this time frame, US and global stock prices at first rose through October 2007; thereafter, they began to fall as the mortgage finance crisis accelerated and macroeconomic conditions deteriorated. Returns on U.S. stocks relative to U.S. taxable bonds, measured by the spread between the monthly return on the S&P 500 Index and the Barclay's US Aggregate Bond Index, widened and became increasingly negative. Market volatility rose early in 2008 as the US mortgage financing crisis deepened, and in September 2008, investment bank Lehman Brothers collapsed and insurer AIG was rescued by the federal government. These events marked the beginning of an accelerated decline in stock prices and an extraordinary increase in stock price volatility, with stocks underperforming bonds in the worst months by -14 percent (October 2008), -10 percent (November 2008) and -10 percent (February 2009).

To examine the impact of this market shock on 401(k) trading patterns, we draw on administrative records for active 401(k) participants in nearly 1,900 defined contribution plans observed over the 39-month period.⁶ On average, 65,000 of the 2.25 million 401(k) participants observed traded or moved money between investment options in their plans.⁷ The dataset provides extensive information on individual plan participants including their age, sex, account balances, plan tenure, indicators of non-retirement-plan wealth and homeownership, and whether the participants were registered for web account access.⁸ We also observe each person's trade date as well as the amount, source, and destination of funds traded, summarized on a monthly

basis. The trading dataset is augmented with information on monthly returns of all investment options in each plan.

Our goal is to compare observed trading patterns *pre-crisis*, or January 2006-August 2008, with trading activity *during the crisis*, defined as September 2008-March 2009. We select the latter to define the crisis period due to the extreme return and volatility characteristics of US stocks over that seven-month span.⁹ Comparing these two periods, Table 1 and Figure 1 show that the fraction of participants trading in a given month rose from 2.4 to 2.9 percent, an increase of 23 percent, and the mean number of participants trading jumped nearly a third, from just over 61,000 pre-crisis to more than 81,000 during the crisis.¹⁰ As a measure of trading intentions, we calculate each trader's net flow to equities, defined as the participant's monthly flow to equities less his monthly flow to fixed income assets, as a fraction of his prior month-end account balance.^{11,12} Prior to the crisis, during which time stocks underperformed bonds by 0.1 percent per month on average, the average trader shifted 1.2 percent of his balance away from equities in a typical month; during the crisis, when stocks underperformed by 6.5 percent per month, the average trader shifted 11.1 percent of his balance away from equities. Equity market volatility, defined as the standard deviation of daily stock index changes in a given month, also rose, from under 1 percent pre-crisis to 3.6 percent during the crisis.

Table 1 and Figure 1 here

Types of traders. Trader characteristics are summarized in Table 6-2, Panel A, for the entire period (Column 1), as well as separately in the pre-crisis (Column 2) and crisis periods (Column 3). As we have found before, 401(k) plans traders tend to be male, affluent, and relatively long-tenured;¹³ the average trader was a 46-year-old man with an account balance of nearly \$115,000 and plan tenure of over 10 years. During the crisis, however, trader characteristics changed

somewhat: they became more female with shorter tenure and lower account balances (by about 12 percent), and with less non-retirement wealth. Inasmuch as these individuals are also those having lower levels of financial literacy (c.f. Lusardi, Mitchell, and Curto, 2010), it suggests that the financial meltdown prompted less financially sophisticated/knowledgeable individuals to trade.

Table 2 here

We are also interested in whether prior experience with trading influenced trading patterns during the crisis. Figure 2 depicts the distribution of number of trades over several time periods. We define *active traders* as those who had traded at least three times pre-crisis; this group accounts for 31 percent of all traders pre-crisis. *Infrequent traders* were the remaining 69 percent of pre-crisis traders, and they traded only 1-2 times pre-crisis. We also identify *first-time crisis traders* as those first observed trading during the crisis period.¹⁴ Panel B compares these three groups and shows that active traders were wealthier (in terms of 401(k) account balance and non-retirement wealth), more male, and longer tenured than other traders. For example, the mean account balance of active traders, at around \$157,000, was more than \$50,000 above average balances for infrequent trader, and nearly \$88,000 above first-time crisis trader balances. Infrequent traders tended to be less wealthy, more female, and less tenured, than active traders, and first-time crisis traders even more so. Again, these characteristics are associated with lower levels of financial literacy.

Figure 2 here

A comparison of portfolio and trading characteristics for the three trader types is presented in Table 3. All three groups shifted money out of equities during the crisis, with active traders shifting the least (-5 percent) and first-time traders the most (-20 percent). All three had

similar equity exposure before the crisis (71-72 percent), but first-time traders moved to the lowest equity position during the crisis (50 percent) versus other traders (60-61 percent), due to their larger shift out of stocks. Active traders had more complex portfolios in terms of number of funds, and they traded more frequently per month; nevertheless, when they traded, they moved a smaller fraction of their portfolios (22 percent) than did infrequent traders (36 percent) or first-time crisis traders (46 percent). Overall, active traders accounted for about two-thirds of trading volume during the entire period, versus 31 percent for infrequent traders and 5 percent for first-time traders. During the crisis, first-time crisis traders accounted for over a quarter of all trading volume.¹⁵

Table 3 here

Multivariate analysis of trading patterns

As noted above, the fraction of 401(k) traders' portfolios shifted out of equities rose by nearly a factor of eight during the crisis period. Several possible explanations for this pattern come to mind. One is a 'fear factor' hypothesis: that is, traders might have sold stocks due to concern over rising market volatility.¹⁶ In other words, the crisis could have induced some to think that markets were riskier than they had previously believed, and so they responded by reducing equity exposure. From this perspective, selling equities represented adaptive learning to new knowledge about equity market 'tail risk.' A second hypothesis is a 'performance chasing' or momentum hypothesis: 401(k) traders might buy equities in response to rising markets but sell equities in falling markets. Because many 401(k) participants are arguably unsophisticated investors, they might be hypothesized to pursue a naive momentum strategy rather than a 'buy on the dips' contrarian strategy.¹⁷ A third hypothesis is that investors' trading patterns may be

influenced by the salience of financial information.¹⁸ In our dataset, we know the month in which participants received their account statements and so we use the delivery of paper statements as a measure of refreshed information regarding one's wealth.¹⁹ Holding all other factors constant, receiving the quarterly statement might have reminded traders of their losses and possibly elicited a separate trading response, independent of market volatility and momentum effects.

We test these hypotheses using the following multivariate model, estimated using OLS with controls for clustering at the plan and individual levels:

$$\begin{aligned} NET_FLOW_PCT_{i,j,t} = & \beta_0 + \beta_1 TRADING_t + \beta_2 TRADING_t * CRISIS_t \\ & + \beta_3 DEMO_{i,t} + \beta_4 PLAN_{j,t} + \varepsilon_{i,j,t} \end{aligned} \quad (1)$$

Here $NET_FLOW_PCT_{i,j,t}$ represents the i th participant's fractional net flow to equities in the j th plan in month t . $TRADING$ is a vector of variables testing our trading hypotheses. For the volatility test, we include the standard deviation of changes in the daily Standard & Poor's price index for the current month t . For the momentum/contrarian hypothesis, we include the spread between equity and bond returns for the current month as well as two lagged months.²⁰ For the report effect, we include a control indicating whether the participant received his statement in month t . $CRISIS$ refers to a dummy time variable flagging the crisis period, September 2008-March 2009. $DEMO$ includes a vector of participant demographic controls²¹ and $PLAN$ factors represent the firm's industrial sector.²² All regressions also incorporate the key interaction term of interest, $TRADING*CRISIS$, indicating the marginal effects of the controls during the crisis versus the pre-crisis period.²³

Coefficient estimates of equation (1) appear in Table 4. The 'fear factor' hypothesis cannot be rejected, judging from increased trader sensitivity to volatility during the crisis: a 1 percent increase in monthly price volatility was associated with a 1.7 percent shift away from

equities pre-crisis, but the effect more than doubled to 3.8 percent during the crisis period. In standardized terms, a two standard deviation increase in month volatility would mean a shift away from equities of 4.3 percent pre-crisis, but a 9.7 percent shift away from equities during the crisis.

Table 4 here

Regarding the momentum hypothesis, trader responsiveness to recent returns seemed to follow the momentum approach pre-crisis, but it moved to a more contrarian strategy during the crisis months. Focusing on the largest effect, a one percentage point rise in the prior month equity-bond spread was associated with a shift pre-crisis *toward* equities of 0.5 percent (Column 1) which is a momentum-based strategy; during the crisis (Column 3), the effect was contrarian with a shift *away* from equities of 0.5 percent. As another example, consider a two-standard deviation decline in the prior month equity-bond spread: pre-crisis, it would have meant a 4.9 percent move away from stocks, and during the crisis period, a 4.8 percent move into stocks for a ‘buy on the dips’ strategy.²⁴

Regarding the salience of information, it would appear that quarterly statements had little impact on movements into or out of equities in the pre-crisis period; however, during the crisis period, the receipt of quarterly statements was associated with a separate 2 percent shift into equities. In other words, the information had a net contrarian or stabilizing effect during the crisis months when stock prices were falling, after controlling for declining stock prices and increased volatility.

Differences by trader type. Next we consider whether experienced traders behaved differently from inexperienced ones, by incorporating *TYPE*, a variable indicating the individual’s prior experience trading in his account. As noted above, active traders had three or more trades pre-

crisis; infrequent traders had 1-2 trades pre-crisis; and first-time crisis traders engaged in trading for the first time during the crisis. We also include an interaction of TRADING*CRISIS with TYPE to measure marginal effects of active and first-time crisis traders are reported relative infrequent investors:

$$NET_FLOW_PCT_{i,j,t} = \beta_0 + \beta_1 TRADING_t + \beta_2 TRADING_t * CRISIS_t + \beta_3 TRADING_t * CRISIS_t * TYPE_i + \beta_4 DEMO_{i,t} + \beta_5 PLAN_{j,t} + \varepsilon_{i,j,t} \quad (2)$$

Table 5 reports results, with marginal effects in Panel A and total effects given in Panel B. Column 1 (in both Panels) focuses on the pre-crisis period and results are virtually identical to the pre-crisis effects reported previously. During the crisis, active traders reacted to volatility similar to all traders pre-crisis; for this group, a 1 percent rise in monthly market volatility during the crisis was associated with a 1.69 percent portfolio shift away from equities. But infrequent traders and first-time crisis traders reacted much more strongly to changes in volatility during the crisis: the same one percent increase in volatility prompted infrequent traders to shift 4.4 percent of their portfolio out of equities (Panel B, Column 3), while first-time crisis traders shifted 6.8 percent (Panel B, Column 4). Put differently, a two-standard deviation increase in volatility would be expected to induce active traders to shift 4.3 percent of their portfolios out of equities, while infrequent investors and first-time crisis traders would move 11.2 percent and 17.3 percent, respectively. Hence the market volatility or ‘fear factor’ response seems more prevalent among the inexperienced.

Table 5 here

In terms of the momentum test, there was a clear shift from momentum to contrarian behavior during the crisis for all three trader types based on the prior month's equity-bond spread (Panel B of Table 5). But first-time investors became even more contrarian than did infrequent investors, who in turn were more contrarian than active investors. Thus a two standard deviation

decline in the equity-bond spread during the crisis would have been associated with a 7.7 percent movement among first-time crisis investors, 6.5 percent for infrequent investors, and 3.7 percent for active traders. We also note that the information salience effect from quarterly statements was positive for all three types of investors, but for reasons that are not entirely clear, infrequent traders were the most responsive (with a 4 percent effect in Column 3, Panel B) versus active traders and first-time crisis traders (2.79 percent or 2.85 percent, respectively).

Conclusion

The financial crisis of 2008-09 produced some of the largest drops in stock returns and largest increases in market volatility ever experienced in the United States since the Great Crash. Although most 401(k) plan participants did not trade in response to these events over the last few years, some investment patterns did change. The number of participants trading rose, and most notably, the fraction of portfolios shifted out of stocks increased by nearly a factor of eight, rising from 1.2 percent of month prior to the crisis to 11.1 percent during the crisis.

Overall, the 401(k) traders examined here exhibited a rather nuanced set of behaviors during the crisis. As anticipated, there was a heightened sensitivity to market volatility which contributed to larger sales of equities. We interpret this as an adaptive learning response, with some investors becoming aware of the true ‘tail risk’ associated with equities and hence reducing their holdings during the crisis. As might also be expected, this heightened sensitivity was most acute among the least experienced trading group, first-time crisis traders. These first-time traders have demographic characteristics often associated with lower levels of financial literacy, and so they might have been anticipated to respond more negatively to a sharp increase in stock market volatility. Yet at the same time, 401(k) traders became more contrarian in their response to

falling markets during the crisis. Therefore the increased sensitivity to market volatility was offset, in part, by a tendency to ‘buy on the dips’ in response to falling markets. What’s more, first-time crisis traders were more likely to be contrarian during the crisis than active traders.

This leads to the paradoxical conclusion that 401(k) participants with characteristics typically associated with less investment experience may have overreacted to market volatility, while still in aggregate engaging in a more sophisticated contrarian strategy than their active-trading counterparts. We also found surprising the fact that those who received their quarterly account statements during the crisis tended to move *into*, rather than out of, equities during the crisis. Perhaps the provision of account information had an independent stabilizing, rather than destabilizing, effect during the financial crisis.

Overall, these patterns belie a simplistic view that 401(k) participants are, in aggregate, naïve investors who pursue momentum or return-chasing in falling markets, selling equities even to the point of liquidating their entire equity positions. It is true that the less experienced plan traders, those who may have been less financially sophisticated, did react more strongly to abnormally high stock market volatility than did experienced traders. Yet their contrarian ‘buy on the dips’ countervailing response to returns indicates more complex dynamics than might have been expected.

Many 401(k) plans today impose trading restrictions designed to counteract frequent market-timing behavior by active traders, yet few (if any) impose ‘circuit breakers’ prohibiting participants from fleeing to safety in response to market shocks, or precluding employees from piling into equities when conditions improve. This research suggests that such restrictions would be unlikely to alter behavior of many 401(k) participants, even during a period of financial upheaval such as that recently experienced by participants.

In future work, we hope to examine individual trader behavior in more detail in an effort to further disentangle momentum and contrarian trading. For example, active traders might include some performance-chasing active traders and other active traders who dynamically alter their strategy over time. People fleeing equity might comprise both inexperienced investors as well as more experienced individuals taking a strong contrarian approach. The deeper question remains, as to why so few participants trade, either for rebalancing or other reasons, and the prevalence of inertia among majority of 401(k) participants.

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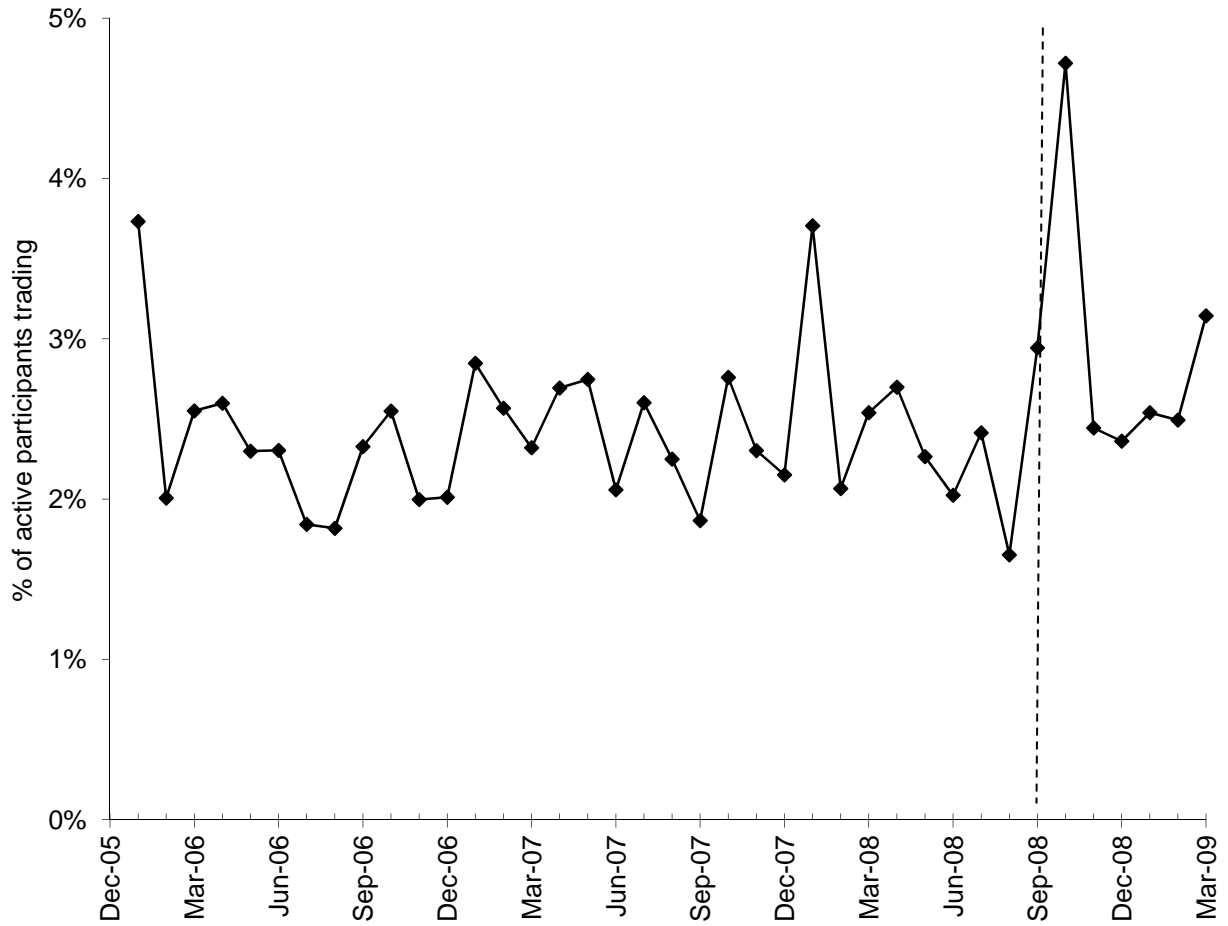


Figure 1. Proportion of 401(k) participants trading over time. *Note:* The vertical line indicates the onset of the crisis period. *Source:* Authors' calculations; see text.

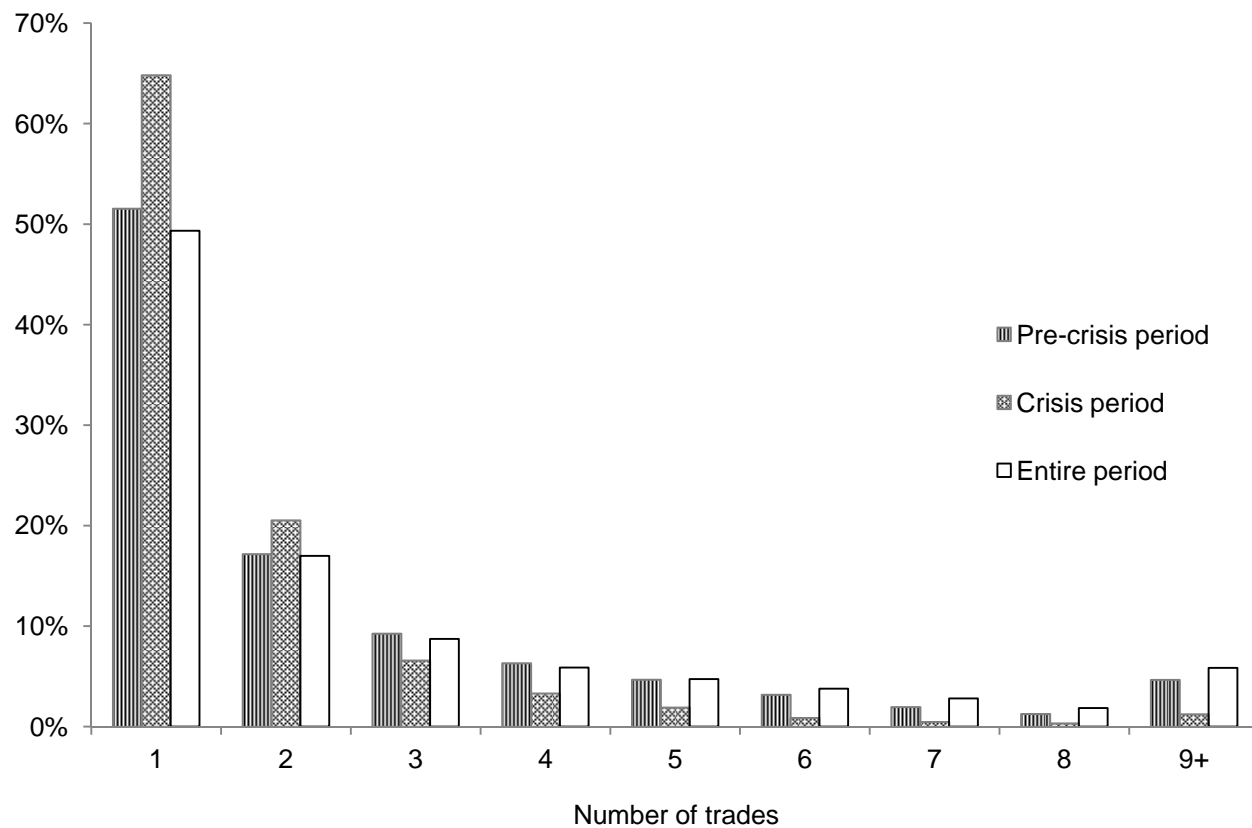


Figure 2. Distribution of the number of trades: Pre-crisis, crisis, and entire period.
Source: Authors' calculations; see text.

Table 1. Incidence of 401(k) trading

	Entire period (1/06-3/09)	Pre-crisis (1/06-8/08)	Crisis (9/08-3/09)	<i>Change</i> (Crisis-Pre-crisis)
# Traders (thousands)	64.80	61.25	81.11	32%
# Participants (millions)	2.25	2.23	2.38	7%
Participants trading (%)	2.5%	2.4%	2.9%	23%
Net flow to equities (%)	-3.5%	-1.2%	-11.1%	789%
<i>Benchmarks:</i>				
Equity/bond spread (%)	-1.69%	-0.17%	-6.89%	3921%
Equity market volatility (%)	1.53%	0.93%	3.59%	286%

Note: Derived from a panel of 1,886 401(k) plans observed January 2006-March 2009. Participants are currently employed and eligible to contribute to the plan in months observed. Traders are participants who exchanged (traded) between one or more investment options in their plans in a given month. Values are monthly averages over the periods indicated.

Source: Authors' calculations (rows 1-4); and WRDS (<https://wrds-web.wharton.upenn.edu/wrds/>).

Table 2. Demographic characteristics of traders as of September 2008

Panel A. All traders

	(1) Entire period	(2) Pre-crisis	(3) Crisis	(4) Diff: crisis - pre-crisis (3-2)	
Age (mean years)	46.2	46.5	46.6	0.1	***
% Male	63%	64%	62%	-2%	***
Av. account balance (\$)	\$114,765	\$123,849	\$108,863	-\$14,986	***
Plan tenure (years)	10.8	11.2	10.5	-0.7	***
% Rich	31%	31%	29%	-2%	***
% Poor	34%	33%	35%	2%	***
% Homeowner	75%	76%	73%	-3%	***
% Web-registered	86%	88%	84%	-4%	***
N	683,399	569,488	320,520		

Panel B. Traders by type

	(5) Active traders, pre-crisis	(6) Infrequent traders, pre-crisis	(7) First-time crisis traders	(8) Diff: active – infrequent traders (5)-(6)		(9) Diff: active - first-time crisis traders (5)-(7)	
Age (mean years)	47.7	46	45.1	2	***	3	***
% Male	69%	62%	57%	7%	***	13%	***
Av. account balance (\$)	\$157,150	\$106,968	\$69,348	\$50,183	***	\$87,802	***
Plan tenure (years)	12.4	10.5	8.6	1.9	***	3.8	***
% Rich	32%	31%	26%	1%	***	6%	***
% Poor	32%	34%	38%	-1%	***	-6%	***
% Homeowner	79%	75%	66%	4%	***	13%	***
% Web-registered	90%	87%	77%	3%	***	13%	***
N	191,572	377,916	113,911				

Note: See Table 6-1 for period definitions. Participant characteristics measured as of September 2008. Active traders traded 3+ times pre-crisis (31 percent) and infrequent traders had 1-2 trades pre-crisis (69 percent). First-time crisis traders did not trade pre-crisis but did trade for the first time during the crisis. Average monthly account balance refers to the average balance in months where the trader had a balance. Wealth indicators are as follows: 'poor' refers to non-retirement wealth < \$7,280; 'rich' > \$61,289; with the reference category omitted. Panel A (column 4) versus Panel B (columns 8-9) differences indicated via t-tests (***) indicates 1% significance level).

Source: Authors' calculations.

Table 3. Portfolio and trading characteristics

	Entire period (1/06-3/09)	Pre-crisis (1/06-8/08)	Crisis (9/08-3/09)
<i>Net flow to equities</i>			
Active traders	-2%	-1%	-5%
Infrequent traders	-5%	-3%	-12%
First-time crisis traders	-20%	NA	-20%
All traders	-4%	-2%	-11%
<i>Percent of portfolio in equities</i>			
Active traders	69%	72%	60%
Infrequent traders	69%	71%	61%
First-time crisis traders	66%	71%	50%
All traders	69%	71%	61%
<i>Number of funds held</i>			
Active traders	5.8	5.8	5.6
Infrequent traders	4.6	4.6	4.7
First-time crisis traders	4.1	4.1	4.0
All traders	5.3	5.4	4.9
<i>Mean number of trades per month</i>			
Active traders	1.2	1.2	2.4
Infrequent traders	1.0	1.0	1.6
First-time crisis traders	1.1	NA	1.1
All traders	1.1	1.1	1.8
<i>Mean % of portfolio traded</i>			
Active traders	22%	22%	20%
Infrequent traders	36%	36%	34%
First-time crisis traders	46%	NA	46%
All traders	28%	27%	31%
<i>Fraction of dollar trading volume</i>			
Active traders	64%	68%	49%
Infrequent traders	31%	32%	25%
First-time crisis traders	5%	NA	26%
All traders	100%	100%	100%

Note: See Tables 6-1 and 6-2 for variable definitions. Percent of portfolio trade is calculated as the sum of total inflows and outflows divided by 2 and divided by the prior month's balance. Equities include equity funds and the equity portfolio of balances funds, estimated at 60 percent of balanced fund assets. Sources: Authors' calculations.

Table 4. Determinants of net flows to equities for 401(k) plan traders: Pre-crisis versus crisis periods.

	Mean	σ	(1) Pre-crisis (marginal) (1/06-8/08)		(2) Crisis (marginal) (9/08-3/09)		(3) Total crisis effect	
<i>I. Market shock test</i>								
Equity market volatility month t (%)	1.53	1.27	-1.68	***	-2.12	***	-3.80	***
<i>II. Momentum/contrarian test</i>								
Equity bond spread month t (%)	-1.69	5.28	0.33	***	-0.32	***	0.01	***
Equity bond spread month t-1	-1.80	4.60	0.53	***	-1.06	***	-0.53	***
Equity bond spread month t-2	-1.25	4.34	0.37	***	-0.16	***	0.21	***
<i>III. Information salience test</i>								
Report month (=1)	0.39	0.48	-0.07	*	2.24	***	2.16	***
N			2,131,938					
R^2			0.05					

Note: The dependent variable in this ordinary least squares regression is participant net flow to equities (monthly mean value of -3.18 percent); explanatory variables are as listed as well as a control for the crisis period. The model includes plan and participant-level controls: male indicators, age home ownership, account balance, web access, year dummies, industry sector indicator and missing value indicator. Column 1 reports coefficients for the pre-crisis period; Column 2 reports additional effects for the crisis period; and Column 3 provides total effects for the crisis period. *** indicates 1% significance level.

Source: Authors' calculations.

Table 5. Determinants of net flows to equities for 401(k) plan traders by type of trader: Pre-crisis versus net flow to equities.
Panel A. Marginal effects

	Mean	σ	(1) Pre-crisis (1/06-8/08)	(2) Crisis (9/08-3/09)	(3) Crisis: Active traders (9/08-3/09)	(4) Crisis: First-time traders (9/08-3/09)
<i>I. Market shock test</i>						
Equity market volatility month t (%)	1.53	1.27	-1.85 ***	-2.57 ***	2.73 ***	-2.37 ***
<i>II. Momentum/contrarian test</i>						
Equity bond spread month t (%)	-1.69	5.28	0.32 ***	-0.26 ***	0.04 *	-0.08 ***
Equity bond spread month t-1	-1.80	4.60	0.53 ***	-1.23 ***	0.30 ***	-0.13 ***
Equity bond spread month t-2	-1.25	4.34	0.36 ***	-0.08 ***	0.00	0.10 ***
<i>III. Information salience test</i>						
Report month (=1)	0.39	0.48	-0.11 ***	4.11 ***	-1.21 ***	-1.15 ***
N	2,131,938					
R ²	0.06					

Panel B. Total effects

	Mean	σ	(1) Pre-crisis (1/06-8/08)	(2) Crisis (9/08-3/09)	(3) Crisis: active traders (9/08-3/09)	(4) Crisis: first-time traders (9/08-3/09)
<i>I. Market shock test</i>						
Equity market volatility month t (%)	1.53	1.27	-1.85 ***	-1.69 ***	-4.42 ***	-6.80 ***
<i>II. Momentum/contrarian test</i>						
Equity bond spread month t (%)	-1.69	5.28	0.32 ***	0.09 *	0.06 ***	-0.03 ***
Equity bond spread month t-1	-1.80	4.60	0.53 ***	-0.40 ***	-0.70 ***	-0.84 ***
Equity bond spread month t-2	-1.25	4.34	0.36 ***	0.29	0.29 ***	0.39 ***
<i>III. Information salience test</i>						
Report month (=1)	0.39	0.48	-0.11 ***	2.79 ***	4.00 ***	2.85 ***
N	2,131,938					
R ²	0.06					

Note: See Table 6-4. The regression also includes interaction terms for the crisis, and for active and first-time traders during the crisis (infrequent traders are the reference group). The model includes plan and participant-level controls: male indicators, age, home ownership, account balance, web access, year dummies, industry sector indicator and missing value indicator. Panel A, Column 1 reports coefficients for the pre-crisis period; Column 2 additional effects for the crisis period (also the additional effect for infrequent traders, the reference group); Column 3 additional effects for active traders during the crisis; and Column 4 additional effect for first-time traders during the crisis. Panel B summarizes total effects for the pre-crisis period and for the three types of traders in the crisis. *** indicates 1% significance level.

Source: Authors' calculations.

Appendix Table A1. Net flow to equities, rebalancing test

	Mean	(1) Pre-crisis period (1/06-7/08)	(2) Crisis period (9/08-3/09)	(3) Total effects
<i>I: Rebalancing test</i>				
Risk share change month t-1 (%)	0.02	-0.15 ***	-0.13 ***	-0.28 ***
<i>II: Market shock effect</i>				
Equity market volatility month t (%)	1.53	-6.09 ***	2.09 ***	-4.01 ***
<i>III: Report effect</i>				
Report month dummy	0.39	-0.29 ***	1.23 ***	0.94 ***
N		2,131,938		
R^2		0.05		

Note: This table reports marginal effects from an OLS regression of net flow to equities (mean monthly value of -3.18%) on several independent variables, with mean values shown, and a dummy interaction term for the crisis period. Column 1 reports coefficients during the pre-crisis period; Column 2, additional effects for during the crisis period; and Column 3, total effects for the crisis period. Regressions include plan and participant controls.

Source: Authors' calculations.

Appendix Table A2. Net flow to equities by type of trader, rebalancing test

Panel A. Marginal effects

	Mean	(1) Pre-crisis period (1/06-7/08)	(2) Crisis period (9/08-3/09)	(3) Crisis period active traders (9/08-3/09)	(4) Crisis period first-time traders (9/08-3/09)
<i>I: Rebalancing test</i>					
Risk share change month t-1 (%)	0.02	-0.15 ***	-0.10 ***	-0.44 ***	-0.005
<i>II: Market shock effect</i>					
Equity market volatility month t (%)	1.53	-6.03 ***	1.72 ***	1.90 ***	-1.98 ***
<i>III: Report effect</i>					
Report month dummy	0.39	-0.28 ***	2.48 ***	-0.51 ***	-1.38 ***
N		2,131,938			
R ²		0.06			

Panel B. Total effects

	Mean	(1) Pre-crisis period (1/06-7/08)	(2) Crisis period active traders (9/08-3/09)	(3) Crisis period Infrequent traders (9/08-3/09)	(4) Crisis period first-time traders (9/08-3/09)
<i>I: Rebalancing test</i>					
Risk share change month t-1 (%)	0.02	-0.15 ***	-0.69 ***	-0.25 ***	-0.26
<i>II: Market shock effect</i>					
Equity market volatility month t (%)	1.53	-6.03 ***	-2.41 ***	-4.31 ***	-6.30 ***
<i>III: Report effect</i>					
Report month dummy	0.39	-0.28 ***	1.69 **	2.20 ***	0.82 ***
N		2,131,938			
R ²		0.06			

Note: This table reports marginal effects from an OLS regression of net flow to equities (mean monthly value of -3.18%) on several independent variables, with mean values shown. The regression includes a dummy interaction term for the crisis period and for active and first-time traders, with infrequent traders as the reference group. In Panel A, Column 1 reports coefficients for the pre-crisis period, which includes only active and infrequent traders; Column 2, the additional effect for the crisis period (which is also the additional effect for the reference group of infrequent traders); Column 3, the additional effect for active traders during the crisis period; and Column 4, the additional effect for first-time traders during the crisis period. Panel B summarizes total effects for the pre-crisis period as well as the three types of traders during the crisis period.

Regressions include plan and participant controls. *Source:* Authors' calculations.

Endnotes

¹ DOL (2010) reports that private profit-sharing and thrift plans covered over 62 million active participants as of 2008. ICI (2011) reports that 401(k) and similar DC plan assets reached \$3 trillion as of September 2010. Vanguard (2010) reports that the average equity allocation of its DC plans was approximately two-thirds.

² In our dataset, the number of participants trading per month rose from 2.23 million pre-crisis to 2.38 million during the turmoil period.

³ See among others, Agnew, Balduzzi and Sunden (2003); Tang, Mitchell, Mottola and Utkus (2010); Yamaguchi, Mitchell, Mottola and Utkus (2007); and Young and Utkus (2011).

⁴ See Odean (1999); Barber and Odean (2000).

⁵ Tang, Mitchell, Mottola and Utkus (2010) also show that most 401(k) participants do not invest particularly efficiently in non-crisis times, despite having a well-designed investment menu.

⁶ The dataset is drawn from Vanguard's recordkeeper information under restricted access conditions.

⁷ The dataset only includes trading consciously conducted by the 401(k) participants. It does not include the rebalancing by portfolio managers.

⁸ Using zip codes of individual participants, we impute their nonretirement wealth and homeownership provided by IXI Corporation.

⁹ We confirm this definition by checking whether the daily S&P 500 returns are within one standard deviation of the mean and if monthly S&P 500 volatilities are within one standard deviation of volatility mean (the monthly volatility is derived from S&P 500 daily return data from January 2008 through March 2009). Over this period, the only months with more than half of daily returns and monthly volatilities outside one standard deviation are September 2008-February 2009.

¹⁰ The trading dataset is not a balanced panel; that is, while many participants are in the dataset over the entire period, we also include participants who arrived in or departed from their DC plan over the period. These individuals appear in the analysis only for months when observed. As noted in Table 1, the total number of participants in the sample grew by seven percent, which includes both new entrants and well as those leaving the plan. We do not exclude new entrants or those leaving the plan in order to avoid a tenure-biased sample.

¹¹ Equity assets include both domestic and international funds and company stocks, as well as the equity portion of balanced funds such as target-date, static allocation and traditional balanced funds (where the equity position is assumed to be 60 percent of the fund's balance). Fixed-income assets include bond funds, money-market funds and contract funds.

¹² In this paper we concentrate on participant-driven trading in existing balances as these represent the bulk of retirement assets; changes in future contributions are usually tiny compared to balances.

¹³ Participant characteristics are collected as of September 2008.

¹⁴ First-time traders can include long-tenured participants who participated in the DC plan prior to January 2006 but simply did not trade until the crisis period; they can also include new participants entering their DC plan after January 2006 or even during the crisis period itself and then trading in the crisis months.

¹⁵ Note that trading population varies over time and so these monthly statistics cannot be simply annualized. For instance, first-time traders on average moved 20 percent of their balance to equities during the crisis period and traded 1.1 times per month, but one cannot extrapolate this figure to infer that first-time traders sold out of equities entirely (a 20 percent per month shift over seven months) or traded 8 times (1.1 over seven months). This is because even among traders, trading is infrequent, and so the composition of the trading group varies from month to month.

¹⁶ Other research on aggregate investment flows has suggested that trading volume generally rises with market volatility. See Epps and Epps (1976), Karpoff (1987), and Cornell (1981).

¹⁷ However, evidence on this point is mixed: for instance Grinblatt and Keloharju (2001) report that Finnish households display contrarian behavior.

¹⁸ A related phenomenon is the “ostrich effect,” where investors are more likely to look at their wealth holdings online in rising markets versus falling markets (Karlsson, Loewenstein, and Seppi, 2009).

¹⁹ Paper statements are generally sent quarterly.

²⁰ Correlations between current month equity volatility and the spreads between equity and bond returns for the three time lags are negative in pre-crisis and the crisis periods, as well as over the entire period.

²¹ Participant control variables include indicators for male, age, tenure, home ownership, account balance, and web access. We also include year dummies. For a robustness check, we also included tenure in the regressions to check whether new entrants and leavers behaved differently; results were quantitatively similar. The same robustness check for regression (2) in the following section also produced the same coefficient pattern as without tenure.

²² Multivariate analysis below also controls for the plan’s industry sector (agriculture/mining/construction; transportation/communication/utilities; manufacturing; media/entertainment/leisure; trade; finance/ insurance/real estate; professional /non-profit services; education /health; and government services).

²³ Standard errors are also adjusted for heteroskedasticity due to plan clustering of participant data.

²⁴ Effects for the current month and two-month lagged spread show a similar contrarian effect; on a net basis, however, there was a small momentum effect for the lagged spread during the crisis period.