

# **Mental Accounting in Portfolio Choice: Evidence from a Flypaper Effect**

James J. Choi, David Laibson and Brigitte C. Madrian

## **APPENDIX A. An Upper Bound on the Role of a Short Sales Constraint in the Plan Change Effect**

Suppose that pre-March 2003 enrollees want to reduce their own-contribution flow allocation to employer stock in order to compensate for the 100% employer stock allocation in their matching contribution flows. However, they are unable to allocate less than zero to employer stock in their own-contribution flows, and they are unwilling to reallocate their balances after contributions are made. After March 2003, enrollees could allocate less than 100% to employer stock in their matching contribution flows, effectively relaxing this short-sales constraint. How much of the reduction in total employer stock flow allocations among post-March 2003 enrollees could be accounted for by this relaxing of the short sales constraint?

To answer this question, we start with the null hypothesis that the short sales constraint is the only reason for the observed differences between the flow allocations to employer stock of pre-March 2003 and post-March 2003 enrollees. We then calculate what pre-March 2003 enrollees' total flow allocation to employer stock would have been in the absence of a short sales constraint.

Let  $S_i$  be the actual 2003 total employer stock flow allocation of a pre-March 2003 enrollee  $i$ . Let  $S_i^*$  be  $i$ 's latent desired total employer stock flow allocation in the absence of the short-sales constraint. Note that  $S_i^* = S_i$  for enrollees with a positive own-contribution allocation to employer stock, since such enrollees are not constrained. We estimate any unobserved  $S_i^*$  using the distribution of total employer stock flow allocations among post-March 2003 enrollees. Thus,

$$\widehat{S}_i^* = \begin{cases} S_i & \text{if own-contribution employer stock share} > 0 \\ E(S_{post} | S_{post} < S_i) & \text{if own-contribution employer stock share} = 0 \end{cases}, \quad (1)$$

where  $S_{post}$  is the 2003 total employer stock flow allocation of post-March 2003 enrollees.

Using  $\widehat{S}_i^*$  values derived from March 2003 enrollees' choices, we estimate an average unconstrained total employer stock flow allocation for the February 2003 enrollment cohort of 35%. This is substantially higher than the 23% average allocation observed for the March 2003 enrollment cohort. The estimated unconstrained average for the January to February 2003 enrollees is 37% when using March to April 2003 enrollees to estimate  $\widehat{S}_i^*$ , which is again higher than the 25% average allocation the March to April 2003 enrollment group chose. For September 2002 to February 2003 enrollees, the unconstrained average is 40% when using March to August 2003 enrollees to estimate  $\widehat{S}_i^*$ . The March to August 2003 enrollees actually allocated only 27% on average. In sum, short-sales constraints cannot quantitatively generate the drop in total employer stock allocations we observe starting in March 2003.

Note that short-sales constraints will *mechanically* appear to explain a substantial fraction of the flypaper effect even if no pre-March 2003 enrollee thinks she wants a lower total flow allocation to employer stock and the March 2003 plan change effect is entirely due to mental accounting. Mental accounting predicts that the distribution of post-March 2003 enrollees' total flow allocations will be similar to pre-March 2003 enrollees' own-contribution flow allocations. Consistent with this prediction, about half of pre-March 2003 enrollees allocated nothing to employer stock for their own-contribution flows, and about half of post-March 2003 enrollees allocated nothing to employer stock for their total contribution flows. An econometrician wanting to confirm the short-sales constraint null hypothesis will count as constrained the 50% of pre-March 2003 enrollees who allocated none of their own contributions to employer stock.

The econometrician would then impute  $\widehat{S}_i^*$  for these ostensibly constrained investors as being close to 0, since so many of the post-March 2003 enrollee total allocations are close to 0. Therefore, the pre-March 2003 enrollees' estimated unconstrained allocations will be considerably lower than their actual allocations even if none of the pre-March 2003 enrollees were actually thinking that they wanted a lower total employer stock allocation.

## APPENDIX B. A Lower Bound on the Prevalence of Ignorant Employees Needed to Generate the Plan Change Effect

This appendix calculates a lower bound on the proportion of pre-March 2003 enrollees who need to be ignorant of the match's existence in order to quantitatively generate the portfolio effect of the 2003 plan change.

Let  $x_i$  be the fraction of participant  $i$ 's 401(k) contribution flow that is her own contributions (rather than the employer match). Let  $S_i^*$  be the desired employer stock proportion of the total contribution flow (own plus matching contribution flow), and  $S_i$  be the actual employer stock proportion of total contribution flow. When ignorant of the match's existence, a participant believes that her own-contribution flow allocation equals the total contribution flow allocation. In fact, the match is directed entirely to employer stock. Thus, the actual total flow allocation to employer stock of an ignorant participant is

$$S_i = x_i S_i^* + (1 - x_i). \quad (2)$$

Starting in March 2003, it became impossible for an enrollee to be ignorant of the match's existence because enrollees had to actively choose an asset allocation for their matching contribution flow. Assume that a participant who is aware of the match's existence allocates her match and own-contribution flows so that  $S_i = S_i^*$ . For a participant who would have been ignorant in the pre-March 2003 regime, the difference in the total employer stock share between the two regimes is

$$\Delta S_i = (1 - x_i) S_i^* - (1 - x_i). \quad (3)$$

What is the resulting population average change in employer stock share? Let  $p$  be the fraction of ignorant people among pre-March 2003 enrollees. Assuming that non-ignorant people would choose the same allocation in both regimes, it is straightforward to show that

$$p = \frac{E(\Delta S_i)}{E(S_i^* | \text{ignorant}) - E(x_i S_i^* | \text{ignorant}) - 1 + E(x_i | \text{ignorant})}. \quad (4)$$

Let  $p_x$  be the fraction of participants with an own-contribution share of  $x$  who would be ignorant in the first regime. By conditioning on  $x$ , we can pull it out of the expectations operator and get

$$p_x = \frac{E(\Delta S_i | x_i = x)}{(1-x)[E(S_i^* | \text{ignorant}, x_i = x) - 1]}. \quad (5)$$

We can observe  $E(\Delta S_i | x_i = x)$  directly from the data by calculating the change across regimes in total employer stock allocations among people whose own-contribution percent of total contributions is  $x$ . Therefore, the only unobserved parameter in (5) is  $E(S_i^* | \text{ignorant}, x_i = x)$ .

The assumption that  $S_i^*$  has the same distribution among pre- and post-March 2003 enrollees imposes restrictions on  $E(S_i^* | \text{ignorant}, x_i = x)$ . Specifically, suppose a fraction  $p_x$  of pre-March 2003 enrollees with  $x_i = x$  are ignorant. Then there must be some subset of post-March 2003 enrollees with  $x_i = x$  which (a) contains exactly a fraction  $p_x$  of all post-March 2003 enrollees with  $x_i = x$ , and (b) has an average total employer stock allocation equal to  $E(S_i^* | \text{ignorant}, x_i = x)$ . Because  $p_x$  is increasing in  $E(S_i^* | \text{ignorant}, x_i = x)$ , a lower bound on  $p_x$  will minimize this expectation by classifying as ignorant those with the lowest  $S_i^*$ . The lower bound  $\underline{p}_x$  is then the lowest  $p_x$  that satisfies the equation

$$p_x = \frac{E(\Delta S_i | x_i = x)}{(1-x)[E(S_i^* | x_i = x, F_x(S_i^*) < p_x) - 1]}, \quad (6)$$

where  $F_x$  is the cdf of the  $S_i^*$  distribution among post-March 2003 enrollees for whom  $x_i = x$ .

To calculate  $\underline{p}_x$ , we start with the guess that there are no ignorant people for whom  $x_i = x$ , so  $\underline{p}_x = 0$ . If equation (6) is not satisfied under this guess, we add the post-March 2003 enrollee with the lowest  $S_i^*$  value to the ranks of the ignorant and check to see if (6) is now satisfied. We continue to add to the ranks of the ignorant from the left of the  $S_i^*$  distribution until (6) is satisfied or there are no more people who can be added, in which case we set  $\underline{p}_x = 1$ .

Now we have, for each  $x$ , a lower bound on the fraction of ignorant people. We can calculate a lower bound for the ignorant proportion of the entire population by integrating over  $x$ :

$$\underline{p} = \int \underline{p}_x g(x) dx, \quad (7)$$

where  $g(x)$  is the pdf of the  $x$  distribution. We implement the above by discretizing the  $x$  space on a grid whose values are those that would arise from contributing at an integer contribution rate for the entire year. We find that a lower bound on the fraction of participants who must be ignorant to fully explain the flypaper effect is 92%, 94%, or 93% using the 2003 contribution flows of the one-month, two-month, or six-month comparison groups in Table 1, respectively, to estimate the flypaper effect.

## APPENDIX C. Additional Tables and Figures

APPENDIX TABLE C1—401(K) PLAN FEATURES

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<i>Eligibility</i>	
Eligible employees	U.S. employees
First eligible to enroll in plan	Before April 2003: 12 months after hire, minimum 1,000 hours of work at company Starting in April 2003: 90 days after hire
First eligible to receive matching contributions	12 months after hire, minimum 1,000 hours of work at company
<i>Enrollment default</i>	
	Not enrolled unless employee opts into plan
<i>Contributions</i>	
Maximum employee contribution	Before January 2002: 15% of salary Starting January 2002: 50% of salary
Employer match	150% match on first 1% of pay contributed, plus 50% match on next 4% of pay contributed
<i>Vesting</i>	
Employee contributions	Immediate
Employer matching contributions	100% vested upon 3 years of service, 0% before
<i>Other</i>	
Loans	Available
Hardship withdrawals	Available
Investment options	Before January 2002: 6 options, including employer stock Starting January 2002: 8 options, including employer stock

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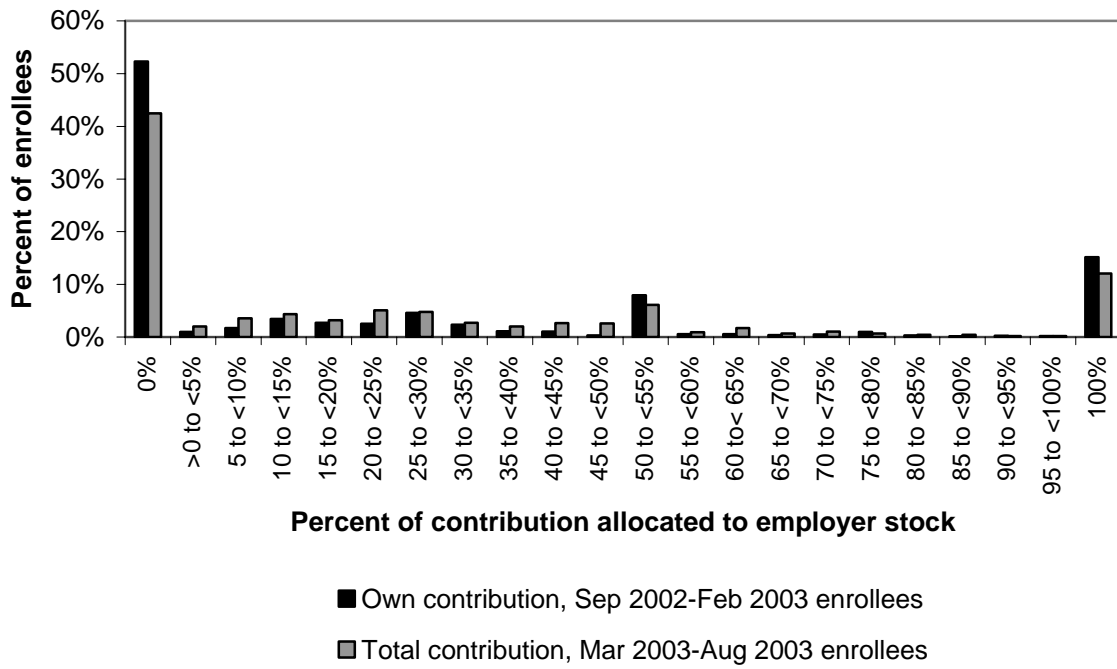
*Source:* Summary Plan Description and personal communication with plan administrator.

APPENDIX TABLE C2—CHARACTERISTICS OF MATCH-ELIGIBLE 401(K) PARTICIPANTS  
BY PLAN ENROLLMENT DATE

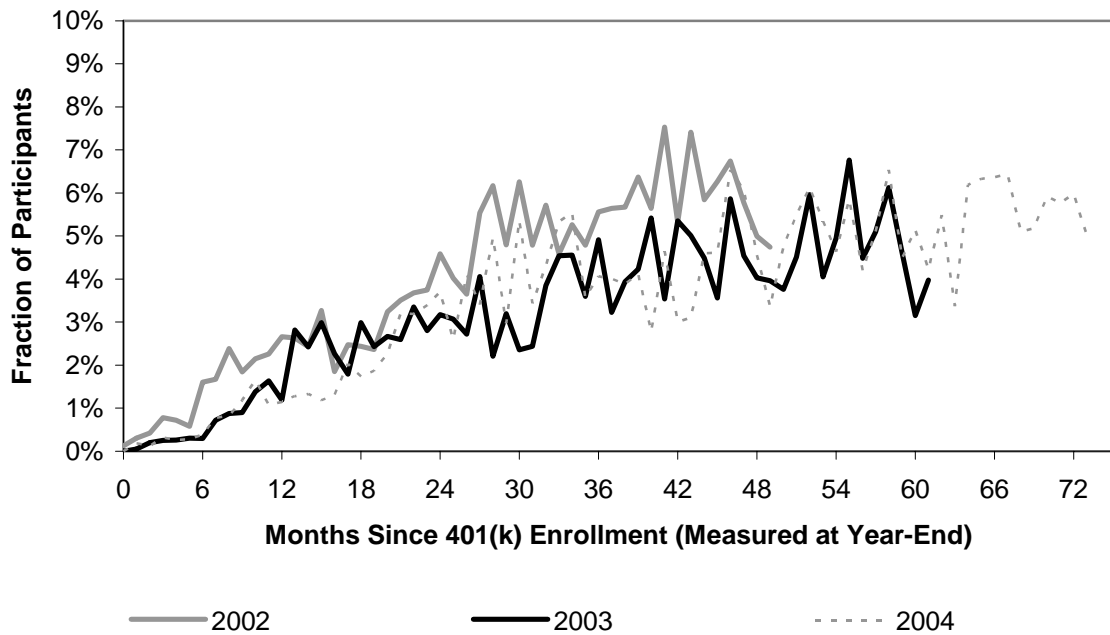
	Enrolled in February 2003	Enrolled in March 2003	Enrolled September 2002 - February 2003	Enrolled March 2003 - August 2003
Average age (years)	38.3	41.1	38.7	38.2
Fraction male	59.1%	62.0%	60.6%	61.3%
Average tenure (years)	2.7	2.4	3.0	2.3
Fraction married	33.3%	31.6%	33.2%	26.6%
Avg. annual income	\$27,393	\$29,069	\$28,835	\$28,149
Median annual income	\$25,865	\$26,000	\$26,603	\$25,584
Number of participants	1,015	2,234	6,911	10,753

*Notes:* The sample is match-eligible 401(k) plan participants who enrolled in the 401(k) in the months specified and satisfy the other sample selection criteria discussed in the text. Income reported is for calendar year 2004. All other variables are observed at year-end 2003.

*Source:* Authors' calculations.

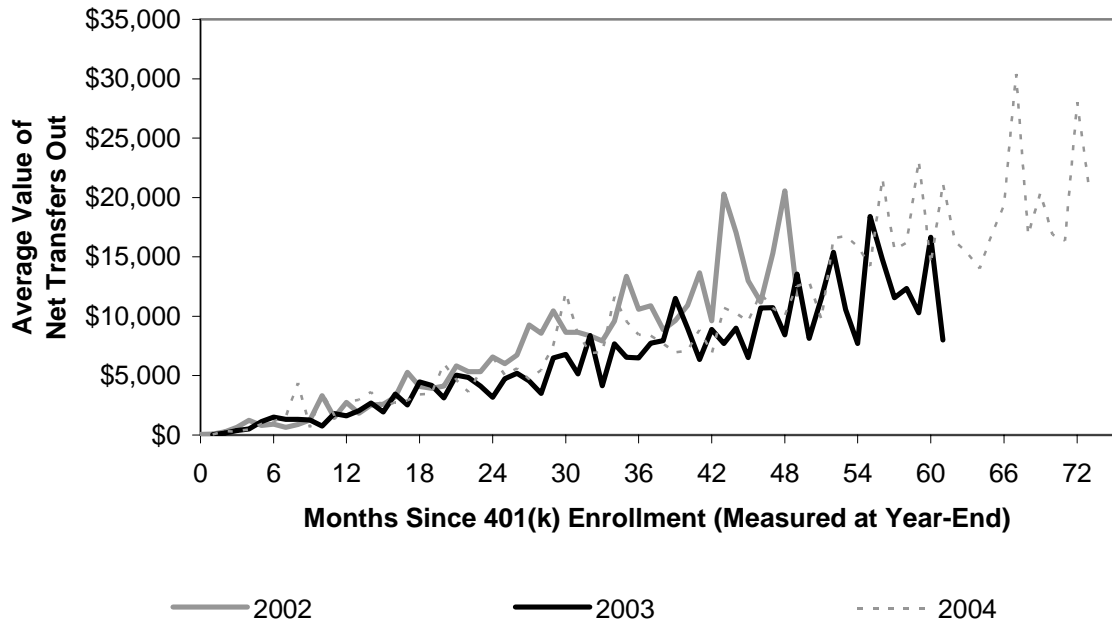


APPENDIX FIGURE C1. HISTOGRAM OF THE FRACTION OF ANNUAL CONTRIBUTION FLOWS ALLOCATED TO EMPLOYER STOCK DURING 2003



APPENDIX FIGURE C2. FRACTION OF PARTICIPANTS WITH  
A NET TRANSFER OUT OF EMPLOYER STOCK DURING 2002, 2003, AND 2004

*Notes:* To calculate net transfers for a participant, we subtract the dollar value of all his transfers out of employer stock during the calendar year from the dollar value of all his transfers into employer stock during the calendar year. If this number is negative, then the participant is counted as having a net transfer out of employer stock during the year.



APPENDIX FIGURE C3. AVERAGE VALUE OF NET TRANSFERS OUT OF EMPLOYER STOCK, CONDITIONAL ON A NON-ZERO TRANSFER DURING 2002, 2003, AND 2004

*Notes:* To calculate net transfers for a participant, we subtract the dollar value of all his transfers out of employer stock during the calendar year from the dollar value of all his transfers into employer stock during the calendar year. Averages weight each participant equally.