Social Interaction Effects and Individual Portfolio Choice:

Evidence from 401(k) Pension Plan Investors

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Abstract

This paper explores whether social interactions influence investors' decisions to hold equity and allocate their portfolios, in the context of defined contribution retirement savings accounts. Using a rich dataset of 401(k) plans, we provide empirical evidence that participants are influenced by their coworkers when they make equity investment decisions. Specifically, we show that individuals are likely to increase their risky share if their peers earned higher equity returns in the past period relative to average returns; they are also likely to decrease their risky share when past peer equity returns are strongly negative. These results are consistent with the limited attention hypothesis that people are more likely to pay attention to significant outcomes.

I. Introduction

Standard portfolio choice models typically make the assumption that individual investors are fully informed and thus make independent asset allocation decisions to maximize their lifetime utility. Yet economists have long noticed that many individuals make economic decisions based on information received via social interaction.[1] Several studies have found that such word-of-mouth communication has a strong influence on investors' decisions to enter the stock market,[2] but no previous work explores whether social interactions also affect the extent of risk exposure among investors. This paper examines the influence of word-of-mouth communication among participants in the most rapidly growing form of pensions in the United States, namely 401(k) plans.

[1] Social interaction effects are found in various economic settings including criminal activities (Glaeser, Sacerdote, and Scheinkman, 1996), social group membership acquisition (Sacerdote 2001), and automobile choices (Grinblatt, Keloharju, and Ikaheimo, 2008).

[2] See Hong, Kubik, and Stein (2004), Brown, Ivkovic, Smith, and Weisbenner (2008), and Kaustia and Knupfer (2010).

Our focus is on how peer interactions influence the extent to which individuals hold equities in their retirement accounts. We show that social interactions have direct and measurable effects on 401(k) plan investors' equity exposure. Using data from the Vanguard Group covering over 600 defined contribution (401(k)) plans and their participants, we track monthly trading and contribution records as well as participant residential ZIP codes to identify both individual and peer effects. We confirm that 401(k) investors are more likely to increase their equity holdings after their peers have enjoyed higher returns on their own equities in the past period. This effect is stronger in workplaces where the equity exposure rate is high, suggesting that risk-loving people are more likely to be impressed by short-term excess equity returns and increase their risk exposure. Furthermore, investors also decrease their equity holdings after their peers experience substantially negative equity returns. To make sure that our results are not driven by other mechanisms, we run multiple robustness checks to rule out alternative explanations.

Our unique dataset from Vanguard gives us an opportunity to examine social interaction effects within workplaces. Our sample of close to two million observations contains the ZIP code of each individual's residence. This allows us to explore social interaction among workers within the same firm and city. We consider this to be an improvement upon prior studies on peer effects, where "peers" are typically defined as people living within the same city or ZIP code. Our approach allows us to explore peer effects in much smaller communities, where people are much closer in their relationships. Our dataset also includes abundant variables of investor characteristics and financial

conditions, as well as monthly updated individual contribution and trading records. We take advantage of the richness of our dataset to make various controls in our analysis.

Our study is related to a growing literature on peer influence in investment decisions. In view of the fact that the average 401(k) investor's financial knowledge is limited (Lusardi and Mitchell 2009), it is reasonable to suspect that people may solicit peers' advice when making investment decisions. Selective communication models suggest that people may enjoy discussing stock market investments with their colleagues when they enjoy high returns on equities (Festinger, 1957, Benabou and Tirole, 2002). There is also evidence that people may align their investments with the investments of people in their social group, doing so to "keep up with the Joneses" (Bernheim 1994). If so, people may increase their equity exposure when their peers experience a positive outcome in the market. Furthermore, this can have an aggregate impact if asset prices rise with market participation. Thus, holding more equity can have a direct influence on the equity premium, as shown by Heaton and Lucas (2000). Other analysts have also suggested that large inflows of funds can generate momentum returns (Jegadeesh and Titman 2001). To our knowledge, we are the first to explore whether these patterns are applicable in the pension arena.

We outline the rest of the paper as follows. Section II reviews the previous literature. Section III introduces the data. Section IV discusses the empirical strategy, and presents the results. Section V provides robustness checks. We conclude in Section VI.

II. Previous Literature

Social interaction has long been considered an important factor in influencing people's economic decision-making. Banerjee (1992) and Bikhchandani, Hirshleifer, and Welch (1992) present models of social interaction as a means of observational learning, and Bernheim (1994) models the "keeping up with the Joneses" effect, i.e. people trying to conform to the social group to which they belong. Cao and Hirshleifer (2009) discuss why people may converge upon poor decisions as a result of group communication. However, Manski (1993, 2000) argues that empirically identifying social interaction is difficult since unobserved variables may induce a spurious correlation between individual choices and peer choices. Nevertheless, a large body of research uses various identification strategies to explore the social interaction effect in various economic settings, including criminal activities (Glaeser, Sacerdote, and Scheinkman 1996), social group membership acquisition (Sacerdote 2001), automobile choice (Grinblatt, Keloharju, and Ikaheimo 2008), office selection (Topa, Bayer, and Ross 2009), and health plan choice (Sorensen 2006).

There is also a set of studies examining how social interaction influences investment decisions in practice. Shiller and Pound (1989) report survey evidence indicating that investors ask their friends for trading ideas. Hong, Kubik, and Stein (2004), and Brown, Ivkovic, Smith, and Weisbenner (2008) find that regular investors are more prone to participate in the stock market when more of their neighbors are investing in stocks. Using other datasets, Hong, Kubik, and Stein (2005), Ivkovic and Weisbenner (2007), and Shive (2010) all find that trades of mutual fund managers and retail investors in the same neighborhood are correlated. These studies mostly focus on action-based

social learning, or in other words, people mimicking their neighbors' investment actions, without considering the influence of peer outcomes.

In contrast with these works, Kaustia and Knupfer (2011) examine how peer outcomes affect individual investment decision-making. Specifically, using stock market data from Finland, they find that people are more likely to enter the stock market when their neighbors enjoyed higher returns in the past period. The present paper is related to this work, in that we also use peer equity returns as the main vehicle for identifying social interactions. However, unlike other studies, we focus not on the decision to enter the stock market, but on how the share of risky investments within 401(k) accounts is influenced by peer returns.

We are also interested in contributing to the growing literature on 401(k) investment patterns. Many authors have shown that financial literacy among U.S. workers is low, including Lusardi and Mitchell (2006, 2008) who report that only one third of respondents in the Health and Retirement Study (HRS) can correctly answer correctly three simple questions about inflation, compound interest, and risk diversification. This is important since the least financially literate are also least well-prepared for retirement (Lusardi and Mitchell, 2006, 2007). They are also less likely to invest in stocks (Kimball and Shumway, 2006, van Rooij, Lusardi, and Alessie, 2007, Yoong, 2007). In view of this widespread financial illiteracy, we can see why employees will tend to talk to others at the workplace in search of information. There is evidence that employee saving behavior is strongly affected by plan sponsor behavior, particularly the default contribution rate and asset allocation in 401(k) plans (Madrian and Shea, 2001). In research closer to ours, Duflo and Saez (2002) show that people's decision to

enroll in a retirement plan is directly affected by co-worker behavior. In what follows, we extend this literature to evaluate whether peers influence not only stock market participation, but also portfolio risk exposure.

III. Data and Descriptive Statistics

We analyze a proprietary dataset from the Vanguard Group on 401(k) pension plans administered by that firm. Vanguard is one of the largest 401(k) plan administrators in the U.S., and the plans cover a wide rage of industries, with a large variation in plan size and fund choices. The dataset also includes a number of investor characteristics including age and sex, financial characteristics including household income and non-retirement financial wealth[3], and, invaluable for our purposes, the ZIP code of each respondent's residence. The administrative records include individual contribution and trading records updated monthly.

Previous studies of social interaction effect typically define "community" or "neighborhood" as people living in the same Metropolitan Statistical Area (MSA) (Brown, Ivkovic, Smith, and Weisbenner 2008, Hong, Kubik, and Stein, 2005) or ZIP code (Kaustia and Knupfer, 2011, Shive, 2010). One drawback to these approaches is that when community is defined in this way usually includes a very large population and covers a large geographical area. Accordingly, this could easily dilute the true effect of peer-to-peer communication. As an example, it is difficult to imagine a management

[3] We use IXI wealth code for non-retirement financial wealth. IXI wealth code is generated by the IXI Corporation. It is a categorical measurement of household non-retirement financial assets based on ZIP code. We collapsed the original wealth classes into three groups: Poor (wealth<$7,280), Medium ($7,280 to $61,289), and Rich (>$61,289).

consultant living in Manhattan discussing her pension portfolio with a supermarket manager in Brooklyn, New York.

The richness of our dataset allows us to focus on social interaction within co-workers. For our study, we define "co-workers" as those people who work for the same employer, enroll in the same 401(k) plan, and live in the same MSA.[4] In what follows, we use the word "workplace" in the following sections to denote participants in the same MSA and the same plan. Since each 401(k) plan has a unique investment choice menu, people in the same workplace are hypothesized to be likely to discuss 401(k) investment performance with their co-workers. It is also plausible to assume that an individual has a closer relationship with his co-workers than with random people living in the same city. As a result, since we can identify coworkers, this study has an advantage over previous studies in its ability to cleanly explore social interaction effects.

The entire dataset spans the period January 2005 to December 2009, and over 1.7 million employees participated in those plans at some time during the sample period. We randomly selected 10%, or 173,923 of these participants, to follow for our study, which covers 614 plans and 279 MSAs. In Panel A of Table 1, we report the demographic and financial characteristics of the participants, which we use as controls in the multivariate regression analysis below.

Table 1 here

The main goal of this paper is to study the relationship between individual participants' equity holdings and the past equity returns received by people in the same workplace. Every plan in our sample has at least one bond or money market fund, one

[4] While it is possible that a firm may have more than one workplace in a city, it is reasonable to assume that employees in the same plan and city have a higher chance to communicate with each other.

balanced fund, and one pure equity fund in the menu to choose from, so that every participant observed could elect an equity ratio ranging from 0% to 100%. The fraction of dollars invested in equity in each participant's 401(k) account balance is measured at the end of each quarter, along with the same statistics for every participant in his workplace. We construct each person's "workplace level equity ratio" by averaging the equity ratio of all other participants in that workplace that quarter. (We weight by participant instead of assets as social interaction occurs between individuals rather than dollars.) Similarly, we construct the "workplace level equity return" by averaging the quarterly return on equity funds of each participant in the same workplace.

We measure the equity exposure of each participant in our sample at the end of every quarter. On average, a participant stays in the plan for close to 12 quarters within our sample period. This gives us a total of 1,933,592 observations in our regression analysis. In Panel B of Table 1, we report results for those person/quarter observations. Here we see that 401(k) plan participants tend to invest most of their retirement assets in equities; in fact, only 8% of the participants sampled have no equity exposure. The 25th percentile participant has more than half of his 401(k) assets invested in equities. On average, close to 70% of 401(k) assets are invested in the equity market. Compared to previous studies that report lower (10-30%) stock market participation rates among all individuals (Brown, Ivkovic, Smith, and Weisbenner, 2008, Kaustia and Knupfer 2011), our sample has a much higher percentage of people invested in equity. There are two reasons that contributed to this difference. First, a large proportion of the whole population does not have a job or steady income, and hence is less likely to invest in stocks, while all of the participants in our sample are employed. Second, there is no

barrier to investing in equity funds once one is enrolled in a 401(k) plan, whereas investing in stocks requires the effort and initiative to open a brokerage account.

Over the period examined, equity returns were quite volatile and included both a bull market and a deep financial crisis. Accordingly, the highest quarterly equity return observed at the workplace level exceeded 40%, while the lowest was -26%. On average, the quarterly workplace level equity return was just 25 basis points.

IV. Methods and Identification

4.1. A Baseline Model

The baseline model used to explore peer effects on individual portfolio risk exposure posits that an individual's equity fraction in his 401(k) portfolio is affected by the average equity holding of other workers in the same workplace. This approach is similar to that used by Hong, Kubik, and Stein (2005), who examined peer effects among mutual fund managers. Pooling the data from January 2005 to December 2009 and denoting that an individual *i* works in plan *p*, city *c*, we run the following regression:

$$Y_{p,c,i,t} - Y'_{p,c,i,t} = a + b_1 * Q_{p,c,-i,t-1} + b_2 * R_{p,c,i,t-1} + b_3 * Z(i) + b_4 * F(p) + \\ + b_5 * F(c) + b_6 * F(t) + e \quad (1)$$

where $Y_{p,c,i,t}$ denotes the equity ratio of individual *i*'s portfolio at the end of period *t* (and $Y_{p,c,i,t-1}$ is the same except lagged); $Q_{p,c,-i,t-1}$ denotes the participant-weighted average past-period equity ratio of the portfolios held by individual *i*'s peers; $R_{p,c,i,t-1}$ denotes the individual's return on equity in the past period. $Y'_{p,c,i,t}$ denotes the 'hypothetical equity ratio' of the individual's portfolio at the end of period *t* in the case that he kept his asset allocation unchanged from the end of period *t-1*. To understand this approach, consider

an example that a person has $10,000 in his 401(k) account at the end of past period. He invested 50% of his assets in an equity fund, while the other half is put in a bond fund. Suppose that the equity fund earns 10% return over the current period, while the bond fund earns 0% return. At the end of the period, he will have $5,500 in equity and $5,000 in bond, hence an equity ratio of 52.7%. Even though the person did not change his asset allocation in the current period, his equity ratio still changes because of different returns from different funds. Hence, simply taking the difference of the current period equity ratio and the past period equity ratio on the left hand side of the equation would give us a biased equity ratio change. To solve this problem, we construct the hypothetical equity ratio. We use the difference of true equity ratio and hypothetical equity ratio as the dependent variable. We control for an individual's own lagged equity exposure, as we hypothesize that each person's own risk attitude is still the main determinant of his equity exposure, and should be relatively consistent over time. The interaction of individual current period equity return and past period equity ratio is also included, in order to control for the equity ratio change that is induced by the individual's own equity return. Z(i) represents individual demographic and financial characteristics. We control for a large group of individual factors, including age, plan tenure, gender, household income, non-retirement financial wealth, and web access to the 401(k) account. We also include plan dummies F(p), MSA dummies F(c), and time dummies F(t) to control for workplace fixed effects and time variant effects. Furthermore, we cluster at the workplace level. If social interaction effects influence individuals' equity exposure, the coefficient b_1 should be positive and statistically significant. As in Hong, Kubik, and Stein (2005), we use quarter-end holdings: for example, for a sample worker seen in June 2005, we examine

the correlation of his June equity exposure against his own equity exposure and the average equity exposure of his peer at the end of March 2005. Therefore, over the 5-year period, we have 20 time points of analysis.

Table 2 reports multivariate regression coefficient estimates for the baseline model. Conditional on own past period returns, it is interesting that peers' equity exposure does not have a statistically significant effect. While our result is different from Hong, Kubik, and Stein (2005)'s finding, this does not tell us that there is no social interaction effect in our study. As Manski (1993) points out, such a baseline model suffers from a serious identification problem, which will produce spurious results which shall not be interpreted as social interaction effects.

Table 2 here

Suppose there exists an unobserved variable $U_{p,c,t-1}$ that affects everyone's portfolio choice in the same workplace, then the 'true' model would be:

$$Y_{p,c,i,t} - Y'_{p,c,i,t} = a + b_1 * Q_{p,c,-i,t-1} + b_2 * R_{p,c,i,t-1} + b_3 * Z(i) + b_4 * F(p) + \\ + b_5 * F(c) + b_6 * F(t) + b_7 * U_{p,c,t-1} + e \quad (2)$$

where $Q_{p,c,-i,t-1} = G(U_{p,c,t-1}) + e'$ (3)

Plugging equation (3) into (2) gives us

$$Y_{p,c,i,t} = a + b_1 * G(U_{p,c,t-1}) + b_7 * U_{p,c,t-1} + b_2 * R_{p,c,i,t} + b_3 * Z(i) + b_4 * F(p) + \\ + b_5 * F(c) + b_6 * F(t) + e + b_1 * e' \quad (4)$$

In this case, social interactions would not have a direct effect on people's portfolio choices, but instead, an apparent 'correlation' between Y and Q in the baseline model

might be due to an omitted unobserved variable U.[5] Even if we controlled for plan and workplace fixed effects as well as time dummies, there could still be other unobserved factors such as changes in the information set or economic environment to a workplace that may affect participants' portfolio choice. As a result, we cannot interpret the positive correlation as a causally social interaction effect.

4.2. Use peer returns on equity as identification

To identify a convincing causal pathway for social interaction effects on 401(k) participant equity exposure patterns, we next turn to outcome-based social influence as an identification strategy to analyze peer effects in the 401(k) universe. People do not just merely copy others' behaviors, but rather they adopt the strategies that yield the best results. Such outcome-based social interaction has been documented in other fields (Bandura and Walters 1963, Call and Tomasello 1994), and has been theoretically modeled in economics (Ellison and Fudenberg 1993, 1995; Banerjee and Fudenberg 2004). In the present context, we hypothesize that 401(k) participants are more likely to increase their equity exposure after they observe high peer equity returns.

This approach was followed by Kaustia and Knupfer (2011) to explore peer effects in stock market participation in Finland. Using microeconomic data on all Finns, they report that positive returns earned by people living in a given neighborhood were correlated with more stock market participation in the neighborhood in the following

[5] To illustrate the issue, suppose that we had two plans in our sample, one an investment bank in New York City, and the other a milk-producer in Nebraska. The employees in the investment bank could be more familiar with equity assets and more financially literate, and therefore more likely to invest in equities, compared to those working in the milk factory. Hence the baseline model would find significant positive correlation between employee equity exposures and peer equity exposure but this correlation would be due to the similarity of personal characteristics within each workplace, and not measure the social interaction effect.

month. In contrast, we analyze peer return effects at the workplace. Moreover, since most of our 401(k) participants hold some equity (versus the 10% market participation rate in the Kaustia and Knupfer (2011)), there are far fewer people likely to be new equity investors. We examine the change in equity exposure across the whole set of employees as follows:

$$Y_{p,c,i,t} - Y'_{p,c,i,t} = a + b_1 * R_{p,c,-i,t-1} + b_2 * Q_{p,c,i,t-1} + b_3 * R_{p,c,i,t-1} + b_4 * Z(i) + \\ + b_5 * F(p) + b_6 * F(c) + b_7 * F(t) + e \quad (5)$$

where Y, Q, $R_{p,c,i,t}$, Z(i), F(p), F(c), and F(t) are identical to equation (1). Now $R_{p,c,-i,t-1}$ is the participant-weighted average past-period equity return of workers other than *i*, who are covered by plan *p* and live in city *c*. For example, for a person in our sample at the end of June 2005, we explore the correlation between his current equity exposure and his prior equity exposure, the average equity exposure of his peers the prior quarter, and his peer's average equity return over the period of January 2005 to March 2005.

Our main hypothesis is that if social interaction has an effect on individual equity exposure, then higher peer returns are more likely to induce individuals to increase their own equity shares. Thus, the coefficient b_1 should be positive and significant if outcome-based social interaction occurs. Since participants can only know their peers' returns by talking to one another, we explicitly identify the social interaction effect with this approach. We regress the dependent variable on the lagged return and the equity ratio to eliminate the possibility of reverse causality. It is possible that increased inflows into equity funds could result in higher returns on the funds held by participants in the same workplace, but such a scenario would not have any effect on lagged return and equity ratios. Furthermore, there may be time-varying shocks producing positive correlations

between local returns and equity exposure. When the market's return is high, media coverage of the stock market may increase, capturing some investors' attention, and leading to a higher risky share. To rule out this possibility and other possible time-varying influences, we include quarter dummy variables in our regression.

There may also be time-invariant local unobserved variables that influence individuals' equity exposure. For example, people in different cities may have different levels of financial literacy, which leads to different levels of equity exposure. Such a possibility would not influence the relationship between peer returns and participant equity ratios. In any event, we eliminate all such influences by controlling for geography with Metropolitan Statistical Area (MSA) dummy variables.

Another possibility is that people in the same plan may experience common shocks. A plan sponsor may decide to provide more information on financial planning to its plan members when the market's return is high. Furthermore, each plan has a different menu of investment options, and an individual may only elect the funds offered in his own plan. To eliminate this effect we control for plan dummy variables. Finally, we cluster at the workplace level for robust standard errors.

Table 3 shows coefficient estimates from regressing individual equity exposure levels on lagged peer equity return. Column 1 omits lagged peer equity ratio; Column 2 provides the full model. As we can see, our main variable of interest, the lagged peer equity return, has a positive impact on the dependent variable, as expected. After incorporating the full model, the coefficient of lagged peer equity return equals 0.148.

Table 3 here

It is interesting to see that the individual's own past period return has a negative and statistically significant impact on his current period change in equity exposure. One concern is that own past period returns might be highly correlated with peers' past period returns. We find that the simple correlation of own and peer past period equity returns is 0.86, while the correlation of these two variables conditional on all the other control variables is 0.54. This seems to suggest that there exists some multicollinearity between these two variables.

This, however, is not a major concern, as the OLS estimator, even in the presence of multicollinearity, is still the best linear unbiased estimator. Multicollinearity can increase the variation of the regressors, making the estimates inefficient. Yet, even with higher variance, the coefficient of our main variable of interest remain statistically significant, suggesting that peer return has a positive impact on individual 401(k) investor's equity exposure change. Specifically, holding market effects and individual's own past period equity return constant, our result translates to a .5 percentage point increase in the individual equity ratio, given a one standard deviation increase in the explanatory variable. This suggests that, while people still mainly follow the status quo regarding risk exposure, there are peer influences on 401(k) participant equity holdings.

4.3. Impact of peer return at different levels on participant equity ratio

Simply regressing 401(k) participant equity exposure on peer equity return may not tell the whole story. One reason is that prior studies have noted that people are more likely to discuss their success stories than their failures, out of a desire to maintain self-esteem (Festinger, 1957, Benabou and Tirole, 2002) or other motives. Hirshleifer (2009)

models investors who discuss trades that generate a profit, but do not discuss those where they lose money. Such selective communication may result in different levels of social interaction effects when people experience different levels of equity returns. Furthermore, people have limited attention (Kahneman, 1973) and may use simple heuristics to make financial decisions.

Hou and Moskowitz (2005), Cohen and Frazzini (2008), Menzly and Ozbas (2010), and Cen, Chan, Dasgupta, and Gao (2009) find that investors can be inattentive to useful information in financial markets, and such inattention can lead to over-reaction to some information. Yuan (2008) reports that stock investors' trading behavior is affected by attention-grabbing events such as record-breaking market indexes and front page articles. Thus, a high level of peer excess return on equities is more likely to capture an individual's attention and lead him to increase his own equity holdings. Kaustia and Knupfer (2011) provide empirical evidence that people are much more likely to participate in the stock market when peer returns are large and positive. Likewise, an individual may also reduce his equity ratio when his peers experience strong negative returns.

To explore this phenomenon in the defined contribution arena, we modify our model by disaggregating workplace equity returns following Kaustia and Knupfer (2011). First, we estimate a piecewise model by differentiating positive and negative returns; the results appear in Column 1 of Table 4. Positive past peer returns have a much higher impact on individual equity ratios than negative past peer returns. A one percentage point increase in peer equity return is associated with 0.24 percentage point increase in individual's equity ratio, when peer return is positive. The impact of prior negative peer

returns is much smaller. This finding is consistent with the results of Kaustia and Knupfer (2011)'s study on stock market participation rates. We then proceeded by disaggregating past peer equity returns further into six categories results in groups where the return was in excess of 4 percent; between 2 and 4 percent; between 0 and 2 percent; between –2 and 0 percent; between –4 and –2 percent; and less than –4 percent (the cutoff points are chosen so that approximately 10 percent of the distribution is within the top and bottom categories). Model 5 then replaces the workplace equity return variable with these categorical variables (between 0 and 2 percent is the reference return group).

Table 4 here

Both Columns 2 and 3 show positive and statistically significant coefficient on the return category in excess of 4 percent. In Column 3, the coefficient on the variable of workplace return in excess of 4 percent equals 1.4, which means that a person is likely to increase his equity ratio by 1.4 percentage points if past period peer equity returns exceed 4 percent (versus the reference return 0 - 2 percent). Interestingly, when peers experience returns lower than negative 4 percent, the individual decreases his equity ratio by 0.9 percentage points versus the reference return group. When peer return is modestly positive or negative, this has relatively little impact on individual equity ratio (While the groups have statistically significant coefficient at 5% or 10% level, the magnitudes are much smaller than the top and bottom return groups). This result is consistent with the limited attention hypothesis: workers are more likely to pay attention when other people are talking about extreme returns, whether positive or negative. Our finding does not support the selective communication hypothesis, that individuals are more likely to discuss their investments only when they have positive experiences. However, it also

does not reject the hypothesis. It is possible that more people talk about their investment when they have high returns versus low returns, bur the evidence suggests that people pay attention to extreme outcomes and may notice large negative returns even when there are only a few people talking about them. We provide an illustration of the impacts of different peer returns in Figure 1: peer returns have the strongest influence when the return is in excess of 4%, or below –4%.

Figure 1 here

Our results suggest that social interaction effects can have a significant impact on workers' equity exposure, especially when the stock market is volatile. Specifically, in a market where strongly positive or strongly negative returns often occur, individuals are predicted to frequently change their equity exposure. Whether such effect is beneficial remains an open question for future research.

4.4. New Entrants or Re-entrants into Equity Funds

Thus far we have focused on exploring how past period peer returns affect 401(k) investors' equity exposure. Yet we are also interested in a subset of these investors, namely those who did not invest in equity in the past period. In this section, we investigate whether these participants are affected by their peers' returns in deciding whether to invest in equity funds. This serves two purposes. First, using this sample, we can directly compare our results to previous studies on stock market participation. Second, people with no equity investment last quarter have no prior period equity return, and hence, we need not be concerned about multicollinearity problem as discussed in section 4.2.

We explore whether past period peer returns affect the probability of investing in equity funds for people with no prior-quarter equity investment; our sample size is of 166,685 observations. As shown in Panel A of Table 5, about 7% of such investors newly contribute to equity funds each quarter. Kaustia and Knupfer (2011) report that only around 0.1% of people enter into the Finland stock market each month. As we have discussed, lower barriers to investing in equity funds in U.S. 401(k) plans make it possible for more participants to move into equity funds.

Table 5 here

In Panel B, we report OLS regression results where the dependent variable is the probability of new entrants or re-entrants into equity funds in a quarter. Here past period equity returns have a statistically significant effect on the probability of non-equity investors entering the equity market. The coefficient on the peer return variable is a statistically significant 0.005, meaning that a one standard deviation increase in peer return is associated with an increase of 1.35 percentage points in the probability of entering the equity market. Our result therefore translates to a 20% increase in new equity fund entrants, which is economically significant. This result is similar to Kaustia and Knupfer (2011) who report an almost one percentage point increase in the probability of buying stocks, given a one standard deviation increase in peer stock returns.

Disaggregating peer returns into several groups, we again find that people are more likely to contribute to equity funds when their peers have earned strongly positive returns. On the other hand, negative peer returns strongly deter non-equity investors from entering the equity market.

4.5. Heterogeneity Analysis

4.5.1. Interacting peer return and peer equity ratio

Having found that social interaction in the workplace can have a significant impact on equity exposure when peer returns are high or low, we now explore whether the impact varies across workplace settings. Here we draw on Hong, Kubik, and Stein (2004) who argue that sociable people in states with high stock participation rates are more likely to invest in stocks, compared to sociable people in low participation states. Similar results are found by Brown, Ivkovic, Smith, and Weisbenner (2008), as well as Kaustia and Knupfer (2011). The reason given is that people are more likely to find someone willing to talk to them about investments when community participation rates are higher.

Our setting, however, is different from the prior studies since most of our 401(k) participants already have stock exposure. In Figure 2, we show the distribution of the proportion of employees holding equity at the workplace level. In our sample, more than 90% of the workplaces have more than three-quarters of their employees holding equity assets in their 401(k) accounts, while only around 1% of the workplaces have less than half of their employees investing in equity. A model that is better suited to our context is therefore the gradual information diffusion model based on word-of-mouth communication proposed by Hong, Hong, and Ungureanu (2010). They suggest that information will diffuse at an increasing rate when only a small fraction of investors know the news, but the diffusion rate drops after a certain proportion of the population is

informed.[6] Given that almost everyone in a workplace invests in some equities, it is plausible to hypothesize that a worker will have information on his peer's equity investments, regardless of the workplace's level of equity exposure. Hence, a higher peer equity ratio shall not have a larger effect on the change in an individual's equity exposure.

Figure 2 here

Specifically, we estimate the following model:

$$Y_{p,c,i,t} - Y'_{p,c,i,t} = a + b_1 * [Q_{p,c,-i,t-1} * \mathbf{R}_{p,c,-i,t-1}] + b_2 * Q_{p,c,i,t-1} + b_3 * \mathbf{R}_{p,c,-i,t-1} + \\ + b_4 * R_{p,c,i,t-1} + b_5 * Z(i) + b_6 * F(p) + b_7 * F(c) + \\ + b_8 * F(t) + e \qquad (6)$$

where Y, Q, $R_{p,c,i,t}$, Z(i), F(p), F(c), and F(t) still denote the same variables as in equation (1). Peer equity return **R** is divided into six dummies as specified previously. Our main interest lies in the coefficient b_1, which can be used to explore how peer returns influence participant equity ratios in workplaces having different equity exposure.

Table 6 reports the results of this model, with Column 1 showing the interaction between workplace equity ratio and workplace equity return. Column 2 and Column 3 have workplace equity ratio interacted with different return groups. Evidently the interaction terms for the interaction between workplace equity ratio and the top two groups of workplace equity return are positive and statistically significant. Yet the interaction of the workplace equity ratio and the workplace equity return has little impact on individual equity exposure. Specifically, consider two identical workplaces, one with an equity ratio of 70%, and the other with an equity ratio of 60%. Our result implies that

[6] Shive (2010) provides empirical evidence that social influence follows such a diffusion process for individual investor trades.

when employees in both workplaces enjoy a quarterly equity return greater than 4 percent, a participant in the first locale would only boost his equity ratio 0.6 percentage points more than someone in the second. Alternatively, if they both suffer a quarterly equity return below –4 percent, a participant in the second workplace would decrease his equity ratio 0.3 percentage points more than someone in the first. The coefficients on the other interaction categories are mostly statistically insignificant.

Table 6 here

One potential explanation of such a phenomenon is that the workplace equity ratio may be proxying for risk aversion. People who are more risk loving are more likely to hold higher proportion of equity. They are also more likely to increase their equity share when stock market is rewarding them well. Thus high peer returns in workplaces with higher equity exposure have larger effects than in workplaces with higher equity exposure, consistent with our regression results.

In summary, the results suggest that people in workplaces with higher equity ratios will increase their equity exposure faster than those in workplaces with lower equity ratios when they experience a positive shock on equity return. They will also decrease their equity exposure slower when they experience a negative shock on equity return. Such an effect does not occur when returns are normal.

4.5.2. Interacting peer return and workplace size

It is also possible that workplaces of different sizes might have different social interaction effects on investments. That is, people in small workplaces are more likely to have close relationships with a larger proportion of their colleagues, leading to stronger

peer effects in those workplaces. However, a person in a large workplace may have opportunities to encounter people, hence having more communication about 401(k) investment. Therefore, how workplace size impacts the magnitude of social interaction on the topic of investments is worth further exploration.

To do so we estimate the gollowing model:

$$Y_{p,c,i,t} - Y'_{p,c,i,t} = a + b_1 * Q_{p,c,i,t-1} + b_2 * \mathbf{R}_{p,c,-i,t-1} + b_3 * S_{p,c,t-1} + \\ + b_4 * [S_{p,c,t-1} * \mathbf{R}_{p,c,-i,t-1}] + b_5 * R_{p,c,i,t-1} + b_6 * Z(i) + \\ + b_7 * F(p) + b_8 * F(c) + b_9 * F(t) + e \quad (7)$$

where $S_{p,c,t-1}$ denotes the log-normalized workplace size. In order to examine whether workplace size influences the magnitude of social interaction, workplace size is also interacted with peer equity return. The other variables denote the same constructs as before.

Figure 3 shows the distribution of observations among different workplaces sizes. While the majority of the workplaces in our sample are small (close to 80% of all workplaces have fewer than 100 employees), most of the observations come from medium to large workplaces.

Figure 3 here

Regression results appear in Table 7. As Column 1 shows, workplace size does not have an impact on individual equity exposure. This result still holds when we interact workplace size with workplace equity return, as shown in Column 2. The main variables of interest here are the interactions between workplace size and past period workplace equity returns. Column 2 shows that workplace size does not have an impact on the magnitude of social interaction effects. In Column 4 and Column 6, after interacting with

different categories of peer returns, some of the coefficients become negative and statistically significant, suggesting that social interaction may have a stronger effect in smaller workplaces. Overall, however, there is no strong evidence that workplace size has a substantial impact on social interaction effects.

Table 7 here

V. Robustness Checks

Having demonstrated that social interaction influence 401(k) plan participants' equity exposure, we next evaluate several additional hypotheses. First, when the market return is high and investors' 401(k) assets increase, an employer might invite a financial advisor to give a lecture on personal financial planning, leading more people to have a better understanding of the market and as a result, increase their equity shares. But such a workplace-level financial literacy broadcast story is unlikely to explain our results. A major financial turmoil occurred during our analysis period, giving the equity market a strong negative shock and leaving many 401(k) participants worried about their retirement assets. It is more plausible to hypothesize that employers provide financial literacy training during periods when equity returns are low. Yet we show that people decrease their equity exposure in response to negative workplace equity returns, usually not considered an optimal investment strategy. This suggests that our result is unlikely to be driven by such a mechanism.

Furthermore, a financial lecture, if it occurs, is more likely to be held in a large workplace because of the economies of scale. In the last section, we show that workplace size does not have much impact on the social interaction effect. One might still suspect

that the result could be driven by strong peer effects in small workplaces and financial literacy classes in large workplaces. To check for this, we exclude all the observations from small and large workplaces and re-run our main model, denoting 'small' workplaces as those with fewer than 100 workers, and 'large' as those with more than 3,000 workers. Hence, we only include individuals in workplaces that have between 100 and 3,000 employees. In Column 1 and Column 2 of Table 8, we report the results, which are largely in line with the results from the full sample.

Table 8 here

Workplace level equity returns might also be positively correlated with employee changes in wealth levels: that is, higher wealth could lead employees to invest more of their retirement savings in risky assets. Since we control for fixed effects from MSAs and plans, we eliminate the possibility of city-level and plan-level wealth shocks driving our results. Hence, such a story assumes that the correlation between peer equity returns and individual equity ratios would require a workplace-specific wealth shock. This scenario is also highly unlikely, as the 401(k) plan menus consist of diversified mutual funds and not individual stocks. Nevertheless some plans in our sample include own company stock funds in their plan menus. As a robustness check, we eliminate all the plans with company stocks from our sample and re-run the regression with results shown in Columns 3 and 4 of Table 8. The magnitudes of the variables of our main interest, the workplace return in excess of 4% as well and lower than –4% in Column 4, are actually larger than the results using the whole sample. This strongly suggests that our results are not driven by workplace-level wealth shocks.

Even without locally-held stocks, the broad change in stock market returns may still affect individuals' wealth, and change their risk aversion levels. However, we control for individual equity return and lagged equity exposure, so these effects should be fully incorporated, and should not affect our results.

Another possible scenario is that workplace workers may have information on the specific funds that they are investing in. They may adjust their equity exposure based upon their knowledge of the funds and predict persistent returns when funds experience excess positive or negative returns. For example, if a fund portfolio manager changes, this could be correlated with fund return, as well as individual equity exposure. Even if true, this would not affect our identification as we control for individual lagged equity exposure and current period return. Nevertheless, we test whether past period workplace equity return predicts current period return. Specifically, we estimate the model:

$$R_{p,c,t} = a + b_1 * \mathbf{R}_{p,c,t-1} + b_2 * F(p) + b_3 * F(c) + b_4 * F(t) + e \quad (8)$$

where $R_{p,c,t}$ is the current period workplace equity return. Past period workplace equity return $\mathbf{R}_{p,c,t-1}$ is divided into six dummies as specified previously. Table 9 reports the regression results. As we can see from Column 2, after controlling for market trends, past workplace return exceeding 4% predicts 22 basis points higher return in the current quarter versus the reference group. This seems to suggest that increasing equity exposure after peers enjoy excess return on equities is a good strategy. However, past peer return lower than –4% has no impact on current period return comparing to the reference group. Thus, there is no welfare gain in decreasing equity exposure after low peer returns. Overall, these results suggest that the private information story discussed above is unlikely to drive our main results.

Table 9 here

VI. Conclusions

This paper provides empirical evidence that social interactions in the workplace influence equity exposure for 401(k) plan participants. Our empirical strategy allows us to cleanly identify the effect of social interactions and eliminate other potential possibilities that may drive our results. Specifically, holding other variables constant, we find that equity exposure in individual retirement accounts rises by 1.4 percentage points on a base of 68% when peer equity returns increase by greater than four percent in a quarter. Similarly, when peer equity returns decrease by at least four percent, equity ratio of individual investors fall by 0.9 percentage points. Virtually no change is observed when peer equity return is moderate. These results are consistent with the limited attention hypothesis, which states that people are more likely to pay attention when their peers discuss extreme outcomes. Furthermore, we find that the probability of new entrants into equity funds significantly increases when peer equity returns are high, similar to previous studies on non-401(k) stock market entrants. We also find that when peer returns are high, people in workplaces with higher equity exposure boost their equity shares faster than those in lower equity exposure environments, they also shift their assets away from equity slower when peer returns are low. We hypothesize that heterogeneity of risk aversion across workplaces may drive these results. In the future, we plan to explore whether such social interaction effects are beneficial to individuals' retirement wealth accumulation.

Such investment behavior may have an impact on asset prices. For instance, extrapolating positive peer outcomes might contribute to asset price bubbles, while extrapolating negative peer outcomes could exacerbate trends toward market collapse. It will be interesting to apply a similar methodology to other financial markets for further analysis.

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Table 1. Descriptive Statistics

Panel A. Participant Demographics and Financial Characteristics

Variable	Mean	Standard Deviation	Maximum	Median	Minimum
Age (Years)	40.89	11.22	70.00	41.00	18.00
Male (%)	57.40	--	--	--	--
Plan Tenure (Years)	4.81	6.39	51.79	1.75	0.00
Household Income ($)	86,065.25	42,629.23	253,853.00	85,283.20	7,500.00
Financial Wealth ($)	49,223.61	151,141.83	2,171,683.00	7,280.00	0.00
401(k) Assets ($)	42,787.51	103,028.81	4,115,995.91	6,765.00	0.01
Web Registration (%)	49.46				
Number of Participants	173,923				

Panel B. Participant Equity Ratios, Workplace Equity Ratios and Returns

Variable	Mean	Standard Deviation	Maximum	75%	Median	25%	Minimum
Prt. Equity Ratio (%)	68.77	30.79	100.00	93.12	78.80	51.69	0.00
Workplace Equity Ratio (%)	68.42	12.14	100.00	76.41	69.39	60.86	0.00
Workplace Equity Return (%)	0.25	3.04	42.96	1.91	0.71	-1.01	-26.23
Number of Observations	1,933,592						

This table reports participant and workplace descriptive statistics. Panel A reports demographics and financial characteristics for plan participants in our sample. Each individual's age, sex, plan tenure, household income, non-retirement financial wealth, 401(k) assets, and web registration status is counted at the first month when he or she appears in the sample. "Plan tenure" is the number of years a person has been enrolled in the plan. Financial wealth is calculated using IXI wealth code, provided by the IXI Corporation. "401(k) assets" is the dollar amount of assets in the participant's 401(k) account. "Web registration" is an indicator of whether a person has web access to his 401(k) account. Panel B reports descriptive statistics for participants' own equity holdings and also the average peer equity ratio and equity return. "Workplace" includes all plan participants who live in the same Metropolitan Statistical Area (MSA). "Participant equity ratio" is the percentage of dollars invested in equity in the participant's 401(k) account. "Workplace equity ratio" is the participant-weighted average percentage of equity holdings in an workplace. Both numbers are counted at the end of each quarter. "Workplace equity return" is the participant-weighted average return on equity funds in each quarter.

Table 2. Baseline OLS Model: Determinants of Participant Equity Ratio

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate	Estimate
Workplace Equity Ratio in Quarter T-1	-0.006* (0.003)	-0.005 (0.003)
Own Equity Return in Quarter T-1		-0.033*** (0.011)
Demographic and Financial Controls	Yes	Yes
Time Fixed Effects	Yes	Yes
MSA Fixed Effects	Yes	Yes
Clustering at the Plan Level	Yes	Yes
Number of Clusters	11,496	11,496
Number of Observations	1,933,592	1,933,592
R-Square	0.08	0.08

This table uses as the dependent variable the percentage of dollars invested in equity in individual 401(k) accounts by quarter (T). "Workplace equity ratio in quarter T-1" is the participant-weighted average equity ratio of the same workplace in quarter T-1. "Lagged dependent variable" is the dependent variable in quarter T-1. "Own return in quarter T" is the individual's return on equity funds in quarter T. Lagged dependent variable is interacted with the individual's own equity return in quarter T. We control for individual demographic and financial characteristics (see Table 1). "Time fixed effects" are dummy variables for each quarter. "MSA fixed effects" are dummy variables for each MSA. "Plan fixed effects" are dummy variables for each plan. We cluster standard errors at the workplace level for robustness. Coefficients and standard errors (in parentheses) are also reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 3. Extended OLS Model: Determinants of Change of Participant Equity Ratio including Past Workplace Returns

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate	Estimate
Workplace Average Equity Return in Quarter T-1	0.145***	0.148***
	(0.023)	(0.023)
Workplace Equity Ratio in Quarter T-1		-0.007**
		(0.003)
Own Return in Quarter T-1	-0.078**	-0.078**
	(0.012)	(0.012)
Age	0.002**	0.002**
	(0.001)	(0.001)
Plan Tenure	0.004	0.004
	(0.003)	(0.003)
Male	-0.165***	-0.163***
	(0.020)	(0.020)
Medium Household Income Group	-0.015	-0.013
	(0.027)	(0.023)
High Household Income Group	-0.047	-0.044
	(0.031)	(0.031)
Medium Financial Wealth Group	0.070***	0.073***
	(0.021)	(0.021)
High Financial Wealth Group	-0.003	0.001
	(0.024)	(0.024)
Web Registration	0.660***	0.663***
	(0.035)	(0.034)
Time Fixed Effects	Yes	Yes
MSA Fixed Effects	Yes	Yes
Plan Fixed Effects	Yes	Yes
Number of Clusters	11,496	11,496
Number of Observations	1,933,592	1,933,592
R-Squared	0.08	0.08

This table uses the same dependent variable as in Table 2. "Workplace average equity return in quarter T-1" is the participant-weighted average return on equity funds in quarter T-1. Refer to Table 2 for the descriptions of other independent variables. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 4. Extended OLS Model: Determinants of Change of Participant Equity Ratio including Past Workplace Returns Disaggregated by Return Categories

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate	Estimate	Estimate
Max (Workplace Return, 0)	0.235*** (0.041)		
Min (Workplace Return, 0)	0.069* (0.037)		
Workplace Return >= 4%		1.613*** (0.356)	1.394*** (0.298)
4% > Workplace Return >= 2%			-0.262** (0.105)
2% > Workplace Return >= 0%			
0% > Workplace Return >= -2%			-0.245** (0.115)
-2% > Workplace Return >= -4%			-0.308* (0.182)
Workplace Return < -4%		-0.622*** (0.122)	-0.910*** (0.212)
Workplace Equity Ratio in Quarter T-1	-0.007** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)
Own Return in Quarter T-1	-0.079*** (0.012)	-0.076*** (0.012)	-0.077*** (0.011)
Demographic and Financial Controls	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
MSA Fixed Effects	Yes	Yes	Yes
Plan Fixed Effects	Yes	Yes	Yes
Number of Clusters	11,496	11,496	11,496
Number of Observations	1,933,592	1,933,592	1,933,592
R-Square	0.08	0.08	0.08

This table uses as the dependent variable whether the participant invest in equity funds in quarter T, given that he has no equity exposure in quarter T-1. In Column 2, the return is divided into three groups, with the reference group being the return between –4% and 4%. In Column 3, the return is divided into six categories, with the reference group being the return between 0 and 2%. Other variables are defined in Table 2. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 5. Extended OLS Model: Determinants of New or Re-enter into Equity Funds including Past Workplace Returns

Panel A. Descriptive Statistics

Variable	Mean	Standard Deviation	Maximum	75%	Median	25%	Minimum
New or Re-entrance (%)	7.07						
Workplace Equity Return (%)	0.02	2.70	38.24	1.78	0.38	-1.06	-26.23
Number of Observations	166,685						

Panel B. Regression Results

Dependent Variable: Probability of New or Re-enter Into Equity Fund in Quarter T

Variable	Estimate	Estimate	Estimate
Workplace Return	0.005**		
	(0.002)		
Workplace Return >= 4%		0.017***	0.019***
		(0.004)	(0.005)
4% > Workplace Return >= 2%			0.002
			(0.003)
0% > Workplace Return >= -2%			-0.030***
			(0.004)
-2% > Workplace Return >= -4%			-0.023***
			(0.007)
Workplace Return < -4%		-0.032***	-0.054***
		(0.006)	(0.009)
Workplace Equity Ratio in Quarter T-1	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Demographic and Financial Controls	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
MSA Fixed Effects	Yes	Yes	Yes
Plan Fixed Effects	Yes	Yes	Yes
Number of Clusters	8,723	8,723	8,723
Number of Observations	166,685	166,685	166,685
R-Squared	0.23	0.23	0.23

This table uses the same dependent variable as in Table 2. In Column 1, the workplace return is divided into two groups based on whether the return is positive. In Column 2, the return is divided into three groups, with the reference group being the return between –4% and 4%. In Column 3, the return is divided into six categories, with the reference group being the return between 0 and 2%. Other variables are defined in Table 2. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 6. Extended OLS Model: Determinants of Change of Participant Equity Ratio with Interactions of Past Workplace Equity Ratio and Past Workplace Equity Return

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate	Estimate	Estimate
Workplace Equity Ratio * Workplace Return	0.004*** (0.001)		
Workplace Return	-0.145** (0.061)		
Workplace Equity Ratio in Quarter T-1	-0.009*** (0.003)	-0.016*** (0.003)	-0.026*** (0.005)
Workplace Equity Ratio * [Workplace Return >= 4%]		0.049*** (0.012)	0.061*** (0.012)
Workplace Equity Ratio * [4% > Workplace Return >= 2%]			0.036*** (0.011)
Workplace Equity Ratio * [0% > Workplace Return >= -2%]			0.004 (0.004)
Workplace Equity Ratio * [-2% > Workplace Return >= -4%]			0.011 (0.009)
Workplace Equity Ratio * [Workplace Return < -4%]		0.017*** (0.005)	0.027*** (0.008)
Workplace Return >= 4%		-2.190** (1.149)	-3.282*** (0.998)
4% > Workplace Return >= 2%			-2.858*** (0.843)
0% > Workplace Return >= -2%			-0.532* (0.306)
-2% > Workplace Return >= -4%			-1.097 (0.713)
Workplace Return < -4%		-1.833*** (0.393)	-2.826*** (0.636)
Own Return in Quarter T-1	-0.088*** (0.012)	-0.078*** (0.011)	-0.081*** (0.011)
Demographic and Financial Controls	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
MSA Fixed Effects	Yes	Yes	Yes
Plan Fixed Effects	Yes	Yes	Yes
Number of Clusters	11,496	11,496	11,496
Number of Observations	1,933,592	1,933,592	1,933,592
R-Square	0.08	0.08	0.08

This table uses the same dependent variable as in Table 2 (see Table 4 for descriptions of other variables). In Column 3, workplace equity ratio is interacted with each category of workplace

equity return. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 7. Extended OLS Model: Determinants of Change of Participant Equity Ratio with Interactions of Workplace Size and Past Workplace Equity Return

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Log Workplace Size in Quarter T-1	-0.016 (0.010)	-0.016 (0.010)	-0.014 (0.010)	-0.021 (0.013)	-0.013 (0.010)	0.017 (0.024)
Workplace Return in Quarter T-1	0.148*** (0.022)	0.134*** (0.029)				
Log Workplace Size * Workplace Return		0.002 (0.005)				
Log Workplace Size * [Workplace Return >= 4%]				0.112 (0.086)		0.075 (0.091)
Log Workplace Size * [4% > Workplace Return >= 2%]						-0.144** (0.069)
Log Workplace Size * [0% > Workplace Return >= -2%]						0.013 (0.017)
Log Workplace Size * [-2% > Workplace Return >= -4%]						-0.104** (0.050)
Log Workplace Size * [Workplace Return < -4%]				-0.060* (0.032)		-0.098** (0.048)
Workplace Return >= 4%			1.612*** (0.356)	0.920 (0.564)	1.393*** (0.356)	0.825 (0.562)
4% > Workplace Return >= 2%					-0.262** (0.105)	0.649* (0.377)
0% > Workplace Return >= -2%					-0.245** (0.115)	-0.333*** (0.111)
-2% > Workplace Return >= -4%					-0.308** (0.181)	0.366 (0.311)
Workplace Return < -4%			-0.623*** (0.122)	-0.252 (0.217)	-0.910*** (0.212)	-0.301 (0.314)
Workplace Equity Ratio in Quarter T-1	-0.007** (0.003)	-0.007** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)	-0.009*** (0.003)
Own Return in Quarter T-1	-0.079*** (0.011)	-0.079*** (0.011)	-0.076*** (0.011)	-0.075*** (0.011)	-0.077*** (0.011)	-0.074*** (0.011)
Demographic and Financial Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
MSA Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Plan Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of Clusters	11,496	11,496	11,496	11,496	11,496	11,496
Number of Observations	1,933,592	1,933,592	1,933,592	1,933,592	1,933,592	1,933,592
R-Squared	0.08	0.08	0.08	0.08	0.08	0.08

This table uses the same dependent variable as in Table 2. In Column 5 and Column 6, the return is divided into six categories, with the reference group being the return between 0 and 2%. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Table 8. Robustness Check: Determinants of Change of Participant Equity Ratio including Past Workplace Returns Disaggregated by Return Categories, with Different Samples

Dependent Variable: Change of Individual 401(k) Equity Ratio in Quarter T

Variable	Estimate (Mid-Sized Workplace)	Estimate (Mid-Sized Workplace)	Estimate (No Company Stock)	Estimate (No Company Stock)
Workplace Equity Return in Quarter T-1	0.150***		0.127**	
	(0.022)		(0.052)	
Workplace Return >= 4%		0.756***		1.660***
		(0.199)		(0.449)
4% > Workplace Return >= 2%		-0.146		0.068
		(0.093)		(0.117)
0% > Workplace Return >= -2%		-0.308***		-0.950**
		(0.108)		(0.377)
-2% > Workplace Return >= -4%		-0.189		-0.434
		(0.129)		(0.528)
Workplace Return < -4%		-0.929***		-1.059*
		(0.171)		(0.596)
Workplace Equity Ratio in Quarter T-1	-0.007	-0.008	-0.084***	-0.089***
	(0.005)	(0.005)	(0.009)	(0.011)
Own Return in Quarter T-1	-0.075***	-0.060***	-0.116***	-0.146***
	(0.012)	(0.012)	(0.014)	(0.014)
Demographic and Financial Controls	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
MSA Fixed Effects	Yes	Yes	Yes	Yes
Plan Fixed Effects	Yes	Yes	Yes	Yes
Number of Clusters	2,071	2,071	6,080	6,080
Number of Observations	1,119,768	1,119,768	1,030,618	1,030,618
R-Squared	0.08	0.08	0.07	0.07

This table uses the same dependent variable as in Table 2, but with different samples. In Column 1 and Column 2, the sample only includes participants in workplaces with between 100 to 3,000 employees. In Column 3 and Column 4, the sample only includes participants in plans without company stock funds. In Column 2 and Column 4, the return is divided into six categories, with the reference group being the return between 0 and 2%. Other variables are defined in Table 2. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

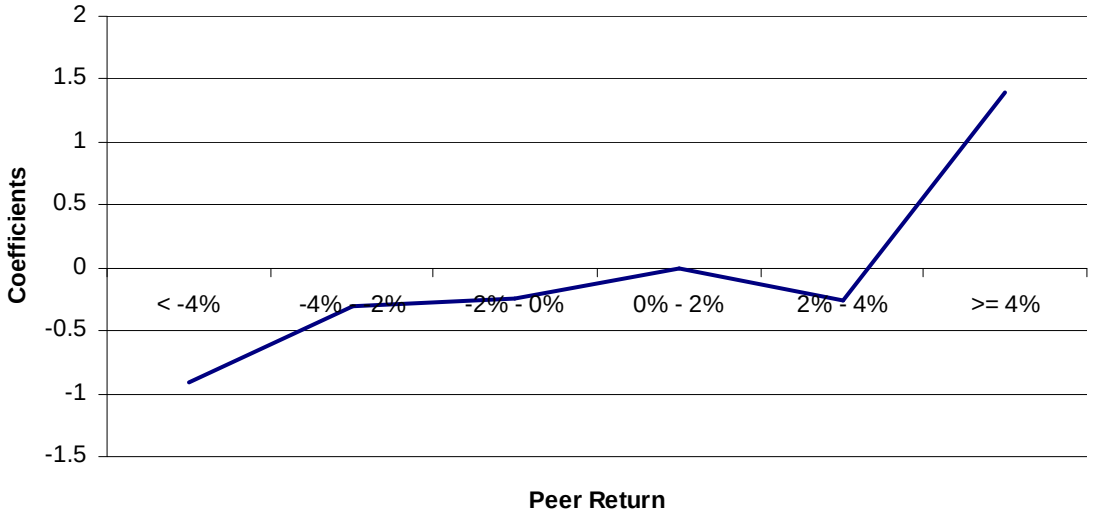
Table 9. Robustness Check: Persistence of Workplace Equity Return

Dependent Variable: Workplace Return in Quarter T

Variable	Estimate	Estimate
Workplace Return in Quarter T-1	0.067***	
	(0.007)	
Workplace Return in Quarter T-1 >= 4%		0.219***
		(0.076)
4% > Workplace Return in Quarter T-1 >= 2%		-0.205***
		(0.066)
0% > Workplace Return in Quarter T-1 >= -2%		-0.288***
		(0.064)
-2% > Workplace Return in Quarter T-1 >= -4%		-0.238***
		(0.060)
Workplace Return in Quarter T-1 < -4%		0.035
		(0.050)
Time Fixed Effects	Yes	Yes
MSA Fixed Effects	Yes	Yes
Plan Fixed Effects	Yes	Yes
Number of Observations	147,087	147,087
R-Squared	0.83	0.83

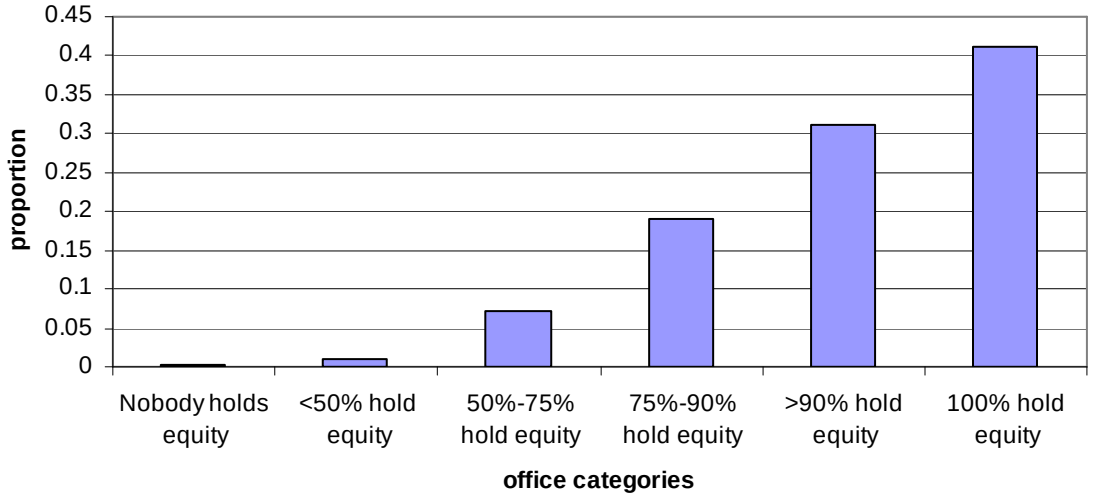
This table uses as the dependent variable the current period workplace equity return. In Column 1, the main explanatory variable is the past period workplace equity return. In Column 2, the past period equity return is divided into six categories, with the reference group being the return between 0 and 2%. Other variables are defined in Table 2. Coefficients and standard errors (in parenthesis) are reported. *, **, *** denote 10%, 5%, 1% significance levels, respectively.

Figure 1. Effect of Peer Returns in Different Categories



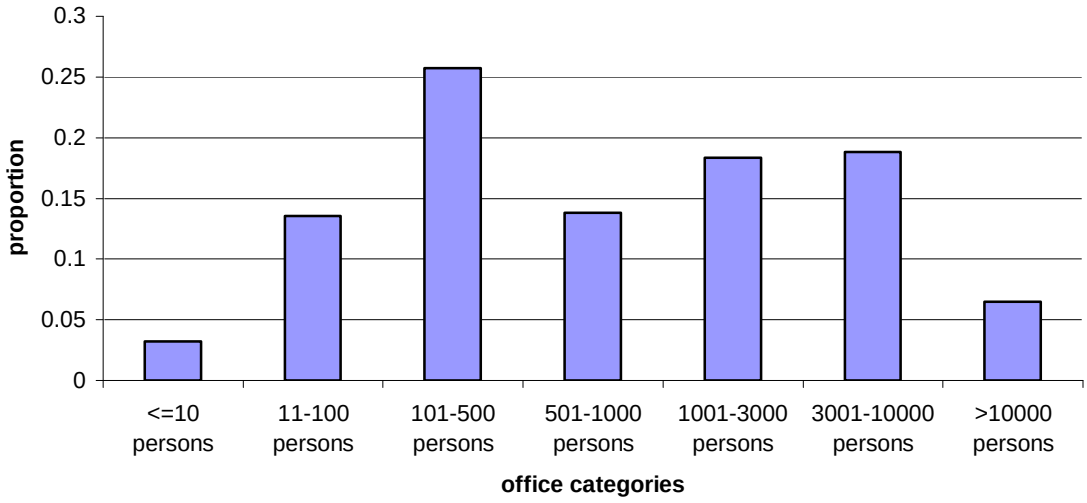
This figure shows the effect of peer returns on the change in the individual equity ratio, with peer returns broken into six categories. The X-axis lists the categories. The Y-axis shows the value of the coefficients in each category, with return between 0% and 2% as the reference group.

Figure 2. Distribution of Proportion of Workers Holding Equity at the Workplace Level



This figure shows the distribution of the proportion of workers holding equity at the workplace level. We divide workplaces into 6 categories: Those with nobody holding equity; less than 50% of employees holding equity; between 50% and 75% of employees holding equity; between 75% and 90% of employees holding equity; more than 90% of employees holding equity; and all employees holding equity. The X-axis lists the categories. The Y-axis shows the percentage of observations in each category.

Figure 3. Distribution of Observations in Different Size of Workplaces



This figure shows the distribution of observations in different size of workplaces. We divide workplaces into seven categories: Those with less than or equal to 10 people; with 11 to 100 people; with 101 to 500 people; with 501 to 1,000 people; with 1,001 to 3,000 people; with 3,001 to 10,000 people; and with more than 10,000 people. The X-axis lists the categories. The Y-axis shows the percentage of observations in each category.