Social Interaction Effects and Individual Portfolio Choice: Evidence from 401(k) Pension Plan Investors

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Abstract

We provide empirical evidence that investors are influenced by their coworkers when they make equity investment decisions. Using a rich dataset of 401(k) plans, we show that individuals are likely to increase (decrease) their risky share when they have lower (higher) equity exposure than their coworkers in the past period. The effect is especially strong when the difference of equity exposure is substantial. Furthermore, they are likely to increase equity exposure if they earned lower equity returns than their peers in the past period. However, when their returns on equity were higher than their peers, they tend not to decrease their risky share. Interaction of peer behavior and peer outcome influences investment decisions, inducing individuals with substantially lower equity exposure relative to peers increase more of risky share when peers also earned higher returns. Heterogeneity exists in short-term excess return, suggesting that peer effects may have different impact on different types of followers.

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1. Introduction

Standard portfolio choice models typically assume that individual investors are fully informed and thus make independent financial decisions to maximize their lifetime utility. Yet economists have long noticed that many individuals make financial decisions based on information received via social interaction. For example, social influence is shown to have significant impact on trading behavior (for example, Guiso et al., 2008; Shiller, 1990,), and on decision to participate in defined contribution retirement plans (Duflo and Saez, 2003). [3] In this paper we examine the influence of word-of-mouth communication among participants in the U.S. 401(k) plans. We specifically analyze how individual's asset allocation decisions are influenced by co-workers' equity exposure and return on equity. Such decisions can directly affect individual and household's life-time wealth, [4] and can also be associated to the forming and burst of asset price bubbles. [5]

Individual decisions can be socially affected either through peer's behavior (action-based social influence) or through peer's outcome (outcome-based social influence). One line of theory suggests that people mimic peers' behavior just because they want to maintain their status by conforming to the social norm, or in another word, 'keeping up with the Joneses' (Bernheim, 1994). Another line of theory, however, suggests that peer effect can be a means

[3] Social interaction effects are also 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).

[4] Examples include Benartzi and Thaler (2001), Agnew, Balduzzi, and Sunden (2003), among others.

[5] Equity exposure is closely related to investor sentiment, which contributes to asset price bubbles, as documented by Baker and Wurgler (2007), and Barber, Odean, and Zhu (2009).

of observational learning (Banerjee, 1992, and Bikhchandani, Hirshleifer, and Welch, 1992), as rational investors may gain useful information from observing peer's actions or outcomes. Yet various heuristic biases may negatively impact the quality of information that one obtains from social interaction. For example, people may selectively communicate only their successful stories for maintaining self-esteem (Festinger, 1957, Benabou and Tirole, 2002). In addition, individuals tend to have limited attention (Kahneman, 1973) and are more likely to be influenced by attention-grabbing news or events (Barber and Odean, 2008). Hence, both action-based and outcome-based peer effects can have negative impact on wealth accumulation if biased information is transmitted.

Most recent studies focus on action-based social influence. They typically find that individuals follow their neighbor's behavior to enter the stock market (Hong, Kubik, and Stein, 2004, Brown et al., 2008), or to purchase specific stocks (Hvide and Ostberg, 2014). However, it remains unclear whether such behavior is due to people learning investment by mimicking, or merely following social norm. Kaustia and Knupfer (2012) shows that high equity return of neighbors also positively impact stock market participation, providing evidence of outcome-based social influence. Yet there is no study investigating the concurrent and interactive roles of outcome-based and action-based social influence on individuals' choice of asset allocation.

In this paper, we focus on how peer interactions at the workplace level influence the extent to which individuals hold equities in their retirement accounts. Using data from the Vanguard Group covering 478 defined contribution plans and their participants, we track asset allocation records as well as participant residential ZIP codes to identify both individual

and peer effects. We confirm that both action-based and outcome-based social influence have direct and measurable effects on 401(k) plan investors' equity exposure. Participants are more likely to increase their equity holdings when their peers hold higher proportion of equity than themselves, or after their peers have enjoyed higher equity returns than themselves in the past period. The effects are both statistically and economically significant. For example, if an individual's prior quarter equity exposure is one standard deviation lower than her peer's, it results in over 1.15 percentage point increase in her current quarter's equity allocation. On the outcome-based side, a one standard deviation lower equity return than her peers in the past quarter leads to an increase of about nine basis points in equity exposure.

We find that action-based social influence tend to lead individuals to converge to the 'social norm'. In another word, participants who invest less in equity than their peers tend to increase their risk shares, while those who invest more in equity than the average tend to decrease equity allocation. On the other hand, outcome-based social influence has asymmetric impact on those who did better and those who did worse. Investors who have lower equity return than their peers in the prior quarter tend to increase their equity exposure, while those who have better than peer returns do not adjust their risk shares downwards. Such influence could be due to selective communications of positive outcomes, which is modeled by Han and Hirshleifer (2012). Overconfidence and optimism may also play a role, as many prior literature documented. [6]

[6] For example, Benartzi (2001) finds that 401(k) plan participants tend to over extrapolate past performance. Barber and Odean (2001), Statman, Thorley, and Vorkink (2006) both find that investors tend to be overconfident about their valuation and trading skills.

Individuals who are extremely different from their peers tend to make the largest shift of asset allocation. For example, participants who are in the lowest decile of equity exposure relative to their peers increase their risky share by over 3 percentage points more than those who have equity exposure relatively close to their peers, which is about 3.5 times of the mean change of equity share in a quarter. This suggests that social interaction may positively impact 401(k) participants' asset allocation adjustment.

Moreover, action-based and outcome-based peer effects interact and strengthen each other. In particular, participants with lower equity exposure than their peers tend to increase their equity share at a higher rate when their peers' equity portfolio performed better than theirs. Individuals appear to be using peer performance as a benchmark to determine whether they shall follow peer's investment behavior. The evidence suggests that observational learning does serve as a purpose of social interaction.

Our unique dataset from Vanguard gives us an opportunity to examine social interaction effects within workplaces. Investment decisions in 401(k) plans are ideal for analyzing workplace level peer effect, as each plan has its own investment menu for the workers to choose from. Moreover, the average financial literacy of the population is low, [7] and hence it is likely that co-workers communicate on their retirement accounts investment to obtain information and knowledge. Such communication, intuitively, can affect investment behavior. Our sample of 671,658 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

[7] Lusardi and Mitchell (2011) shows that most respondents fail to answer a few basic financial concept questions in the Health and Retirement Study (HRS) survey.

"peers" are typically defined as people living within the same city or ZIP code.[8] 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. We take advantage of the richness of our dataset to make various controls in our analysis.

It is known that reverse causality, unobserved common factors affecting the same group, and unobserved common preferences among co-workers could leave to a spurious correlation between individual choices and peer choices (Manski, 1993 and 2000). To address these concerns, we apply lagged explanatory variables to eliminate reverse causality. We apply plan and city fixed effects to control for systematic commonality within plans and local areas. We also include time fixed effects to control for time variant effects. In addition, we control for each individual's demographic and financial characteristics. Finally, in order to eliminate potential common wealth shocks at the workplace level, we include only plans without own company stock on the investment menu in our sample. We also provided robustness tests to exclude the possibility that it is the common information employees received or the common preferences within the workplace that cause the positive relationship between individuals' change in equity exposures and their peers' equity exposures and equity performances.

Last, there is heterogeneity in portfolio performance after adjusting their equity risk exposures in response to their peers' assets allocation choice or equity portfolio performances. Specifically, we find that adjustments following only their coworkers' "action" earn lower abnormal return on equity in the following quarter. In contrast, adjustments

[8] With the exception of Hvide and Ostberg (2014), which also analyzes peer effect at the workplace level.

following colleagues' "outcome", or following both "action" and "outcome" earn positive subsequent abnormal return. The results seem to indicate that some plan participants may be prone to common investment mistakes, as Benartzi and Thaler (2007) pointed out. On the other hand, individuals with good investment skills may exist, and coworkers may seek advices from those people, leading to subsequent better investment return.

Our study is most closely related to a growing literature on peer influence in investment decisions. Our evidence of action-based social interaction effect in a small society is consistent with many prior studies, [9] but is contrast to Feng and Seasholes (2004) who find no evidence of peer effect in Chinese trading rooms. We also find strong outcome-based peer effect, consistent with the finding of Kaustia and Knupfer (2012) in the Finland stock market. 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, Han and Hirshleifer, 2012). Such behavior may induce increment in equity investment, particularly when peers have earned higher returns in the near past. We further show that there exists interaction effect between action-based and outcome-based social influence, which to the best of our knowledge, is not documented in any prior study. The interaction reinforces peer influences, contributing to higher level of adjustment among people who are more different than their peers.

Our study is also contributing to the literature of individual investment in 401(k) plans. As mentioned above, the average financial knowledge of U.S. workers is limited. Individuals with lower level of financial literacy are also less likely to invest in stocks (Kimball and

[9] Hong, Kubik, and Stein (2005), Ivkovic and Weisbenner (2007), and Shive (2010), in addition to the studiess mentioned before.

Shumway, 2010, Van Rooij, Lusardi, and Alessie, 2011, Yoong, 2012). 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. We provide further evidence that peers also influence portfolio risk exposure. Such social interaction might be encouraged as it appears to help boosting equity allocation towards 'workplace average' among people with low risk exposure; it may also help investors improve their equity investment performance in certain cases. This could positively affect their wealth accumulation in the long run.

Finally, peer effects can have aggregate impacts on asset prices. Random short-term high return may induce large correlated inflow of funds, generating momentum returns (Jegadeesh and Titman 2001), affecting asset prices (Kumar and Lee, 2006, Barber and Odean, 2008), and may eventually contributes to asset price bubbles (Hong and Stein, 2007).

2. 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 range 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 such as household income, and invaluable for our purposes, the

ZIP code of each respondent's residence. The administrative records include individual asset allocation 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, 2012, Shive, 2010). One drawback to these approaches is that when community is defined in this way, it 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 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. While it is possible that a firm may have more than one workplaces 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. 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. We first excluded plans offering company stocks in their menus. Participants in those plans often invest a high proportion of their retirement assets in their own company stock (Benartzi, 2001), which may lead to a high correlation of equity return and common wealth shock among coworkers and cause biased estimation in our analysis. We also exclude all workplaces with fewer than five observations from our sample. We then randomly selected 10% of the participants and finally reached a selected sample of 65,894 participants in 478 plans and 257 MSAs. These participants have complete record on variables we will use for regression analysis. On average, a participant stays in the plan for more than 10 quarters within our sample period. This gives us a total of 671,658 observations in our regression analysis.

In Panel A of Table 1, we report the plan characteristics in our selected sample. In Panel B of Table 1, demographic and financial characteristics of the participant*quarter observations are provided. The mean of those variables are very close to the summary statistics of the universe of 401(k) plans reported by Vanderhei et al. (2011), which suggests that our sample is representative.

[Insert Table 1 here]

The main goal of this paper is to study the relationship between the change of individual participants' equity holdings and their relative past equity exposure and past equity returns of their peers. Every plan in our sample has at least one bond or money market fund, one 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%. Similar to Hong, Kubik, and Stein (2005), 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 measure asset allocation change at quarterly instead of monthly, as 401(k) plan participants are prone to inertia when making investment decisions (Madrian and Shea, 2001, Mitchell et al., 2006). Moreover, investment in a retirement account is considered to be long-term focused, hence it is reasonable to assume that participants be more cautious in making changes.

In Panel C of Table 1, we report results for the equity exposure of each participant at the end of every quarter. Here we see that 401(k) plan participants tend to invest most of their retirement assets in equities; in fact, only 3% of the participants in the selected sample have no equity exposure. The 10th percentile participant has more than 40% of his 401(k) assets invested in equities. On average, more than 70% of 401(k) assets are invested in the equity market. This is close to the national average of 62% among 401(k) investors (VanDerhei, et al., 2011), but much higher than the 10-30% stock market participation rates among all individuals reported by previous studies (Brown, Ivkovic, Smith, and Weisbenner, 2008, Kaustia and Knupfer, 2012). 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, the highest quarterly equity return observed at the workplace level was 27%, while the lowest was -28%. On average, the quarterly equity return realized by individual participants was just 15 basis points and participants increased risk share by 0.98% each quarter. Participants in our selected sample had 7.3% higher risk exposure than their coworkers' average (participants are excluded to calculate workplace average); while their equity return is 0.01% lower than their coworkers' average.

3. Peer Effect among Co-workers

3.1. Regression Model

We examine how peer's relative equity allocation and equity return affects one's decision in adjusting equity exposure in 401(k) plan account. We use participants' equity exposure and return relative to peers' as the main explanatory variables, as peer effect is merely people intending to conform to the behavior and outcome of the social group that she belongs to. Furthermore, by taking the difference between the variables of peer's and one's own, we effectively control for alternative explanations that unobserved common preference or environment may drive our results. Hence, we hypothesize that larger difference in behavior and outcome may lead to individuals make larger adjustments in order to keeping up with their peers. 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:

$$\begin{aligned} Qp,c,i,t - Q'p,c,i,t = {} & a + b1 * (Qp,c,-i,t-1 - Qp,c,i,t-1) + b2 * (Rp,c,-i,t-1 - Rp,c,i,t-1) + \\ & b3 * (Qp,c,-i,t-1 - Qp,c,i,t-1) * (Rp,c,-i,t-1 - Rp,c,i,t-1) + b4 * Z(i) + \\ & b5 * F(p) + b6 * F(c) + b7 * F(t) + e \end{aligned} \quad (1)$$

where Qp,c,i,t denotes the equity ratio of individual *i*'s portfolio at the end of period *t*; Qp,c,-i,t-1 denotes the participant-weighted average past-period equity ratio of the portfolios held by individual *i*'s peers; Rp,c,i,t-1 denotes the individual's return on equity in the past period, while Rp,c,-i,t-1 denotes the participant-weighted average equity return of *i*'s peers in the past period. We regress the dependent variable on the lagged difference of equity ratio and equity return to eliminate the possibility of reverse causality.

Q'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, in order to measure the equity allocation change of the participant.

Z(i) represents individual demographic and financial characteristics. We control for a large group of individual factors, including age, plan tenure, gender, household income, and web access to the 401(k) account.

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 the attention of investors with low equity exposure and return, and leading to a shift to higher risky share. To rule out this possibility and other possible time-varying influences, we include quarter dummy variables F(t) 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 in principle would not influence the relationship between participant equity ratio adjustment and relative equity exposure or return to the peers. In any event, we eliminate all such influences by controlling for geography with Metropolitan Statistical Area (MSA) dummy variables F(c).

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., which may induce those who falls behind increasing their equity share. To eliminate the possibilities of such effects we control for plan dummy variables F(p). Finally, we cluster at the workplace level for robust standard errors.

If action-based social interaction effects influence individuals' equity exposure, i.e. people conform to their peer's equity allocation, then the coefficient *b1* should be positive and statistically significant. Similarly, if there exists outcome-based peer effect, we shall observe the coefficient *b2* be positive and statistically significant. As mentioned before, 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 the difference of his own equity exposure

and the average equity exposure of his peer at the end of March 2005. The same applies to the difference of his own return and peer's return on equity. Therefore, over the 5-year period, we have 20 time points of analysis.

3.2. Baseline Results

Table 2 shows coefficient estimates from regressing individual equity exposure changes on lagged peer equity exposure and peer equity return relative to one's own. First, individuals indeed tend to allocate their equity shares closer to the level of their peers. The effect is not only statistically significant, but also economically substantial. As shown in Column (1) of Table 2, a one standard deviation lower of equity exposure than peers in the past period translates to over 1.15 percentage point increase in equity exposure in the current quarter, or 117% of the mean quarterly equity ratio adjustment. Indeed, action-based peer effect has a strong impact on asset allocation decisions among 401(k) participants. Such action-based peer effect is consistent with the findings of previous literature, such as Hong, Kubik, and Stein (2005), and Brown et al. (2008).

[Insert Table 2 here]

We then turn to outcome-based peer effect. Specifically, we look at Column (2) of Table 2, where the lagged difference of past period's peer equity return and one's own equity return is incorporated in the explanatory variables. Again, we find evidence that outcome-based peer effect exists. When a person's past quarter equity return is one percent lower than her peers, she is likely to increase her equity share by nine basis points in the current quarter (t-statistic equals 3.97). This suggests that outcome-based peer influence also has a substantial impact on 401(k) participant equity holdings.

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). People do not just merely copy others' behaviors, but rather they adopt the strategies that yield the best results. Using microeconomic data on all Finns, Kaustia and Knupfer (2012) 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 month. By analyzing relative peer return effects at the workplace among 401(k) plan participants, we confirm that outcome-based peer effect significantly impacts individual's investment decision.

Furthermore, we explore the concurrent effects of action-based and outcome-based social influences in Column (3). It shows that both action-based and outcome-based have significantly positive effects on individuals' asset allocation decisions.

Intuitively, given that action-based and outcome-based peer effects both have impact on people's investment decision, it is plausible to hypothesize that they may interact and strengthen each other when individuals gather peer's investment information through social interaction. Particularly, imagine that a person has both lower equity share and lower equity return than her peers, this may inspire her to invest in equity more aggressively than someone else who may earn lower return, but has comparative equity shares relative to peers. Therefore, we further investigate the interaction effects of action-based and outcome-based social influences in Column (4) by regressing on the interaction of the two explanatory variables. Indeed, we find that such interaction effect exists. Column (4) of Table 2 shows that the coefficient is positive and statistically significant. Better performance by their peers

induces people to invest more aggressively in equity, when their risky shares are also lower than their peers.

We are the first to explore and document the interaction impact of action-based and outcome-based peer effects in the context of equity investment. Individuals are motivated to follow other's behavior (investing more in equity) when they observe peer's good performance (higher equity return). Peer's performance, hence, is set as benchmark here by the person to determine whether she should keep up with peer's behavior. This suggests that individuals are not just merely herding to their peers behavior without judgment, but there does exist an observational learning procedure in social interaction. Of course, it remains a question as whether such social learning help improve investment outcome.

3.3. Peer Effects of Different Groups

The baseline model that we explored may not tell the whole story. On the action-based peer effect, individuals with different level of equity exposure may have different levels of motivations to adjust equity allocation based on peer's behavior. For instance, individuals with low level of exposure to equity (or lower than their peers) are typically those with lower financial literacy (Van Rooij, Lusardi, and Alessie, 2011). Those people may also have more incentives to learn from their peer's investment pattern and adjust their portfolio accordingly. On the other hand, people with high proportion of equity investment may have more knowledge in finance and be more confident, hence being less affected by others.

On the outcome-based peer effect, the story is even more complicated. First, 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. Han and

Hirshleifer (2012) 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.

Second, 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 (2013) find that investors can be inattentive to useful information in financial markets, and such inattention can lead to over-reaction to some information. Yuan (2014) 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.

Third, individual investors are prone to over-confidence (Barber and Odean, 2001) and over extrapolate past performance (Benartzi, 2001). Hence, people with good performance in the prior period may mistakenly attribute it to skills and over-estimate their future returns on equity. When observing peer's relatively low return, those people may not adjust their equity share downwards, based on the reasons stated above.

All those heuristic biases may affect outcome-based peer effect disproportionally. Indeed, Kaustia and Knupfer (2012) provide empirical evidence that people are much more likely to participate in the stock market when peer returns are large and positive. In our settings, we hence hypothesize that individuals are more likely to increase their equity shares when they earn lower returns on equity than their peers. Conversely, those who earn higher equity returns than peers in the past period may not decrease their equity holding.

We hence explore these phenomenon by disaggregating relative equity exposure and equity return to the peers. First, we estimate a piecewise model in Table 3. We differentiate positive and negative relative equity exposure, as well as relative returns. We thus regress the dependent variable on the differentiated explanatory variables.

[Insert Table 3 here]

Column (1) of Table 3 shows the results of action-based peer effect. Regardless of positive or negative relative equity exposure to the peers in the past quarter, the coefficients are positive and statistically significant. This suggests that among individuals with relatively lower equity exposure than their peers, those who are further away from their peers tend to increase their risky share at a higher rate. Similarly, among people with relatively higher equity ratio, those whose equity exposure much higher than their peers tend to adjust their risky share downwards more. In another word, people tend to conform to the peer average with regards to equity exposure in the retirement accounts. However, the coefficient of positive relative equity exposure (peer's equity exposure higher than the individual's equity exposure) is 0.09, while the coefficient of negative relative equity exposure (peer's equity exposure lower than the individual's equity exposure) is 0.02. This means that those with lower risky shares than their peers conform to the 'social norm' about 4.5 times of those with higher risky shares than their peers. This finding is consistent with the observational learning theory. Participants with lower equity ratio are more likely to have lower financial literacy as well, and they are more likely to learn from their coworkers in making investment decisions, hence the higher rate of adjustment in equity share.

We then turn to the relative return on equity, shown in Column (2) of Table 3. The coefficient is positive and statistically significant for positive relative peer returns (peer's equity return higher than the individual's equity return) in the past period, suggesting that among participants with lower returns than their peers, those who did relatively poorer tend to increase their risky share at a higher rate. Interestingly, the coefficient for negative relative peer returns (peer's equity return lower than the individual's equity return) is negative and statistically significant. This means that among individuals with higher past period returns than their peers, those who did especially well comparing to their peers tend not to decrease their risky share, or maybe even increase equity exposure. As we've mentioned before, selective communication and limited attention plays an important role in outcome-based peer effect. People are more likely to hear their peers bragging about successful investments, and paying attention to them when peers returns are higher (relative to oneself). Therefore, when peers are doing well, participants are able to obtain the information and increase their risky share. In contrast, it is harder to gather information when peers are doing poorly. Moreover, when individuals are doing well, especially when earning higher returns than peers, they tend to overestimate their abilities. As a result, they increase their risky share, thinking that they have exceptional investment skills. Combining those effects lead to the negative coefficient for negative relative peer returns. Results in Column (3) of Table 3 shows the consistent story when we incorporate action-based and outcome-based effects into one model.

We then proceed by examining peer effects of the extreme groups, i.e. those with the highest and lowest relative equity exposure and return to their peers. In particular, we disaggregate relative peer equity exposure into three groups: those in the top decile; those in

the decile; and those in between. We disaggregate relative peer equity return into three groups as well, following the same rule. We explore peer effects of participants in the extreme groups, relative to those in the middle. The results are shown in Table 4.

[Insert Table 4 here]

When an individual's equity exposure is substantially lower than her peers, she tends to increase her equity share at a much higher rate to keep up with others. For example, Column (3) of Table 4 shows that people in the top decile of relative peer equity exposure (peer's equity exposure minus the individual's equity exposure) increase 3.44 percentage points more of equity than those in the reference group. This is an enormously high number, given that the average change of equity share in a quarter is only 0.98 percentage points. Social interaction helps those who have the lowest equity exposure relative to peers adjusting their risky shares upwards. Those in the bottom decile of relative peer exposure decrease their equity shares 1.13 percentage points more than those in the reference group. Indeed, people with extremely high equity exposure relative to their peers tend to decrease their risky shares, making their equity allocation more similar to the social group, which they belong to.

Those findings suggest that social interaction plays a positive role in helping 401(k) plan participants adjusting their equity exposure. The long-term nature of 401(k) investment indicates that people need to allocate a proper proportion of equity in their savings in order to accumulate wealth at a reasonable pace. Action-based peer effect, in particular, helps those who under-allocate in equity shift their risky shares upwards. This can have long-term positive impact on their retirement wealth.

As for the outcome-based social interaction, we confirm our previous finding. Both those in the top and bottom decile group increase more of their equity share, relative to the reference group. While people who did much poorer than their peers react by increasing their equity share, hoping to catch up the others; those who did much better than the others do not really conform to the social mean. Instead, they increase their risky share as well, suggesting that over extrapolation of past return may play a role.

In summary, the analysis of peer effects of different groups confirms our hypotheses. On the action-based side, individuals adjust their equity share towards the mean of the peer group. On the outcome-based side, peer effect appears to have a more significant effect on those who did poorer in the past period. Those who have much higher return than peers in the past period, however, appear not to worry too much of their peers lower returns, and instead increase their risky shares. Overconfidence, along with selective communication and limited attention, may explain such phenomenon.

4. Robustness Checks

The design of our analysis of social interaction effect eliminates most other potential spurious correlations. Our specifically designed explanatory variables control for potential unobserved common preferences or environment within workplaces. By taking the lagged explanatory variable, we eliminate the possibility of reverse causality. By controlling for plan, MSA, and time fixed effects, we eliminate all time-invariant common shocks at the plan and the local level, as well as potential time variant shocks. Equity ratio change may also due to workplace level wealth shock. However, we find that those with lower equity return than

their peers tend to increase their equity share more, essentially eliminating this possibility. Nevertheless, there are still a couple of potential alternative explanations for our results.

First, people may self-select themselves to work in an environment where they have more commonalities with their peers. Such commonalities may include preference of risk at a similar level. Although our explanatory variable is the relative difference of equity exposure to the peers, it is still possible that most coworkers have relatively close equity exposure, and adjust their shares to the mean occasionally, driving to the results that we observe.

Second, an employer may invite a local 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, adjust their equity shares. In this section, we address these issues.

4.1. Unobserved common preferences

With regards to potential unobserved common preferences, we have run regressions comparing those with extreme differences to their peers with the reference group. In this section, we further analyze the subsample of participants who have the most different equity exposure choices from their peers. In particular, we select participants who have at least one year of plan tenure. We then take the sample with equity share in the lowest and highest quartile in the workplace, and examine the effects of equity ratio and return differences in each group seperately. The idea is that after one year of plan tenure, if a participant still have different equity exposure from their peers, then she is less likely to have unobserved preferences similar to her peers. Therefore, if we find similar or even stronger effects among those people, it is likely to be due to the peer effects that we hypothesized.

In Table 5 we display the results. Clearly, in both the highest and lowest quartile groups, the action-based and outcome-based peer effects are significantly positive. Particularly, for participants who have the lowest equity ratio, the peer effects are much stronger than in results of the baseline analysis in Table 2, suggesting that those participants tend to adjust equity share to the peer average at a higher rate. Higher peer return also induces them to invest more in equity. For those who have the highest equity ratios, such pattern remains statistically significant.

[Insert Table 5 here]

Our results show that 401(k) participants who are most different in investment pattern from their peers are also strongly impacted by their peers. This provides strong evidence that the peer effects shown in the baseline analysis cannot be explained by common preferences of co-workers.

4.2. Unobserved common information

Workplace level common information, such as financial education, may drive our results. However, such financial education, if occurs, is more likely to be held in a large workplace because of the economies of scale. On the other hand, 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. Therefore, we explore how workplace size impacts magnitude of social interaction on the topic of investments. Specifically, if we find that our main explanatory variables have stronger effects in smaller workplaces, it suggests that peer effects are more likely to take place, instead of common information observed by the whole group. We hence estimate the following model:

$$Qp,c,i,t - Q'p,c,i,t = a + b1 * (Qp,c,i,t-1 - Qp,c,i,t-1) + b2 * (Rp,c,-i,t-1 - Rp,c,i,t-1) + b3* [Sp,c,t-1 * (Qp,c,i,t-1 - Qp,c,i,t-1)] + b4 * [Sp,c,t-1 * (Rp,c,i,t-1 - Rp,c,i,t-1)] + b5* Sp,c,t-1 + b6 * Z(i) + b7 * F(p) + b8 * F(c) + b9 * F(t) + e \quad (2)$$

where Q, R, Z(i), F(p), F(c), and F(t) still denote the same variables as in equation (1). Sp,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 interacted with relative peer equity ratio and peer equity return.

Regression results appear in Table 6. In Column (1), it is shown that workplace size itself does not have an impact on participant's equity exposure change. This is reasonable as workplace size shall not have systematic influence on participant's adjustment of risky shares upwards or downwards. We then incorporate the main variables of interest: the interactions between workplace size and past period relative difference of equity exposure and return from peers, in Columns (2) through (4). Both interactions have negative and statistically significant coefficients. This suggests that both action-based and outcome-based social interaction have stronger effects in smaller workplaces.

[Insert Table 6 here]

Even though workers in the same plant may observe common information that might affect their investment decisions, there is no plausible reason why such effect shall be stronger in workplaces with smaller sizes. The results shown in Table 6 hence are consistent with our peer effect hypothesis, but not supporting the alternative hypothesis of common information shocks in workplaces.

5. Subsequent Returns

How does social interaction affect subsequent investment return? This is important both in theory and in practice. The observational learning models (Banerjee, 1992, Ellison and Fudenberg, 1993) suggest that social interaction reveals useful information, and hence may improve one's investment performance. Our findings, as discussed above, show that observational learning does play a role in social interactions. However, Benartzi and Thaler (2007) find that people in 401(k) plans merely just transform noise information. Hvide and Ostberg (2014) also finds no evidence of peer effects providing higher investment returns in the Norway stock market.

In this section, we investigate if 401(k) participants can improve the performance of their equity portfolio by following their peers' action or outcome. We first identify two types of equity allocation adjustments: (1). Action-based: participants increase their equity shares when their own equity ratios in previous quarter were lower than the workplace average; and (2). Outcome-based: participants increase equity shares when their previous quarter equity returns were lower than the workplace average.

A participant who raises equity share in a quarter can be an "action-based only follower" if his equity allocation adjustment is action-based, but not outcome-based in that period. Similarly, an "outcome-based only follower" makes outcome-based equity allocation adjustment, but not action-based adjustment; An "action and outcome-based follower" reacts to both equity ratio and equity return differences in the previous quarter. By such definition, 43,474 (or 8.1%) of individual equity allocation adjustments are identified as "action-based

only," 86,749 (or 16.2%) are identified as "outcome-based only," and "49,284" (or 9.3%) observations are identified as "action and outcome-based."

We then explore whether participants' improved on their equity return in the following quarter after each type of adjustment. We use four types of return measures to evaluate the performance of a participant's equity portfolio before and after the equity share changes:

(1) Raw equity return;

(2) Raw equity return – workplace average equity return (excluding participant's own equity return);

(3) Risk-adjusted return of equity estimated by the CAPM model:

$$R_{i,t} - R_{f,t} = \alpha_p^1 + \beta_p^1\left(R_{m,t} - R_{f,t}\right) + \varepsilon_{p,t} \quad (3)$$

where $R_{i,t}$ is the raw equity return realized by individual i in quarter t; $R_{f,t}$is the risk-free rate in quarter$t$; $R_{m,t}$is the market return in quarter t. α is the market-adjusted excess return.

(4) Risk-adjsuted return of equity estimated by the Fama-French three-factor model:

$$R_{i,t} - R_{f,t} = \alpha_i^3 + \beta_{i,Rm}^3\left(R_{m,t} - R_{f,t}\right) + \beta_{i,SMB}^3 SMB_t + \beta_{i,HML}^3 HML_t + \varepsilon_{i,t} \quad (4)$$

where $R_{i,t}$, $R_{f,t}$ and $R_{m,t}$ are the same as in equation (3); SMB_t is the return on the mimicking portfolio for the common size factor in stock returns in quarter t; and HML_t is the return on the mimicking portfolio for the common book-to-market equity factor in stock returns in quarter t.

We calculate the quarterly raw and risk-adjusted returns of participants' equity in the quarter before equity share changes and in the quarter after the change for the three identified types, respectively. We also use t-test to investigate if the change in equity return is

statistically significant after equity allocation adjustment. Results are summarized in Table 7. In all cases, equity return decreases after "action-based only" equity share change; while "outcome-based only" and "action and outcome-based" equity allocation adjustments are followed by equity performance improvement. For example, as show in Panel C of Table 7, risk-adjusted returns estimated by the Fama-French three factor model in the quarter before equity share increase are significantly negative in all three types of equity share adjustments. Equity held by action-based only followers turned to be even worse, lowered by 0.11% after they increased their risk share. Conversely, outcome-based only followers were able to improve their equity performance by 0.49%, while action and outcome-based followers boosted their equity return by 0.88%.

[Insert Table 7 here]

While we find heterogeneity of subsequent equity returns following different types of equity ratio adjustment based on peer effects, we should notice that investment in 401(k) accounts is typically aimed at very long term. Pre-tax savings are contributed to the accounts periodically, and in most cases will remain there until retirement. [10] Hence, short-run investment return fluctuations in the retirement accounts have virtually no impact on the eventual retirement wealth accumulation. Instead, keeping equity exposure at a proper level and make periodical adjustments is much more important. Therefore, even though 'action-based only followers' earn lower equity return in the following quarter, as long as

[10] It is possible to make early withdrawal of 401(k) account savings. However, early withdrawal is subject to penalty tax and is strongly discouraged. In practice, only a very small portion of 401(k) savings are withdrawn before retirement.

such equity adjustments lead them towards better asset allocation, it can still benefit them in the longer term.

Nevertheless, the other two types of followers see immediate improvement of equity return in the short run. Whether such improvement can be persistent in the long run remains an interesting question to be explored in the future. It would also be interesting to investigate whether there exist certain 'leaders' in workplaces who have better skills in equity investment, and help their colleagues achieve higher returns.

6. Conclusions

This paper provides empirical evidence that social interactions in the workplace influence equity allocation for 401(k) plan participants. We document that participants are affected both by the relative equity exposure and by the relative equity return to the peers. In particular, on the action-based side, individuals tend to make asset allocation adjustments so that their equity exposures are closer to the peer average. People with lower equity exposure than their peers make such adjustments at a higher rate. On the outcome-based side, individual with lower equity return relative to peers is more likely to increase her equity share. When investors' past equity return is much higher than her peers', however, she is also likely to increase her equity share. Such behavior is consistent with heuristic biases such as overconfidence, selective communication, and limited attention. Moreover, there exists interaction effect of action-based and outcome-based social influence. When equity return relative to peers is low, people with lower equity exposure boost their equity shares faster than those with higher equity exposure. Our empirical strategy allows us to cleanly identify

the effect of social interactions and eliminate other potential possibilities that may drive our results.

Our findings suggest that social interaction can have positive effect on equity allocation among 401(k) investors. Individuals should maintain a sufficiently high level of equity exposure in order to make proper level of long-term wealth accumulation in retirement accounts. Peer communication effectively increases equity exposure of participants who are behind of their peers. The boost of equity allocation could have a positive impact on long term wealth accumulation. Hence such social interaction should be encouraged. However, we should also notice that social interaction has its limitations. Action-based peer effects tend to move participants' equity allocation towards peer average. If the average equity exposure is too low, social interaction will not help correct it. Instead, it may drag those who originally have relatively high equity exposure towards the lower 'social norm'. Hence, proper financial education and other relevant policies are still needed, while social interaction can serve as an additional channel to prompt better asset allocation.

Sufficiently correlated trading among individual investors can have an impact on asset prices. Outcome-based peer effect may act as such a channel, as individuals tend to increase equity holding when their coworkers are making higher returns. The over extrapolation of peer outcomes may contribute to asset bubbles. We do find that outcome-based peer effect has positive impact on subsequent excessive return over the short-run, although longer period effect remains to be explored.

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Table 1. Descriptive Statistics

A. Plan characteristics							
Number of participants	65,894						
Number of plans	478						
Number of MSAs	257						
Number of industries	155						
B. Participants characteristics	**Mean**		**Std. Dev.**		**Median**		
Age (years)	45.15		10.47		46		
Male (%)	52.69		49.93		100		
Plan tenure (years)	8.09		6.75		6.25		
Online 401(k) account registration	63.33		48.19		100		
Household income	$86,695		$49,496		$87,500		
Number of observations	671,658						
Panel C. Participants equity ratio and return (%)	**Mean**	**Std. Dev.**	**Maximum**	**90th Percentile**	**Median**	**10th Quartile**	**Minimum**
Participant equity ratio	73.02	23.63	100	98.89	78.73	42.54	0
Participant equity return	0.15	3.03	26.94	3.84	0.57	-3.49	-27.86
Deviation of equity ratio from workplace average	-7.30	23.17	99.81	22.8	-10.25	-33.70	-96.87
Deviation of equity return from workplace average	0.01	1.01	20.47	0.84	0.004	-0.79	-20.23
Participant equity share change	0.98	9.84	100	2.14	0	-1.39	-100
Number of observations	671,658						

Note: This table reports plan and participant descriptive statistics. Panel A reports plan-level statistics. Panel B summarizes demographic and financial characteristics of plan participants in our selected sample. Plan tenure is the number of years a person has been enrolled in the plan. Online 401(k) account registration is an indicator of whether a person has web access to his 401(k) account. Panel C provides descriptive statistics of participants' own equity holdings and returns, and average change in equity shares each quarter among 671,658 observations in our selected sample. "Participant equity ratio" indicates the average percentage of dollars invested in equity in the participant's 401(k) account. Participant equity ratio is the average return on equity funds participants realize in each quarter. Participant equity share change calculates the difference between a participant's equity ratio in a quarter and his hypothetical equity ratio, which is his equity share if he kept his asset allocation unchanged from last quarter.

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

Variable	(1)		(2)		(3)		(4)	
Intercept	6.93		4.36		6.92		6.90	
	(7.93)	***	(5.56)	***	(7.92)	***	(7.93)	***
Deviation of equity ratio from workplace average in previous quarter	0.05				0.05		0.05	
	(19.47)	***			(19.51)	***	(19.17)	***
Deviation of equity return from workplace average in previous quarter			0.09		0.06		0.05	
			(3.97)	***	(2.65)	***	(2.12)	**
Deviation of equity ratio from workplace average in pervious quarter *							0.01	
Deviation of equity return from workplace average in previous quarter							(6.35)	***
Demographic and financial controls	Yes		Yes		Yes		Yes	
Plan fixed effects	Yes		Yes		Yes		Yes	
MSA fixed effects	Yes		Yes		Yes		Yes	
Time fixed effects	Yes		Yes		Yes		Yes	
Number of observations	671,658		671,658		671,658		671,658	
Number of clusters	3,904		3,904		3,904		3,904	
Adjusted R-Square	0.1087		0.0940		0.1088		0.1090	

Note: This table shows the regression results from OLS model on determinants of change of participant equity ratio. The dependent variables in four regressions are the change of equity share in individual 401(k) participants. Model (1) includes "deviation of equity ratio from workplace average in previous quarter" as the explanatory variable, which measures the difference between average equity ratios among participant's co-workers (participant excluded) and participant's equity ratio in previous quarter. Model (2) uses "deviation of equity return from workplace average in previous quarter" as the explanatory variable, which measures the difference between average equity returns among participant's co-workers (participant excluded) and participant's equity return in previous quarter. Model (3) includes both explanatory variables. Model (4) uses both explanatory variables and their interaction terms in the regression. We control for individual demographic and financial characteristics, and plan, MSA, and time fixed effects in all regressions. Coefficients from the regressions are reported and t-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Table 3. Piecewise Regression: Determinants of Change of Participant Equity Ratio

Variable	(1)		(2)		(3)	
Intercept	6.13		4.26		6.10	
	(6.82)	***	(5.33)	***	(6.75)	***
Max (0, deviation of equity ratio from workplace average in previous quarter)	0.09				0.09	
	(31.81)	***			(31.00)	***
Min (0, deviation of equity ratio from workplace average in previous quarter)	0.02				0.02	
	(5.75)	***			(6.37)	***
Max (0, deviation of equity return from workplace average in previous quarter)			0.54		0.24	
			(13.75)	***	(6.62)	***
Min (0, deviation of equity return from workplace average in previous quarter)			-0.33		-0.16	
			(-8.11)	***	(-3.42)	***
Demographic and financial controls	Yes		Yes		Yes	
Plan fixed effects	Yes		Yes		Yes	
MSA fixed effects	Yes		Yes		Yes	
Time fixed effects	Yes		Yes		Yes	
Number of observations	671,658		671,658		671,658	
Number of clusters	3,904		3,904		3,904	
Adjusted R-Square	0.1108		0.0951		0.1110	

Note: This table shows the regression results from piecewise OLS model on determinants of change of participant equity ratio. The dependent variables in three regressions are the change of equity share in individual 401(k) participants. The three models correspond to models 1 through 3 in Table 2. The explanatory variables are divided into positive and negative values. We control for individual demographic and financial characteristics, and plan, MSA, and time fixed effects in all regressions. Coefficients from the regressions are reported and t-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Table 4: OLS Model: Determinant of Change of Participant Equity Ratio with Disaggregated Explanatory Variables

Variable	(1)		(2)		(3)	
Intercept	5.51		4.34		5.50	
	(7.22)	***	(5.42)	***	(7.11)	***
Deviation of equity ratio from workplace average in previous quarter (ref: [10-90 percentile])						
>90 percentile	3.51				3.44	
	(32.57)	***			(31.23)	***
<10 percentile	-1.07				-1.13	
	(-8.29)	***			(-10.06)	***
Deviation of equity return from workplace average in previous quarter (ref: [10-90 percentile])						
>90 percentile			0.73		0.46	
			(4.86)	***	(2.88)	***
<10 percentile			0.84		0.67	
			(7.59)	***	(5.04)	***
Demographic and financial controls	Yes		Yes		Yes	
Plan fixed effects	Yes		Yes		Yes	
MSA fixed effects	Yes		Yes		Yes	
Time fixed effects	Yes		Yes		Yes	
Number of observations	671,658		671,658		671,658	
Number of clusters	3,904		3,904		3,904	
Adjusted R-Square	0.1064		0.0947		0.1069	

Note: This table shows the regression results from OLS model on determinants of change of participant equity ratio. The dependent variables in three regressions are the change of equity share in individual 401(k) participants. The three models correspond to models 1 through 3 in Table 2. Explanatory variables are divided into three categories: the top decile; the bottom decile; every other observation in between. The reference group is the middle group. We control for individual demographic and financial characteristics, and plan, MSA, and time fixed effects in all regressions. Coefficients from the regressions are reported and t-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Table 5. OLS Model: Determinants of Change of Participant Equity Ratio among Participants with Equity Ratio in the Lowest and Highest Quartiles

Variable	(1). Participants with equity ratio in the lowest quartile		(2). Participants with equity ratio in the highest quartile	
Intercept	6.43		13.52	
	(3.55)	***	(14.29)	***
Deviation of equity ratio from workplace average in previous quarter	0.11		0.04	
	(29.59)	***	(5.88)	***
Deviation of equity return from workplace average in previous quarter	0.18		0.27	
	(3.75)	***	(3.94)	***
Demographic and financial controls	Yes		Yes	
Plan fixed effects	Yes			
MSA fixed effects	Yes			
Time fixed effects	Yes			
Number of observations	154,473		155,047	
Number of clusters	2,443		2,399	
Adjusted R-Square	0.1636		0.1516	

Note: This table shows the regression results from OLS model on determinants of change of participant equity ratio. Model (1) includes participants whose previous quarter equity ratio was ranked in the lowest quartile in his workplace. Model (2) includes participants whose previous quarter equity ratio was ranked in the highest quartile in his workplace. The dependent variable and the explanatory variables are the same as in Table 2. We control for individual demographic and financial characteristics, and plan, MSA, and time fixed effects in all regressions. Coefficients from the regressions are reported and t-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Table 6: OLS Model: Determinants of Change of Participant Equity Ratio with Workplace Size Effect

Variable	(1)		(2)		(3)		(4)	
Intercept	6.86		7.71		4.34		7.66	
	(8.15)	***	(10.56)	***	(5.59)	***	(10.39)	***
Deviation of equity ratio from workplace average in previous quarter	0.05		0.09				0.09	
	(19.45)	***	(11.29)	***			(11.30)	***
Deviation of equity ratio from workplace average in previous quarter *			-0.01				-0.01	
Log workplace size			(-3.54)	***			(-3.52)	***
Deviation of equity return from workplace average in previous quarter	0.06				0.34		0.27	
	(2.65)	***			(4.81)	***	(4.03)	***
Deviation of equity return from workplace average in previous quarter *					-0.04		-0.03	
Log workplace size					(-3.46)	***	(-3.15)	***
Log workplace size in previous quarter	0.02		-0.01		-0.004		-0.01	
	(0.64)		(-0.49)		(-0.16)		(-0.46)	
Demographic and financial controls	Yes		Yes		Yes		Yes	
Plan fixed effects	Yes		Yes		Yes		Yes	
MSA fixed effects	Yes		Yes		Yes		Yes	
Time fixed effects	Yes		Yes		Yes		Yes	
Number of observations	671,658		671,658		671,658		671,658	
Number of clusters	3,904		3,904		3,904		3,904	
Adjusted R-Square	0.1088		0.1092		0.0941		0.1093	

Note: This table shows the regression results from OLS model on determinants of change of participant equity ratio. The dependent variable and the four regression models correspond to those in Table 2. Log workplace size denotes the Ln(number of participants in the workplace that an employee belongs to). We also interact it with the main explanatory variables in models 2 through 4. We control for individual demographic and financial characteristics, and plan, MSA, and time fixed effects in all regressions. Coefficients from the regressions are reported and t-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.

Table 7. Performance of Action- and Outcome-Based Followers

	No. of obs	(1). Quarter *before* equity share change		(2). Quarter *after* equity share change		(3). Change (2)-(1)	
A. Participant equity return: Raw return							
Action-based only	43,474	-0.27%		-0.33%		-0.06%	
		(-0.13)		(-0.11)		(-0.02)	
Outcome-based only	867,49	-1.13%		0.59%		1.72%	
		(-0.38)		(0.18)		(0.33)	
Action and outcome-based	49,284	-0.97%		0.44%		1.41%	
		(-0.32)		(0.14)		(0.28)	
B. Participant equity return: Alpha from CAPM model							
Action-based only	43,474	-0.13%		-0.24%		-0.11%	
		(-30.40)	***	(-47.79)	***	(-3670.36)	***
Outcome-based only	867,49	-0.85%		-0.39%		0.46%	
		(-384.26)	***	(-130.69)	***	(36700.19)	***
Action and outcome-based	49,284	-0.97%		-0.15%		0.82%	
		(-264.26)	***	(-29.73)	***	(28851.08)	***
C. Participant equity return: Alpha from Fama-French model							
Action-based only	43,474	-0.18%		-0.34%		-0.17%	
		(-44.39)	***	(-63.66)	***	(-5161.83)	***
Outcome-based only	867,49	-0.90%		-0.40%		0.49%	
		(-388.65)	***	(-149.92)	***	(40950.58)	***
Action and outcome-based	49,284	-1.06%		-0.18%		0.88%	
		(-247.84)	***	(-40.72)	***	(31301.33)	***
D. Participant equity return - workplace equity return average							
Action-based only	43,474	0.60%		0.07%		-0.53%	
		(0.65)		(0.07)		(-0.35)	
Outcome-based only	867,49	-0.53%		0.07%		0.61%	
		(-0.73)		(0.09)		(0.50)	
Action and outcome-based	49,284	-0.61%		0.21%		0.82%	
		(-0.62)		(0.21)		(0.58)	

Note: This table shows the performance of action-based only, outcome-based only, and action and outcome-based followers. Column (1) shows the return in the quarter before the equity share adjustments; column (2) reports the return in the quarter after the equity share adjustments; column (3) compares the return after equity share changes with that before equity share changes and uses t-test to evaluate if the difference is statistically significant. Panel A shows the equity portfolio raw return realized by investors; Panel B reports the difference between individual participant's raw return and the workplace average; Risk-adjusted returns in Panel C and D are estimated by CAPM and Fama-French three factor model respectively. T-statistics are included in parentheses. *, **, *** denote 10%, 5%, and 1% significance level, respectively.