Serenity Now, Save Later?
Evidence on Retirement Savings Puzzles from a 401(k) Field Experiment

Saurabh Bhargava[†] Lynn Conell-Price[§]

March 2021

Abstract

Economists have advanced several psychological frictions to explain why many 401(k)-eligible employees undersave for retirement despite generous matching incentives. We provide evidence on four of these frictions through a field experiment randomizing undersaving employees to information- and incentive-based treatments linked to a survey assessing each friction's baseline incidence. We describe four main findings: (1) We corroborate prior work showing pervasive deficits in *retirement literacy* and their correlation with saving but reject any meaningful increase in saving from personalized recommendations that demonstrably improve literacy. (2) In an (unplanned) analysis of *plan confusion*, we estimate that 20 to 37 percent of non-participants mistakenly believed themselves to be enrolled—these employees enrolled at high rates when prompted to review their enrollment status. (3) We find no evidence that *enrollment complexity* impedes saving—few employees perceived enrollment as prohibitively time-consuming and simplifying enrollment further did not increase saving. (4) Finally, we directly implicate *present focus* as a cause of undersaving by showing that a significant share of employees increased saving in response to a small but immediate microincentive ($10 gift card) but not to clarification of the dramatically larger, but delayed, plan match. Calibrations suggest that beta-delta models of present bias cannot account for observed delays in actual, and forecasted, enrollment without assuming implausibly large enrollment hassle costs. We propose an alternative hedonic model of present focus and delayed optimism that does explain our findings—and possibly other retirement savings puzzles—and offers a psychological rationale for reforms that encourage long-run savings through the use of microincentives or dual-accounts that link existing 401(k) accounts to a more liquid account designed to relieve near-term financial anxiety.

JEL: D14, D15, D91, G51, J26

---

† Carnegie Mellon University; sbhar@andrew.cmu.edu. § Wharton, University of Pennsylvania; lynncp@wharton.upenn.edu.
Acknowledgments: We thank Linda Babcock, Karna Basu, John Beshears, Dan Black, David Card, Keith Chen, James Choi, Leah Clark, Carol Conell, Stefano DellaVigna, Ray Fisman, Jonathan Guryan, Kareem Haggag, Hilary Hoynes, Damon Jones, Ryan Kessler, Botond Köszegi, Howard Kunreuther, David Laibson, Robin Lipp, George Loewenstein, Brigitte Madrian, Vikram Pathania, Chris Price, Alex Rees-Jones, Emmanuel Saez, Frank Schilbach, Jesse Shapiro, Justin Sydnor, Lowell Taylor, Oleg Urminsky, and seminar participants for helpful feedback. We thank Stephanie Rifai and Cassandra Taylor for excellent project support. The project was funded in part by a research center at The Tepper School of Business and was approved by Carnegie Mellon's Institutional Review Board.

1 INTRODUCTION

Despite its canonical position within economics, the classical life-cycle model of saving struggles to explain several empirical features of how working Americans save. For example, many employees appear to save insufficiently for retirement despite access to tax-advantaged 401(k) plans with sizable matching incentives (e.g., GAO 2017), are not highly responsive to changes in the generosity of such incentives (Madrian 2013), and routinely express the intent to save more but systematically fail to follow through (Bernheim 1995; Choi et al. 2002). Perhaps equally puzzling for standard economic theory, employees respond materially to largely non-economic features of 401(k) plan structure such as the presence of automatic enrollment (Madrian and Shea 2001) or small variation in the design of a plan's digital enrollment interface (Bhargava et al. 2021).[1]

Economists have advanced several potential departures from the standard economic framework—or psychological frictions—to explain these empirical puzzles. Four of these frictions have come to occupy a central role in the literature. The first, which we refer to as *retirement literacy*, encompasses both low financial literacy (the absence of working knowledge of financial concepts or the propensity to misapply such concepts) and biases in other retirement-relevant beliefs that might lead an employee to underestimate their saving needs. An extensive literature has documented widespread deficits in various measures of retirement literacy and found correlations between at least some of these deficits and retirement planning or saving outcomes.[2] The second, *plan confusion*, refers to the possibility that an employee's confusion about plan details concerning eligibility or the plan match, as examples, might deter saving. While direct evidence on confusion in the context of 401(k) plans is limited, studies have cited confusion as a barrier to take-up across other a range of health and financial benefit programs.[3] The third friction, *enrollment complexity*, describes the possibility that the economic and psychological costs associated with complicated administrative enrollment could lead employees to delay saving.[4] Finally, the fourth friction that researchers commonly cite as a potential impediment to saving is *present focus*, the propensity to privilege immediate relative to delayed flows of consumption utility. Within economics, the dominant framework for understanding present focus is through beta-delta models of present bias (Phelps and Pollak 1968; Laibson 1997; 1998). (As suggested by Ericson and Laibson (2019), we adopt the term "present focus" to distinguish between present-biased preferences and a diverse set of alternative mechanisms that lead people to seemingly favor the present). In the context of retirement savings,

[1] Researchers have also documented the sensitivity of saving to other non-standard factors such as plan complexity (Beshears et al. 2013), auto-escalation (Thaler and Benartzi 2004), or the framing of incentives (Choi et al. 2017; Duflo et al. 2006).
[2] For a review of evidence documenting deficits in retirement literacy and their correlation with retirement planning and savings outcomes, see Hastings, Madrian, and Skimmyhorn (2013) and Lusardi and Mitchell (2014).
[3] For example, see Domurat, Menashe, and Yin (2019), Bhargava and Manoli (2015), and Chetty, Friedman, and Saez (2013).
[4] For example, see Choi, Laibson, and Madrian (2009), Beshears et al. (2013), and Bertrand, Mullainathan, and Shafir (2004).

economists have invoked present-biased preferences to explain low plan participation, the persistent gap between intended and actual saving, and the efficacy of automatic enrollment (Laibson 1997; 1998; O'Donoghue and Rabin 1999a; Diamond and Köszegi 2003). While individual measures of present bias have been found to negatively correlate with savings (Goda et al. 2019; Brown and Previtero 2018) and to predict response to experimentally varying plan defaults (Blumenstock, Callen, and Ghani 2018), arguably the most direct evidence implicating present bias in the decision to save is the demand for saving commitments routinely found in development contexts (see Bryan, Karlan, and Nelson 2010).

Despite the regularity with which these four frictions are discussed, evidence as to their causal role in the savings of US employees remains scarce.[5] In the present research, we attempt to provide such evidence through an online field experiment that administered incentive- and information-based treatments to 1,137 low-saving, 401(k) plan-eligible, employees at a large US firm with a generous plan match. We embedded the experimental interventions within a broader survey intended to assess the employee-specific incidence of the four frictions, along with a fifth friction, *financial anxiety*, that we sought to explore in deference to its increasing prominence among practitioners, policymakers, and outside of economics as an important determinant of financial decision-making. After summarizing evidence from the survey-linked field experiment, we investigate whether the findings can be explained by existing behavioral models of enrollment through a series of calibrations. We conclude by advancing a new hedonic model of saving that offers a potentially unifying framework to understand the decisions and stated intentions of employees in the present setting as well as empirical savings puzzles more broadly.

Three features of our research design make it particularly promising for clarifying how psychological frictions affect employee saving. First, by situating the field experiment within a detailed survey of beliefs and decision-making, we could estimate the baseline prevalence of each friction (and its naïve correlation with saving), the average causal effect of reducing a specific friction on saving, and the differential effect of reducing a specific friction on saving across employees varying in baseline incidence of that friction. To illustrate with the case of retirement literacy: The survey permitted us to estimate the baseline prevalence of literacy and its naïve correlation with saving while the experimental provision of a personalized saving recommendation revealed the effect of improved literacy on average saving and, in conjunction with the survey, the (differential) effect of improved literacy for those with low baseline literacy. Second, our field study targets undersaving employees with access to a 401(k) plan with a generous plan match—that is, the employer matched each dollar of contribution up to four percent of annual salary with a guaranteed minimum of $2,000 for anyone contributing at least four percent over a calendar year. As a consequence, for employees contributing below the match limit, the rate of return to

[5] For example, with respect to the literature on financial literacy and education, Beshears et al. (2018) note that the "biggest limitation of this literature is a dearth of studies that credibly estimate causal effects."

an additional dollar of contribution ranged from 100 to 367 percent—a marginal return not easily rationalized through traditional economic channels. Finally, we implemented the study via an interactive online instrument where we could monitor respondent attrition, attentiveness and, in some cases, changes in beliefs. The implementation ensured that an employee assigned to a treatment was very likely to have engaged that treatment. This avoids the inferential challenges often encountered in field paradigms where the rate at which a respondent actively engages an experimental email, text, or mailed notice might be low, non-representative, and unobserved. We believe this research is the first to simultaneously test the role of multiple psychological frictions in 401(k) savings, to integrate experimental reductions of frictions with survey measures of incidence, and to use time-varying incentives to assess the role of present focus.

We administered the field study by inviting a few thousand employees situated below pre-specified saving and income thresholds to participate in an online survey marketed as an opportunity to provide confidential workplace feedback. Beyond capturing demographic and financial background, the initial module of the survey elicited a range of retirement-relevant beliefs and included questions meant to diagnose candidate frictions for the 1,332 respondents. Employees were then randomized to one of several experimental variants of a second module promising a personalized assessment of retirement preparedness. Across experimental treatments, the assessment truthfully conveyed that the employee was not "on track" for retirement security, advised the employee to increase their contribution rate, provided simple instructions to any employee seeking to adjust their contribution, and asked the employee about their future intentions to save. To experimentally test each friction, the treatments varied the presence of (1) a personalized saving recommendation, (2) information clarifying the magnitude of the plan match, and (3) a small, but immediate, microincentive ($10 Amazon gift card) to encourage employees to visit the enrollment portal and contemplate their saving decision.

We report four primary findings from the field experiment, each corresponding to a candidate friction. First, while we corroborate previous research indicating widespread deficits in retirement literacy—employees underestimated how much they should save to ensure retirement security and scored poorly on tests of financial literacy—and correlations between at least some measures of literacy and baseline saving, the field experiment implies that these deficits *do not* themselves cause undersaving. Specifically, we find that providing a concrete and personalized recommendation (that we show improves the accuracy of employee beliefs) has a small, precisely-estimated, effect on plan contribution, even among employees with severe deficits in literacy. The data offers multiple insights to help reconcile this finding with existing research asserting a link between retirement literacy and saving. As one example, while many employees underestimate how much to save for retirement security, most also recognize the (often substantial) insufficiency of their present saving.

Second, we offer novel evidence that employee confusion about their 401(k) plan may explain a significant share of undersaving. We distinguish between two specific types of plan confusion: confusion about plan details (i.e., eligibility and the plan match) and an unanticipated dimension of confusion about one's enrollment status. Regarding the former, we find that while employees had accurate beliefs about eligibility, 30 percent of employees had inaccurate beliefs about the match, most of whom underestimated its generosity. Despite a strong correlation between match underestimation and baseline saving, we find that experimentally clarifying match incentives did not lead employees to increase saving on average, nor did it lead to a differential increase in saving among underestimating employees. However, we do find that an unexpected share of non-participants reported themselves as being enrolled. After attempting to adjust for potential inattention to the survey or willful exaggeration through analyses of other survey responses (we find little evidence for either), we conclude that 20 to 37 of non-participants were genuinely confused about their enrollment status. Consistent with this interpretation, discrepant employees with an increased likelihood of discovering their actual enrollment status, by virtue of assignment to the microincentive condition, were three times more likely than counterparts to increase their contribution. While such a striking degree of confusion about 401(k) enrollment may seem implausible, we speculate that such confusion may arise from the broader complexity of benefit program offerings at large US firms. Newly hired employees at this particular firm were asked to make enrollment decisions in up to twelve benefit programs each with varying rules governing eligibility and enrollment.

Third, we present evidence indicating that perceptions of enrollment complexity do not inhibit plan engagement. While a modest share of employees appears to overestimate the time required to adjust their contribution, only a small minority perceived enrollment to be sufficiently time-consuming so as to conceivably affect the decision to save—even allowing for the possibility of psychological costs of enrollment substantially significantly exceeding wage-based time-costs. The experiment suggests that those assigned to a baseline treatment communicating how quickly and easily one could adjust their contribution did not increase saving relative to a pre-study comparison period on average or for employees originally perceiving plan adjustment as highly time-consuming (the treatment did reduce perceptions of the time required to enroll). In an era of predominantly digital enrollment, these results suggest the perceived complexity of administrative plan changes may not seriously deter saving.

Finally, we present some of the first evidence directly implicating present focus as a barrier to 401(k) saving. Specifically, we found that 8 to 16 percent of employees increased their contribution rate in response to the microincentive across multiple treatment implementations but found a precisely-measured non-response to clarification of the far larger, but delayed, plan match. The effect of the small reward persisted over subsequent months for which we observed administrative data and at least one-half of adjustments entailed an increase of more than one percent of salary, suggesting the response was not

intended as a temporary strategic adjustment. The pattern of differential response was exhibited by employees who underestimated the match (and for whom clarification plausibly constituted new information) and employees tagged as present-focused in the survey were 2 to 3.5 times more responsive to the reward than counterparts. For those contributing below the match limit, assuming no subsequent adjustments, the response to the $10 reward implied an average (maximum) gain from the match of $677 ($1,583) in the remaining five months of the year and $2,632 ($5,383) in the next calendar year.

To explore the mechanisms underlying the response of employees to the experiment and the baseline decision of many (well-informed) employees to lengthily delay enrollment, we consider existing economic models of present focus. Given its central standing among economists, we initially consider a beta-delta model of present-biased saving adapted from DellaVigna (2018). The model describes the decision of a utility-maximizing employee with present-biased preferences to enroll in a 401(k) plan with a generous plan match but potentially costly enrollment (economically and psychologically). For a sophisticated employee, calibrations suggest that for the model to rationalize delay in enrollment exceeding a few days would require an unrealistically extreme degree of present bias or implausibly high enrollment costs. While the approach typically adopted by the literature to explain lengthier delays is to assume that employees naively anticipate a much shorter delay (O'Donoghue and Rabin 1999b; DellaVigna 2018), our survey data on employee intentions to save soundly rejects the assumption of naiveté—most employees intend to save more in the future, but expect to do so only after a delay measured in weeks or months rather than days. We further note that for the model to explain the differential response of employees to the small reward and match clarification would require both implausibly high enrollment costs *and* that such costs fall within an impossibly narrow ten-dollar margin.

After contemplating similar challenges associated with other economic models of present focus, we conclude by proposing a novel mechanistic account informed by an intriguing empirical correspondence between employee saving and financial anxiety, the fifth psychological friction explored in the field survey. Specifically, we note that most employees reported substantial anxiety about their current financial situation yet expressed optimism about achieving relief from such anxiety in the intermediate (a few months) but not immediate (days to a few weeks) future. This pattern of high present anxiety and delayed optimism parallels the low present savings and deferred intent to increase future saving among the same employees. Informed by this correspondence, and a large literature on the avoidant effects of anxiety on decision-making, we specify a hedonic model of present-focused savings. The model stipulates that (low-saving) employees persist in a state of high financial anxiety that imposes a hedonic cost to engaging stressful financial decisions, such as enrolling in a retirement plan. Crucially, employees believe that their high anxiety is temporary and have well-defined (and possibly even miscalibrated) beliefs regarding the transition to a state of low anxiety. A prediction of the model is that a

well-informed, utility-maximizing, but financially anxious, employee will delay enrollment if they expect relief from such anxiety early enough such that the benefits of delay (i.e., the reduced costs associated with less anxious enrollment) exceed its costs (i.e., foregone benefits from the match). In avoiding the need to solve for potentially complicated equilibria via backwards induction over innumerous future time-periods, the model implies a simpler, and perhaps more realistic, decision-process than present bias with sophistication. In this framework, microincentives motivate an employee not through their immediate financial value but by reframing enrollment from an anxiety-ridden financial decision to an exercise in reward-seeking (an interpretation for which there is neuroscientific support, e.g., McClure et al. 2004).

Calibrations indicate that the model can account for both lengthy delays in enrollment and the stated intent of employees to increase saving in the intermediate future under plausible assumptions about the disutility of enrollment. And consistent with model predictions, we observe a negative correlation between anxiety and plan engagement in the present and a positive correlation between forecasts of hedonic relief and future intentions to save. We note that the descriptive success of the model, particularly relative to other economic models of present focus, depends on anxious employees exhibiting delayed optimism regarding their hedonic future. To corroborate this dynamic in a broader sample of employees, from a distinct period in time, we administered a supplementary survey of US employees in November 2019. The survey, like the field study, revealed the prevalence of financial anxiety and optimism about the intermediate but not immediate future—indeed, the most anxious respondents systematically expected their hedonic situation to *worsen* before eventually improving (we believe this is the first evidence asserting the phenomenon of systematically delayed optimism regarding future financial anxiety). Beyond advancing an explanation for the present findings, the framework offers a potential explanation for other empirical saving puzzles—e.g., those involving employee responsiveness to the plan match, automatic enrollment, and future auto-escalation—and the efficacy of microincentives across a range of domains.

We see this research as offering several practical lessons for policymakers and for plans seeking to improve the financial well-being of employees. First, our precise estimates regarding the modest effect of personalized recommendations on saving should temper expectations about the benefits of financial education and decision-aids delivered in proximity to an enrollment decision. Despite their widespread adoption by plans, advocacy from industry experts, and considerable existing research on the prevalence of retirement illiteracy, the influence of recommendations may be limited if most employees already recognize that their present saving is insufficient (we note that this admonishment does not extend to behavioral interventions designed to persuade rather than educate). Second, if our conjecture as to the origins of apparent employee confusion regarding enrollment status is correct, employers could increase plan participation by reducing the broader complexity of benefit program offerings through, as an example, integrated enrollment portals or standardized plan communications. Next, the success of

microincentives in increasing saving, particularly in comparison to the limited responsiveness of employees to changes in the plan match, implies that 401(k) plans could meaningfully improve plan participation through the systematic use of small rewards. While the use of participation rewards would likely require new regulatory language, there is precedence for their use in other participatory contexts including prize linked savings, online learning, employee wellness programs, and public health (e.g., vaccine take-up).

Lastly, our hedonic account of present-focused savings intimates the need for more fundamental reform that restructures retirement savings plans so that they better reflect the psychology that governs the decision to save. An example is provided by dual-account proposals that would direct initial plan contributions to a liquid buffer account before automatically transferring accumulated savings above a threshold into a less-liquid account resembling a traditional 401(k). The dual-account model has been advocated in recent years in various forms by academics and policymakers galvanized by concerns over short-term liquidity (Beshears et al. 2015; 2020; Gruber 2016; John 2015; Mitchell and Lynne 2017). We see the present research as offering a psychological rationale for some of these proposals in that, for many employees, addressing near-term financial anxiety may be a precursor for long-term saving.

2 BACKGROUND AND INSTITUTIONAL SETTING

2.1. Overview of 401(k) Plan Structure, Engagement, and Retirement Preparedness

Plan Structure. In recent decades, 401(k) plans have become the primary channel through which US employees at for-profit institutions save for retirement to supplement Social Security. These plans, named after the sub-section of the legislation that enabled them, The Revenue Act of 1978, permit qualified employees to contribute a capped share of pre-tax salary by automatic deduction into a portable, tax-deferred, and immediately vested savings account. As of 2016, when we conducted the field experiment in this paper, 401(k) plans comprised 80 percent of all employer-sponsored retirement plans and covered 82.7 million employees.[6] Beyond favorable tax-treatment and portability, a key incentive featured in most 401(k) plans is an often-generous plan match. A plan match refers to employer contributions equivalent to some share of an employee's contribution up to a threshold usually ranging from 3 to 6 percent of annual salary. An industry survey, contemporaneous with the field study, indicated that 75 percent of 401(k) plans offered a plan match; while the generosity of the match varied, the modal match involved an employer contribution of 50 cents per contributed dollar up to 6 percent of salary.[7]

[6] See Table A1(a) of the Private Pension Plan Bulletin Abstract of 2016 Form 5500 Annual Reports EBSA (2018).
[7] Based on data from the 2017 PLANSPONSOR survey of defined contribution plans.

Plan Engagement. Three often-cited metrics help to characterize plan engagement among plan eligible employees— the participation rate, the average participant contribution rate, and the rate of full match take-up. Prior to the advent of automatic enrollment, participation in 401(k) plans was low and differed substantially by employee age and income. The aggressive adoption of automatic enrollment over the last few decades, particularly among larger firms, has sharply increased overall participation and its demographic parity. Despite increases in plan participation, a significant share of 401(k) eligible employees fail to fully claim available matching incentives. One industry analysis of plans spanning 4.4 million participants found that the 25 percent of eligible employees who did not exhaust their plan match left an average of $1,336, or 2.4% of annual salary, unclaimed (Financial Engines 2015). Although one might expect plan participation, average contribution, and full match take-up to increase with the generosity of a plan, several studies point to a modest relationship between the presence and generosity of a plan match and plan engagement (e.g., Papke and Poterba 1995; Choi et al. 2002; Duflo et al. 2006; Kusko, Poterba, and Wilcox 1994; see Madrian 2013 for a review).

Retirement Preparedness. While researchers and policy analysts concerned about retirement preparedness have typically focused on challenges pertaining to plan access and participation, recent industry, academic studies have asserted that a significant share of 401(k) *enrollees* may be insufficiently prepared for retirement. An analysis by Fidelity found that 32 percent of working US households were "not on track" for retirement, while our own simulations based on administrative records for several hundred 401(k) plans with automatic-enrollment projected, under a range of plausible assumptions, a majority of enrollees faced a non-trivial risk of "retirement insecurity" (i.e., characterized by a level of savings at the onset of retirement that would not sustain a modest standard of living without a return to the labor market or means-tested benefits) (Bhargava et al. 2021). Researchers have cited several potential factors contributing to undersaving among plan-eligible employees, including non-participation, low initial rates of contribution (perhaps due to low default rates in plans with automatic enrollment), insufficient adjustment to plan contributions over time, incomplete take-up of the plan match, and the propensity of many employees to take costly early-withdrawal loans (see Beshears et al. 2019).

2.2. 401(k) Plan Environment at Firm

Our field partner offered its more than 40,000 benefit-eligible employees a 401(k) plan with several features representative of 401(k) plans more broadly. The firm had instituted automatic enrollment for new hires beginning in 2015 at a default contribution rate of 4 percent (with default investment allocation to a target-date fund). In June 2015, the firm conducted an "enrollment sweep" whereby they informed employees who had become benefit-eligible before 2015 and were contributing less than 4 percent that they would be automatically enrolled in the plan at a 4 percent contribution rate the following

month unless they decided to actively opt-out.[8] As of July 2016, approximately 10 to 15 percent of new hires eligible for automatic enrollment or existing employees subject to the enrollment sweep opted out of participation—a participation rate similar to large national samples of plans with automatic enrollment (e.g., Bhargava et al. 2021). As with most large firms, employees could adjust their contribution by proceeding through a simple web-flow from their online benefits portal. Enrollment adjustments were processed with a one- to five-day lag before taking effect for the subsequent two-week pay-cycle.

Like many of its counterparts, the firm offered a plan match, which was distinctive in its generosity. The plan matched employee contributions, dollar-for-dollar, up to 4 percent of eligible salary and additionally guaranteed a minimum annual match of $2,000 to any employee contributing at, or above, the match threshold over the calendar year. For those earning less than $50k annually and not yet contributing at the threshold, this minimum implied an effective return that could significantly exceed 100 percent assuming the contribution was maintained. For such employees in our sample, the match offered an expected return to each marginal dollar ranging from 100 to 367 percent, with a median marginal return of 125 percent. Despite these incentives, a significant share of plan-eligible employees at the firm had not taken full advantage of the match, including 76 percent of those invited to participate in the study.

3 THEORETICAL FRAMEWORK OF EMPLOYEE SAVING DECISION

To organize tests of candidate frictions, we introduce a simple theoretical framework to describe an employee's decision to save. The framework adapts the notation and exposition of DellaVigna (2018), who models the saving decision of a present-biased employee in the presence of a plan match and potentially high hassle costs associated with enrollment. We initially describe the case of a fully-informed employee maximizing utility subject to an exponential discount function and then consider departures from this baseline corresponding to each psychological friction of interest.

3.1. The Saving Decision

We define the savings decision for a non-participating benefit-eligible employee as a choice between enrolling in a 401(k) plan now or delaying enrollment to a future period, indexed in days. For simplicity, we restrict our attention to the decision to enroll with a 4 percent contribution rate in a plan that offers a dollar-for-dollar match up to a 4 percent threshold. We allow for employees to have present-biased preferences through beta-delta discounting of present versus future periods.

We specify the employee's total utility by the following equation:

$$U_t = u_t + \beta \sum_{v=1}^{\infty} \delta^v u_{t+v}$$

[8] Conversations with industry suggest the increasingly popularity of "enrollment sweeps" targeting tenured employees.

where $U_t = (u_t, u_{t+1}, \ldots)$ represents the present discounted value of instantaneous utility associated with future periods, *t*, indexed in days. $\beta\delta$ denotes the employee's discount factor between today and tomorrow, while δ denotes the discount factor between any two days in the future ($\beta, \delta \in (0,1)$). For additional tractability, and to reflect the inertia typically observed in contributions, we assume that once an employee decides to enroll, she continues to contribute at 4 percent each year until she retires at time *T* and receives accumulated savings as a lump-sum. We normalize the value of never saving to 0.

To assess the conditions under which an employee will enroll, we must specify the costs and benefits of enrollment. We denote the costs of enrollment by *k* and interpret such costs to include the opportunity time-costs associated with administrative enrollment. To capture the fact that these costs may vary across days, in practice, we can interpret *k* in a specific period as being drawn from a uniform distribution over potential costs. Next we define the net utility gained from contributing *s* dollars in a given period by *b*. To simplify, we normalize constant marginal utility of consumption to 1 and assume that the long-term discounting factor equals the interest rate, such that, $\delta = 1/(1+r)$. This permits us to specify the net utility gain an employee receives from contributing *s* dollars in a period as: $b = \tau_0 s + \mu - \tau_R(s+\mu)$. where τ_0 is the tax rate for consumption today that she avoids by deferring income, μ is the effective return on savings from the employer match, and $\tau_R \leq \tau_0$ is the tax rate in retirement. We first consider the decision to save, or enroll, for a baseline employee, whose behavior is subject to the standard model, and then proceed to the more interesting case in which employees exhibit psychological frictions, or departures from the standard baseline model of enrollment.

3.2. Standard Model ($\widehat{\boldsymbol{\beta}} = \boldsymbol{\beta} = \mathbf{1}$)

A utility-maximizing employee with time-consistent preferences will enroll immediately if the present value of future expected benefits from enrollment exceeds the costs of enrollment. Otherwise, the employee will never enroll. Her enrollment decision can be described with the following inequality:

$$-k + \sum_{t=1}^{\infty} \delta^t b \geq 0$$

Noting the Taylor series expansion for $\frac{\delta}{1-\delta}$ allows us to rewrite the decision rule as:

$$k \leq \frac{\delta b}{1-\delta} = \frac{\delta(\tau_0 s + \mu - \tau_R(s+\mu))}{1-\delta}$$

Prediction: The probability of enrollment increases in *b* and decreases in k.

3.3. Psychological Frictions

Friction 1: Present Bias ($\beta < 1$). The initial psychological friction we incorporate in the model is present focus, here modeled as present bias with beta-delta preferences. While present bias permits delays in

actions such as enrolling in a 401(k) with a generous match, a key insight from O'Donoghue and Rabin (1999b) is that a sophisticated present-biased discounter will not delay action indefinitely due to knowledge that she will encounter similar temptations to not act in the future. O'Donoghue and Rabin derive a bound on the maximal delay t^* for a sophisticate that makes her indifferent between acting today or in t^* days. This employee will enroll today rather than enrolling in t^* days whenever:

$$-k + \beta\delta\frac{b}{1-\delta} \geq \beta\delta^{t*}\left(-k + \frac{\delta b}{1-\delta}\right)$$

Using a Taylor expansion approximation for $\delta \to 1, (1-\delta^{t*}) \approx (1-\delta)t^*$, a sophisticated present-biased employee will enroll if:

$$k \leq \frac{\beta\delta(1-\delta^{t*})b}{(1-\beta\delta^{t*})(1-\delta)} = \frac{\beta b}{1-\beta}t^* = \frac{\beta(\tau_0 s + \mu - \tau_R(s+\mu))}{1-\beta}t^*$$

Such an employee will delay no more than $t^* = k\frac{1-\beta}{\beta b}$ days.

In contrast to the sophisticate, a fully naive present-biased employee anticipates that she will act like an exponential discounter at her next opportunity to invest, tomorrow. She will invest today if:

$$k \lesssim \frac{\beta(\tau_0 s + \mu - \tau_R(s+\mu))}{1-\beta}$$

and will delay indefinitely if enrollment costs are above this decision threshold and below her anticipated cost of delay, $\frac{\delta(\tau_0 s+\mu-\tau_R(s+\mu))}{1-\delta}$. We assume sophistication among present-biased employees for the remainder of this section and revisit the possibility of naiveté later in the paper.

Prediction. For a sophisticated present-biased employee, the likelihood of enrollment rises with β, such that $\frac{\partial \Pr[\text{Enroll}]}{\partial\beta} > 0$, and differentially rises with an immediate, rather than delayed, increase in benefits: $\frac{\partial \Pr[\text{Increase}]}{\partial(b_{now})} > \frac{\partial \Pr[\text{Increase}]}{\partial(b_{later})}$.

Friction #2: Deficit in Retirement Literacy ($\hat{b} < b$). The next friction we consider captures the possibility that deficits in understanding about one's financial needs in retirement, or how much savings is sufficient to meet such needs, can causally influence enrollment. We model deficits in retirement literacy as distorted beliefs about the benefits of saving and specifically restrict attention to instances in which an employee underestimates the expected benefits of savings, such that $\hat{b} < b$. An employee suffering from deficits in literacy (along with potential present bias) will enroll if: $k \leq \frac{\beta\hat{b}}{1-\beta}t^*$.

Prediction: A prediction of the model is that the likelihood of enrollment for an employee who underestimates the benefits of saving increases as the magnitude of such deficits decrease: $\frac{\partial \Pr[\text{Enroll}]}{\partial(\hat{b}-b)} > 0$.

Friction #3: Plan Confusion ($\hat{\mu} < \mu$). The third friction we consider captures the possibility that employees underestimate, or are unaware of, the generosity of the plan match. In general, we denote the perceived net utility gain from savings as a function of the perceived match $\hat{\mu}$, so that $\hat{b} = \tau_0 + \hat{\mu} - \tau_R(1 + \hat{\mu})$. The decision rule for an employee who underestimates plan generosity can be written as:

$$k \leq \frac{\beta\delta(1-\delta^{t*})(\tau_0 s + \hat{\mu} - \tau_R(s+\hat{\mu}))}{(1-\beta\delta^{t*})(1-\delta)} \approx \frac{\beta(\tau_0 s + \hat{\mu} - \tau_R(s+\hat{\mu}))}{1-\beta} t^*$$

Prediction: A prediction of the model is that the likelihood of enrollment for an employee underestimating plan generosity increases as the magnitude of underestimation decreases: $\frac{\partial \Pr[\text{Enroll}]}{\partial(\hat{\mu}-\mu)} > 0$.

Friction #4: Enrollment Complexity ($\tilde{k} > k$). A final friction captures the possibility that the employee overestimates the time-costs associated with administrative enrollment because of a belief that administrative enrollment is highly complicated. We can think of enrollment costs in this case as some $\tilde{k} = k + k'$ where k captures the true opportunity time-cost of enrollment and k' reflects overestimation due to a perception of enrollment complexity. Alternatively, invoking the possibility of hassle costs associated with small administrative burdens (e.g., Bertrand, Mullainathan, and Shafir 2004), one could interpret k' as reflecting the presence of psychological costs of enrollment that significantly exceed the economic value of the time required to enroll. The decision-rule for an employee who overestimates the costs of enrollment due is identical to that displayed above, but for the replacement of k with k'.

Prediction: A prediction of the model is that the likelihood of enrollment for an employee who overestimates enrollment costs due to perceived enrollment complexity will decrease as perceived enrollment complexity increases: $\frac{\partial \Pr[\text{Enroll}]}{\partial k'} < 0$.

4 EMPIRICAL RESEARCH DESIGN

4.1. Overview

To investigate the causal relationship between the four candidate frictions and 401(k) plan engagement, we administered a survey and field experiment targeting low-saving employees at a large US

firm in the financial services sector in July 2016.[9] The field experiment took place in an online study marketed as an employer-sponsored opportunity to provide confidential feedback on benefit programs. The first module of the study was a survey capturing background information and assessing the incidence of the candidate frictions for each employee, while the second module implemented the field experiment.

Specifically, the latter module promised each employee a retirement preparedness assessment based on their prior responses and to facilitate any desired plan contribution adjustments based on this assessment. In practice, this module also experimentally varied across several web-flow variations based on two randomizations to information- and incentive-based treatments designed to test each candidate friction. While differences in employee response across these treatments constitute our primary causal evidence (evidence for one friction, enrollment complexity, relies on a pre-period comparison), integrated analysis of the survey and experiment provides insight into the baseline prevalence of each friction and potential heterogeneity in experimental response across employees differing in incidence of the targeted friction. We describe the sample, procedures, and experimental treatments in greater detail below.

4.2. Employee Sample

Two considerations shaped the composition of our employee sample—the desire to target undersaving low-to-moderate income employees and the firm's request to limit the invited sample to 5,000. Because we sought to assign employees to a distinct set of interventions based on whether they had exhausted the plan match, we invited two non-overlapping samples to participate in the survey. The principal invited sample (henceforth, the Low-Saving Arm, or "Low Arm") comprised the universe of 3,719 401(k) plan-eligible employees who, as of July 2016, were 25 to 55 years of age, earning less than $100k annually, and contributing less than the 4 percent match limit to their 401(k) (inclusive of non-participants). A second sample of 1,000 (henceforth, the Moderate-Saving Arm or "Moderate Arm") comprised a random sample of all plan-eligible employees who, as of July 2016, were 25 to 55 years of age, earning less than $100k annually, and contributing 4 to 9 percent to their 401(k).

Across these two study arms, 4,719 employees were invited to participate in the field study, of whom 1,332 (28%) participated in the study during the pre-specified 10-day period. We attribute the relatively high response rate for an email solicitation to the firm's sponsorship and promotion of the initiative, an email reminder, and a lottery-based participation incentive. After excluding employees who could not be assigned to a treatment based on their reported contribution rate or who dropped out prior to reaching the final module, we randomized the remaining 1,137 employees to an experimental treatment within one of the two study arms (780 in the Low Arm; 357 in the Moderate Arm).[10]

[9] The firm, whose identity we anonymize, is a national provider of retail and commercial financial services.

[10] We excluded 165 respondents reporting a contribution rate at or exceeding the recommended rate or 10 percent and 30 respondents who dropped out prior to reaching the experimental treatments. Because study arm assignment was determined by

Table 1 describes the demographic background and saving behavior of invited employees as well as some additional detail for respondents. The table offers two insights speaking to the generalizability of the research. First, the table reveals the significant demographic diversity of the sample (the sample, like the broader firm, is disproportionately female). For specific clarity as to the representativeness of the sample by income, Appendix Figure A1 compares the income distribution of invited and respondent employees to a contemporaneous, national sample of full-time US employees drawn from the 2015 CPS. The figure suggests that employees in the study resemble that of the national cross-section but for the former modestly over-sampling the middle two earnings quartiles. Second, the table permits us to compare the invited and respondent samples. While the table suggests approximate demographic similarity, it indicates that respondents were modestly more engaged than non-respondents by plan participation and full match take-up. Overall, we interpret the table as attesting to the demographic and financial diversity of the sample and indicating that observable selection into the sample was modest.

4.3. Survey of Psychological Frictions

4.3.1. Structure and Procedure

On July 19, 2016, we invited the pre-specified sample of employees to participate in a ten- to fifteen-minute survey marketed as an opportunity to provide confidential feedback on their employer's benefit programs. The email invitation explained that the survey was offered in partnership with the firm in order to help advance employee well-being but designed and administered by academic researchers from Carnegie Mellon University. Employees were directed to the online instrument hosted on the Qualtrics platform via a customized link included in the email. To encourage response by the ten-day deadline, employees were informed that completing the survey would enter them into a raffle for an Apple iPad. We reminded non-responding employees to complete the survey through a second email on the morning of the deadline. As depicted in Figure 1, the online instrument featured two modules of which the first comprised the employee survey and the second administered the field experiment.

4.3.2. Survey Content

The central goals of the survey were to collect detailed background characteristics and assess incidence of the four candidate frictions for each respondent. For ease of exposition, we organize our description below of the survey content by categories addressing each of these aims. The survey was largely identical across respondents except in instances where questions were customized to reflect prior response or restricted questions to a randomized subset of employees to manage survey length.[11]

self-reported contribution, 17 employees contributing at or above 4 percent were assigned to the Low Arm, while 115 low-saving employees were assigned to the Moderate Arm.

[11] To limit survey length, we randomized employees to subsets of questions pertaining to non-saving benefit plans, financial literacy, financial liquidity, present focus, and financial anxiety. While randomizations were implemented within the survey flow,

A first set of questions informed our calculations of the recommended rate of contribution used in the experiment and subsequent analyses. These items included questions about demographics (e.g., age, gender, approximate income, household status, education, tenure) and financial background (e.g., accumulated savings, financial liquidity). Data from this module informed a number of subsequent analyses and allowed us to calculate the recommended rate of contribution that we presented to select employees in the final module.

To assess the retirement literacy friction, a second set of questions elicited retirement-relevant beliefs and measured financial literacy. To generate a direct measure of beliefs about required saving, we asked employees to estimate the minimum annual contribution rate for someone like themselves to prepare for a financially secure retirement. To generate an indirect measure of beliefs about required saving, we first asked employees to estimate three inputs for typical retirement calculators to generate saving recommendations —expected age of retirement, expected duration of retirement, and the income replacement ratio (relative to current income) for them to live comfortably in retirement. We input these responses to the commercial retirement calculator on their benefit portal to construct a contribution rate. We compared these measures of direct and indirect beliefs about required saving with actuarial calculations to help characterize retirement literacy. We assessed financial literacy by asking employees widely-used questions about inflation and compound interest introduced by Lusardi and Mitchell (2007).

To assess plan confusion, another set of questions measured employee awareness and knowledge of the 401(k) plan. We asked employees about their 401(k) eligibility, enrollment status, and contribution rate, as well as their knowledge of plan features, including the plan's match limit and the automatic enrollment policy recently instituted for new hires. These responses were also used to route employees to the appropriate study arm (determined by self-reported contribution rate). To help differentiate confusion from careless responses, we also included an item gauging task attention that instructed respondents to proceed to the next page without selecting a response for the question below asking them to rate their work-life balance. We assessed perceptions of enrollment complexity through a single item asking respondents to estimate the time required to adjust their contribution rate.

Finally, a last set of questions assessed present focus, related beliefs, and potential correlates. Our most direct measure of present focus asked employees to make pairwise choices between sooner-smaller or larger-later effort costs with and without a front-end delay.[12] A second assessment was based on a question taking the strategy of asking the relevant populations to evaluate possible explanations for

due to higher than anticipated response on the fourth day of the survey, we expanded the rotation to include (previously excluded) questions pertaining to liquidity and financial anxiety.

[12] We abbreviated a multiple price list elicitation of present bias with payoffs one month apart with or without a one-month front-end delay and adapted it to use effort costs rather than monetary payoffs. Respondents made three choices with and three without a one-month front end delay between a fixed sooner smaller duration (25 minutes) of a tedious effort task and three larger later durations (30, 40, or 50 minutes).

empirical puzzles (see e.g., Bhargava and Manoli 2015 regarding causes of EITC non-claiming). Specifically, we asked employees to introspect about why automatic enrollment increases 401(k) participation and then select the best among candidate explanations involving procrastination (indicative of present focus), low awareness, or enrollment complexity. We also elicited anticipated contribution adjustments in the future to inform our estimates of a beta-delta model of present bias and asked about financial anxiety to help test alternative theories of present focus introduced later in the paper.

4.4. Field Experiment

4.4.1. Overview and Procedure

Following the initial survey module, employees progressed to a subsequent module that promised to evaluate their retirement preparedness based on earlier survey responses and to subsequently guide them through any desired adjustment to plan contribution. In practice, this module also implemented the field experiment. As depicted in Figure 1, the specific web-flow an employee saw was determined by random assignment to a primary experimental treatment within their study arm and, for some employees, a subsequent random assignment to a secondary experimental treatment. Across all variations, the module presented employees with an assessment of their retirement preparedness (*Retirement Assessment*) and then asked if they wanted to adjust their contribution rate (and provided step-by-step guidance to those interested in doing so) (*Saving Decision*). Employees who did not change their contribution were prompted to reconsider their decision (*Saving Reconsideration*). Finally, all employees were asked a series of follow-up questions about their choice and their future intentions to save (*Saving Follow-up*).

Random Assignment. Prior to random assignment, employees were assigned to one of the two study arms based on whether or not they were fully taking up the plan match. Employees who had reported contributing 0, 1, 2, or 3 percent of salary were assigned to the Low Arm while those who reported contributing 4 percent or higher were assigned to the Moderate Arm. In a first random assignment, employees in the Low Arm were randomized with equal probability to one of three experimental treatments, while employees in the Moderate Arm were randomized with equal probability to one of two experimental treatments (primary treatment). Balancing tests indicate that the assignment led to observationally similar subsamples within each arm (Appendix Table A1). In a second random assignment, employees who reported not adjusting their contribution and who had not been initially assigned to the small reward treatment were independently randomized to one of two experimental variations of a prompt to reconsider their saving decision (secondary treatment).

4.4.2. Baseline Condition - Generic Recommendation

To simplify the description of the primary treatments, we first describe the four components of a baseline web-flow that delivered a generic recommendation to employees before describing each primary

treatment with reference to departures from this baseline (note that the baseline reflects one of the two primary treatments of the Moderate Arm). Appendix Figure A2 displays the associated screenshots.

1. Retirement Assessment. After an initial screen introduced the retirement evaluation, employees progressed to a page displaying a stylized graphic of a red-to-green gauge with the dial resting on red beneath the text: "You should take action now to get on track for a financially secure retirement." Text beneath the graphic encouraged employees to increase their contribution rate: "We recommend that you increase [in green type] your [redacted] 401(k) contribution rate."

2. Saving Decision. The next screen asked respondents if they wanted to adjust their contribution rate and communicated that adjustment would require only seconds. Those indicating interest in adjusting their contribution proceeded to a screen that provided simple instructions and directed them to the firm's benefit portal via a hyperlink.[13] To encourage employees to make the adjustment, employees were not allowed to proceed from this screen for one minute, after which they proceeded to a prompt asking them to confirm whether they had made the adjustment.

3. Saving Reconsideration. Employees who did not express an initial interest in adjusting their rate or who indicated they had not actually implemented an adjustment were asked to reconsider their decision: "Are you sure you don't want to change your rate?" Employees interested in an adjustment were then provided guidance as described above.

4. Saving Follow-up. Finally, respondents were asked follow-up questions regarding their saving decision, future intentions to save, and, in some instances, their updated perceptions of required saving and enrollment complexity.

4.4.3. Primary Experimental Treatments

Low Saving Arm (0 to 3 percent contribution). Respondents in the Low Arm were randomized to one of three primary treatments: Specific Recommendation, Match Clarification, or Small Reward. We describe how each treatment departs from the baseline web-flow described above and indicate the friction the treatment was intended to test. Appendix Figure A3 displays the associated screenshots:

1. Specific Recommendation [Retirement Literacy]: A first treatment adapted the baseline design to include a specific and personalized recommended contribution rate, *x*: "We recommend that you increase [in green type] your [redacted] 401(k) contribution rate to: <*x*>% [in red type]". For respondents who reached the instruction screen, the recommended rate was displayed again. To calculate the

[13] Text of steps: "Step 1: Go to Pathfinder from your Intranet or by clicking here <*link*>. Step 2: Expand the Retirement & Investments Panel. Step 3: Click Change or Enroll Today to change your contribution rate."

recommendation, we used the commercial retirement calculator available to employees via their benefits portal with inputs informed by their survey responses and actuarial assumptions (our recommendation also accounted for the plan match).[14] The treatment was designed to test whether improving retirement literacy, by effectively reducing employee underestimation of the benefits of saving, would lead to an increase in contribution relative to the pre-study comparison period (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(b-\hat{b})} < 0$). The treatment also served as the control for the match clarification.

2. Match Clarification [Plan Confusion]: A second treatment duplicated the specific recommendation web-flow but for an additional screen clarifying the generosity of the plan match. The message read: "Don't miss out on extra money from [Redacted]. By taking full advantage of the [Redacted] match, you could earn $2,000 or more each year." A graphic illustrated that the match effectively doubled each contributed dollar up to the match limit while additional text explained the $2,000 minimum match. The treatment was designed to test whether reducing underestimation about the generosity of the plan match led employees to increase saving (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(\mu-\hat{\mu})} < 0$). The clarification could have alternatively affected behavior by heightening the salience of the plan match (even for employees with accurate beliefs at baseline). The treatment also served as the control for the small reward.

3. Small Reward [Present Focus]: A third treatment duplicated the match clarification web-flow but for the introduction of a small reward, an $10 Amazon Gift Card, to encourage employees to engage their enrollment decision. The reward offer was communicated by the text above the savings prompt: "To encourage you to think about your financial future, we will email you a $10 Amazon Gift Card if you take action today." An additional note at the bottom of the screen clarified that employees could receive the gift card either by adjusting their plan contribution in either direction or by contacting the researchers through a provided email address to indicate that they had decided not to modify their contribution. In conjunction with the match clarification, the treatment was designed to test for present focus by indicating whether employees were more responsive to a small but immediate reward relative to clarification of the far larger, but delayed, plan match. (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(b_{now})} > \frac{\partial \Pr[\text{Increase}]}{\partial(b_{later})}$).

Moderate-Saving Arm (4 to 9 percent contribution). Respondents in the Moderate Arm were randomly assigned to one of two primary treatments: Generic or Specific Recommendation.

[14] The calculator recommends a contribution rate projected to ensure a salary-dependent income replacement ratio (125% for salary < $25k, 100% for salary $25-$55k, 80% for salary $55k or higher) for 20 years after age 65, after accounting for Social Security benefits and the employer match, for a single employee in the same income and 5-year age category. Reflecting national data, we assume employees under 50 had no accumulated savings, while employees 50 or older had $50,000 in accumulated savings. We make financial industry-standard simplifying assumptions of a projected annual inflation rate of 3% and an annual market growth rate of 8% and constrained recommended contribution rates not to exceed 25%.

1. Generic Recommendation [Enrollment Complexity] – A first treatment was identical to the baseline condition described above. The treatment was designed to test how reducing enrollment complexity—through generic guidance, communication that adjusting one's contribution takes a minimal amount of time, and step-by-step instructions—affected saving relative to a pre-period comparison period (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(k)} < 0$). The treatment also served as the control for the specific recommendation.

2. Specific Recommendation [Retirement Literacy]– A second treatment was identical to the specific recommendation treatment in the Low Arm. The treatment was designed to test whether improving retirement literacy, by effectively reducing employee underestimation of the benefits of saving, would lead to an increase in contribution relative to the generic recommendation (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(b-\hat{b})} < 0$).

4.4.4. Secondary Experimental Treatments

To increase the statistical power of our test of small rewards, we independently randomized select employees across the two study arms to one of two experimental variations of the savings reconsideration prompt. The randomization was restricted to respondents who did not report adjusting their contribution after the primary intervention and who had not been initially randomized to the small reward treatment (we chose not to offer respondents the small reward twice). Specifically, we randomized employees within this restricted sample to either the baseline savings reconsideration prompt or a slightly adapted prompt including the same text offering employees the immediate reward described for the primary small reward treatment. As with the earlier implementation, fine print clarified that employees could earn the reward by either adjusting their contribution or by emailing the researchers of their decision not to do so.

4.5. Data and Empirical Outcomes

Our empirical analysis relies on data collected from employees via the online survey and linked administrative data provided by the firm. The administrative employee records contain basic employee demographics (gender, age, zip code of work location, and income decile within the invited sample) along with information about 401(k) enrollment and contribution from January through November 2016. We used these records to create three central baseline measures of employee saving: an enrollment indicator, contribution rate as a percent of annual salary, and an indicator for full match take-up (i.e., a contribution rate of 4 percent or higher). To assess outcomes from the field experiment, we estimated changes to each of these measures by comparing administrative records associated with the nearest payday preceding the beginning of the study period and the nearest payday following its end.[15]

[15] Paydays occur twice a month at this firm and our survey window includes one payday (July 25, 2016).

5 EVIDENCE ON CANDIDATE FRICTIONS

We now present findings from the field study as they pertain to each candidate friction. After briefly summarizing the overall employee response to the survey and field experiment, we detail evidence on each friction and then attempt to synthesize the evidence in the context of the relevant literature. Specifically, for each of the four frictions, we document its baseline incidence as inferred from surveyed measures, the correlation between incidence and baseline saving, the average increase in saving in response to the corresponding experimental treatment, and, finally, any differential experimental response across employees varying in baseline incidence of the friction.

5.1. Overview of Survey and Experimental Response

Survey Response. We begin by summarizing the overall employee response to the survey and to each experimental treatment. To facilitate analysis and exposition, we constructed several dichotomous indicators from the survey responses associated with each friction. Table 2 organizes these measures by friction and summarizes them for the full sample of surveyed employees, as well as by plan engagement (note that differences in sample size reflect the strategy of randomizing employees across some subsets of questions). The final two columns of the table describe how these measures correlate with engagement, reporting p-values for tests of mean differences across plan participation and full match take-up. We present data on an extended set of survey measures, organized by friction, in Appendix Table A2.

Overall, the table reveals a diverse pattern of incidence across the frictions. The most pervasive friction is that of low retirement literacy, with nearly one-half of employees either directly or indirectly underestimating how much they should save relative to actuarially-informed targets. The table indicates a more moderate degree of plan confusion—while most employees were aware of their plan eligibility, 20 percent underestimated the generosity of the plan match, and an even greater share overestimated their actual plan contribution—and minimal evidence of perceived enrollment complexity. With respect to complexity, we find that while about one-quarter of employees may have overestimated the time required to adjust their contribution (in estimating that it required more than a few minutes), only a small fraction of employees perceived such adjustment as requiring enough time to conceivably affect the decision to save because of prohibitively high time-costs of enrollment.

Finally, the table is less diagnostic as to the prevalence of present focus. Only a small fraction of employees exhibited present focus when measured through the intertemporal effort allocation task, but the large majority of employees for whom this measure cannot rule out present focus suggests that it may be of limited diagnostic value. A far larger share of employees report a lay theory of how auto-enrollment increases plan enrollment based on overcoming procrastination—implicating present focus—when asked to introspect about why this policy affects saving. Critically, several of the friction indicators—including

measures of low retirement literacy and plan confusion—are significant predictors of plan engagement in the theoretically prescribed direction.

Experimental Response. Turning to the experiment, we documented a significant collective response to the experimental treatments. During the two pay cycles of the study, 10.5 percent of employees in the respondent sample modified their contribution, with most of these reflecting increases (9.1 percent). Nearly half of the increases in contribution involved an increase of more than one percentage point and a significant portion involved moving to full take-up of the plan match. As a point of comparison, 1.4 percent of respondents increased their contribution during the pre-study period, indicating that such employees were 6.5 times more likely to increase saving during the study.

We estimate employee response to specific experimental treatments across both study arms through a series of simple regressions. Table 3 summarizes this experimental response by estimating saving outcomes (an indicator for a contribution rate increase, the change in contribution rate, and, for the low-saving arm, an indicator signifying an increase in contribution that leads to full match take-up) for each of the primary (Panel A) and secondary (Panel B) treatment. For example, the first three columns of Panel A reports OLS estimates of the following model for each saving outcome, s_i:

$$s_i = \gamma\, SR_i \quad + \theta\, MC_i + \beta\, Reward_i + \varepsilon_i$$

where SR_i indicates employee *i*'s assignment to the specific recommendation, MC_i indicates assignment to the match clarification, and $Reward_i$ indicates assignment to the small reward. Assuming no treatment interactions, (θ - γ) captures the marginal effect of clarifying the generosity of the plan match on saving, and (β - θ) captures the marginal effect of providing a small reward. The marginal effect of the specific recommendation for employees in the low-saving arm is given by γ, in comparison with the non-experimental pre-period, reported in the table. Given that the two pay-cycle pre-period occurred *after* we identified the invitation sample, but before the study was launched, it offers a good control, under the assumption that so long as this pre-period was not associated with some unobserved shock to saving behavior. The final two columns of the table report estimates for the two relevant saving outcomes from similar models adapted to the two primary treatments in the moderate-saving arm.[16] Panel B reports analogous estimates for the secondary treatments.[17] Figures 2 and 3 graphically depict the rate of contribution increase in response to each of the experimental treatments.

Collectively, these estimates show that the overall change in saving observed for the experimental sample was driven by large responses to the small reward. Providing recommendations (whether generic

[16] For the Moderate Arm primary interventions we estimate: $Pr(\text{Increase}_i) = \gamma\text{GenericRec}_i + \theta\text{Rec}_i + \varepsilon_i$.

[17] We estimate the following model of secondary interventions, separately for each experimental arm: $Pr(\text{Increase}_i) = \alpha\ \text{Reconsider}_i + \pi\ \text{Reconsider10}_i$, where $(\pi - \alpha)$ identifies the marginal effect of offering \$10 relative to a prompt to reconsider with no reward after an employee reports not changing their contribution following the primary intervention.

or specific) and clarifying the match prompted, at best, modest changes in average saving. In contrast, across the primary and secondary treatments, and both study arms, 8 to 16 percent of employees increased saving in response to the small reward. For employees in the low study arm, who had previously not exhausted the match, a substantial share of saving increases led to full match take-up. We turn next to evidence on each of the candidate frictions.

5.2. Low Retirement Literacy - Candidate Friction #1

Baseline Incidence. As discussed, Table 3 indicates that nearly one-half of employees in the sample directly (by estimating the minimum required annual contribution rate) or indirectly (by estimating retirement calculator inputs) underestimated how much they should contribute relative to actuarially-informed benchmarks. We estimate the actuarial benchmark by inputting conventional assumptions for retirement age, life expectancy, and the income replacement ratio into the commercial retirement calculator available to employees on their benefit portal. One could argue that the table understates the deficit in retirement literacy, considering that the reported estimates assume accurate matching incentives while, in actuality, many employees in the sample underestimate the generosity of such incentives. Our second measure of low literacy—a score of zero on the two-question assessment of financial literacy—indicates a more moderate incidence, 20 percent, than the two saving estimation measures, although we note that a significantly higher share of employees, 66 percent, scored one or less on the assessment.[18] Performance on the two-question assessment in our sample, which targets undersaving employees, reflects a lower level of literacy than more representative national samples (see Hastings, Madrian, and Skimmyhorn 2013).

To gain additional insight into employee estimates of saving requirements, Figure 4 compares the average direct (green) and indirect (blue) estimates of the annual required saving rate to the actuarial benchmark by employee age. The figure indicates that underestimation is primarily concentrated among employees in their 40s and 50s, possibly because such employees do not appreciate the trajectory of returns associated with compounding, as suggested by the literature. We can further investigate the source of bias, at least in the indirect estimates, by separately comparing the age-specific average beliefs of the three retirement inputs against appropriate benchmarks. This comparison, shown in Appendix Figure A4, points to clear bias for at least two of the three inputs. The first panel suggests substantial over-optimism in life expectancy relative to actuarial projections, while the second panel shows that employees, particularly of more advanced age, expect to retire much later than 62.7 years, the average median age of recent living retirees in the US. (62.7). The third panel indicates more plausible beliefs about target

[18] Responses to a third financial literacy question about the value of a $1,000 equity investment in twenty years implied widely varying beliefs about annualized market return (IQR: 2.7% to 12.2%). (Appendix Table A2).

income replacement ratios relative to the lower and upper bounds of recommended replacement ratios from academics and financial advisors (particularly if one believes that younger employees with low earnings should reasonably expect increasing income profiles, and thus higher replacement ratios relative to current income).[19]

Table 3 also reports the correlation between measures of retirement literacy and plan engagement. The table corroborates assertions in the literature regarding the positive correlation between financial literacy and plan engagement as judged by plan participation (24 percent of non-participants scored zero; 16 percent of participants scored zero, p = 0.06) or full match take-up (23 percent of those taking up the match scored zero; 11 percent of those not taking up the match scored zero, p = 0.02). The table conveys mixed evidence as to the unconditioned correlation between saving underestimation and plan engagement—indirect underestimation negatively predicts full match take-up but only nominally predicts lower participation; direct underestimation does not clearly predict engagement.

Experimental Test of Low Retirement Literacy. While the survey documents widespread employee underestimation about how much to save each year, a more moderate share of low financial literacy, and a positive correlation between at least some of these measures and low plan engagement, we explicitly test for the causal role of retirement literacy in determining saving through the field experiment. If deficits in retirement literacy, broadly construed, cause employees to underestimate how much they should save each year, or equivalently to underestimate the benefits of saving, such that $(\hat{b} - b) < 0$, and this underestimation leads employees to save insufficiently, then providing a specific recommendation about how much to save should lead to an increase in employee contribution. Further, a causal relationship between literacy and saving implies that employees who initially underestimated how much to save or scored low in financial literacy should be particularly, or differentially, responsive to the experimental receipt of a specific recommendation than their counterparts.

Overall, as reported in Table 3 and graphically depicted in Figures 2 and 3, employees *did not* increase contributions in response to the experimental provision of a specific recommendation (the precision of the estimates permit us to reject anything more than a modest experimental response). Employees in the Low Arm were no more likely to increase contributions in response to the specific recommendation (b = 0.02, se = 0.01) than they were in the reference period prior to the study (b = 0.01, se = 0.004), while employees in the Moderate Arm were not differentially responsive to the provision of a specific (b = 0.04, se = 0.02) as compared to generic (b = 0.03, se = 0.02) recommendation (p_{diff} = 0.70).

[19] We predict actuarially-informed life expectancies for 5-year age bins using SSA projections of life expectancy based on 2014 mortality rates. Retrieved in 2017 from https://www.ssa.gov/oact/STATS/table4c6_2014.html. Data on average age of contemporaneous retirement was recorded from the 2017 Survey of Household Economics and Decision-making. The appropriate replacement ratio may vary widely due to income as well as preferences. A 2016 GAO report indicates financial advisors recommend replacement ratios ranging from 70 to 85%.

Could one attribute the absence of employee response to the specific recommendation to employees not finding the recommendation to be credible or comprehensible or simply ignoring it? To examine these possibilities, we explicitly examined whether exposure to the recommendation changed employees' beliefs about required saving. Table 4 presents estimates from simple regressions estimating improvements to the accuracy of employee beliefs (and perceptions of enrollment complexity) due to experimental assignment for each study arm, with a suppressed constant. Specifically, we define belief accuracy, or more precisely, a reduction in saving underestimation, through an indicator variable denoting whether an employee's estimate of the required saving rate, at the end of the field study, equaled, or exceeded, the actuarial benchmark. The table shows that assignment to the specific recommendation resulted in significant improvements to the accuracy of beliefs across both the low-saving ($b = 0.24$, $p < 0.01$) and moderate-saving ($b = 0.17$, $p < 0.01$) arms.

Differential Response by Baseline Incidence. While the average response to the specific recommendation offers little support for a causal pathway between retirement literacy and saving, our field study permits the additional test of whether employees differing in baseline incidence for each friction indicator differentially respond to the experimental treatment. Table 5 implements this test for the indicators associated with each friction (and also summarizes the cross-sectional evidence for each indicator). Consistent with the overall patterns of experimental response, the first three rows of the table suggest no discernable difference in average response to the specific recommendation for employees for whom low retirement literacy was, and was not, indicated according to each of the three indicators.

5.3. Plan Confusion - Candidate Friction #2

Baseline Incidence. The second friction we consider is employee confusion about 401(k) plan details such as plan eligibility or the generosity of the plan match. In theory, such confusion, particularly if it involved underestimation of eligibility or the plan match, might lead an otherwise rational employee delay enrollment. The survey indicates that while nearly all surveyed employees (correctly) professed awareness of their own eligibility, 30 percent of employees held incorrect beliefs about the threshold up to which the employer matched contributions (inclusive of employees unaware of the existence of a match altogether). The majority of employees with inaccurate beliefs—that is, the 20 percent of respondents reported in Table 2—underestimated the generosity of the plan match. This estimate almost surely understates the true degree of underestimation since we did not explicitly ask employees about the $2,000 minimum match, a provision that effectively increased the generosity of the plan match for a majority of the sample. Consistent with the possibility that plan confusion may be a causal impediment to saving, the table indicates that underestimation of the plan match strongly predicts average plan participation and full take-up of the match (we note the distinct possibility that the correlation may reflect

reverse causation for this particular measure). To our knowledge, ours is the first evidence on the degree to which plan-eligible employees underestimate the generosity of their 401(k) plan match.

Experimental Test of Plan Confusion. To better understand the causal effect of reducing plan confusion, or more specifically, the degree to which employees underestimate the plan match, we examine how employees responded to the treatment clarifying the generosity of the plan match. Comparing the average employee response to match clarification and the specific recommendation reported in Table 3 suggests that clarifying the significant benefits of the match did not lead to an increase in saving among employees in the low-saving arm (again, the estimates are sufficiently precise to reject anything more than a modest experimental response).

To better understand whether employee response to match clarification was sensitive to the magnitude of the foregone match, Figure 5 plots the average response to match clarification (grey line) across employees organized by the estimated 12-month financial value of their unclaimed match. We estimate this value, in nominal terms, by calculating the value of additional matching contributions an employee would earn by increasing their plan contribution to 4 percent and maintaining such a level of contribution for a calendar year.[20] We note that the estimates of the unclaimed plan match are not meant to reflect the precise opportunity cost of the enrollment decision (the value of the unclaimed match could be substantially higher or lower depending on assumptions about contribution inertia and counterfactual changes to future contributions), but are intended to help distinguish employees by the relative value of their unclaimed match. Ignoring possible differences in the composition of employees, the figure affirms that employee response to the match clarification is not sensitive to the potential financial value of the unclaimed match – even employees with significant unclaimed matching incentives do not increase saving when such value is clarified experimentally.

Differential Response by Baseline Incidence. As a final test of the causal role of employee plan confusion, we examine the differential response of employees to experimental clarification of the plan match. Table 5 reveals that employees who underestimated the plan match did not increase contributions in response to match clarification, nor were they differentially more responsive to such clarification than employees who did not underestimate the plan match. Integrating across the survey and field experiment, we find that while many employees underestimated the generosity of the plan match, and such underestimation ostensibly correlates with poor saving outcomes, that evidence suggests that underestimation of the plan match does not cause undersaving.[21]

[20] The calculation includes the dollar-for-dollar match up to 4 percent and the minimum match provision that ensures a match of at least $2,000 for any employee contributing at or above 4 percent during the full calendar year. The calculation is in nominal dollars and assumes no change to salary.

[21] These results are consistent with Choi et al. (2011) who find that clarifying the plan match to a sample of under-saving, elderly, 401(k) eligible employees, did not result in additional savings.

Confusion about Plan Contribution. While our field study was designed to test for plan confusion regarding benefit eligibility and match generosity, our analysis revealed an unanticipated dimension of confusion—remarkably, 28 percent of respondents reported a 401(k) contribution rate inconsistent with administrative records. Most of these discrepancies, 24 percent of the overall sample, involved employees who *overestimated* their actual plan contribution rate. A consequence of these discrepancies, as detailed in Table 6, is that 37 percent of non-participants in our sample spuriously claimed a nonzero contribution, and 15 percent of participants reported a contribution rate exceeding their actual rate. Perhaps most strikingly, 26 percent of non-participants reported a contribution rate that implied full match take-up. As shown in Table 3, over-reporting of one's actual plan contribution rate substantially predicts low plan participation (in part by construction) and full match take-up.

There are at least two plausible explanations for the extremely high share of discrepant reports that do not involve genuine employee confusion. A first is that employees were inattentive to the survey instrument and such inattention led to random response error. However, the systematic direction of the bias—86 percent of discrepancies involved an inflated contribution rate—and the high frequency of discrepant responses at the specific contribution rate of 4 percent (selected from a menu ranging from 0 percent to 10+ percent) seem inconsistent with random error in response. To more formally bound the potential role of inattention, we calculate the share of discrepancies among the 60 percent of respondents who passed the fairly strict attention screen embedded within the survey. As reported in Table 7, this restriction only modestly reduces the share of discrepant reports of participation (from 0.37 to 0.34) and full match take-up (from 0.26 to 0.24).

A second possible explanation for the discrepancies that does not involve confusion is that employees may have deliberately exaggerated their contribution to increase the social desirability of their response. Once again, the distribution of discrepant reported contribution rates—peaking in the lower range of options from an ordered response menu is not superficially consistent with a social desirability motive. To bound the potential role of exaggeration, we can adjust the estimated discrepancy rate by reclassifying responses as exaggeration if the respondent gave another answer that appears consistent with exaggeration. Specifically, we identified the survey items administered to the full sample where a respondent could conceivably infer the most socially desirable response: salary, plan contribution rate, accumulated savings, education, and confidence in retirement preparation. As an additional screen for potential exaggeration, we compared self-reported salary with administrative records of salary decile. As Table 7 shows, reclassifying discrepant responses satisfying any of the enumerated screens as exaggeration reduces the share of discrepant reports of participation from 0.37 to 0.21 and of full match take-up from 0.24 to 0.14. Adjusting for both potential exaggeration and inattention by first reclassifying exaggeration and then conditioning on passing the attention check does not meaningfully reduce the share

of discrepancies any further. Ultimately, the table suggests that roughly one-fifth to one-third of 401(k) non-participants erroneously believe themselves to be enrolled, often at a non-trivial contribution rate.

5.4. Enrollment Complexity - Candidate Friction #3

Baseline Incidence. The third friction we consider is the perceived complexity of plan adjustment. Table 3 conveys baseline perceptions of enrollment complexity by reporting the share of employees who estimated that administrative enrollment (including time required to decide a rate of contribution) would require more than two specific time thresholds corresponding to the categorical elicitation in the survey. Specifically, the table reports that 23 percent of employees perceived that contribution adjustment would require more than a few minutes. Given the administrative simplicity of plan adjustment in this setting—without customizing other plan parameters, contribution adjustment requires a few concrete actions from an employee's intranet that could be completed in a matter of seconds to a few minutes—depending on assumptions about the time required to settle on a specific contribution rate, one could interpret these employees as overestimating the time-costs of adjustment. A far smaller share of employees, 0.11, expected adjustment to require more than a few hours, so as to potentially affect the decision to save through prohibitively high time-costs. Even allowing for psychological costs of plan adjustment that may extend beyond economic time-costs, we interpret this evidence as suggesting that only a small share of otherwise rational, and time-consistent, employees could conceivably perceive the burdens of contribution adjustments to be high enough to deter saving. While (likely) over-estimating the time-costs of plan adjustment does not predict low plan engagement in the cross-section, perceiving such time-costs as extremely high (i.e., as requiring more than a few hours) does seem to moderately predict plan participation (0.14 for non-participants, 0.09 for participants, $p < 0.05$).

Experimental Test of Enrollment Complexity. While the survey offers little evidence to support the possibility that perceived enrollment complexity impedes savings for more than a small share of employees, we turn to the field experiment for more direct evidence. Specifically, we can compare the increase in plan contribution among employees randomly assigned to the generic recommendation in the Moderate Arm employees from the pre-study period. Though the comparison technically offers the joint influence of the generic guidance and survey participation, we hypothesize that, for any employee meaningfully deterred by administrative complexity, exposure to generic guidance—which emphasized that a contribution increase could be accomplished in seconds and detailed the required steps—should lead to an increase in savings.[22] Table 4 supports, at least suggestively, this hypothesis in estimating an

[22] We did not anticipate that survey participation would independently influence employee savings given that the survey was marketed without specific reference to retirement savings and featured content encompassing many benefit programs. To the extent that it did independently influence employee behavior, we assume such influence would be modest and in the direction of

increase of 0.05, from a 0.77 baseline, in the share of employees perceiving enrollment as only requiring a minimal amount of time ($p < 0.10$). Table 3 indicates, however, that the experimental provision of generic guidance did not lead to a discernable increase in saving relative to the comparison group.

Differential Response by Baseline Incidence. As a final test of the causal influence of enrollment complexity, we report the differential response of employees, varying in their baseline perceptions, to generic guidance. Table 6 indicates that employees who perceive enrollment as complex, as defined by perceiving it to require more than minutes to complete, were no more responsive—and in fact were directionally less responsive— to generic guidance than their counterparts. Overall, we interpret the low baseline perception of prohibitive complexity, the lack of saving response to simplifying guidance among treated employees, and the absence of such response among employees perceiving complexity as offering no evidence for the hypothesis that enrollment complexity impedes saving in this setting.

5.5. Present Focus - Candidate Friction #4

Baseline Incidence. The fourth and final friction we consider is present focus. The significant share of non-participating employees in the sample, despite baseline understanding of the generosity of the plan match, as indicated by the survey and discussed earlier, offers initial evidence consistent with present focus behavior. The primary evidence on present focus, however, comes from direct measures of baseline incidence and employee response to the experimental treatments. Table 3 reports two indicators of present focus from the survey. The first, which infers present focus from preference reversals in a hypothetical intertemporal effort allocation, identifies 10 percent of respondents as present-focused. We view this measure as a lower bound on the baseline prevalence given the limits of the elicitation—it enables us to identify present focus within a narrow range of discount factors, but cannot distinguish present focus for the 78 percent of respondents who always chose the sooner-shorter task or the longer-later task. The second indicator infers present focus for employees who introspect about why auto-enrollment increases plan participation and select an explanation about overcoming procrastination as the best among four candidates. If we interpret this lay theory of default effects as diagnostic of one's own present focus, this measure suggests a much higher prevalence of the friction, with 60 percent of employees attributing auto-enrollment's impact to helping overcome employee procrastination. These indicators, while imperfect, suggest that a non-trivial share of employees exhibit present focus, although they do not offer a precise estimate of prevalence. Ultimately, we do not interpret the evidence as necessarily inconsistent with estimates from the literature, such as the 57 percent US adult incidence

increased plan engagement, in which case any behavioral response should be interpreted as an upper bound of the effect of reducing complexity.

documented by Xiao and Porto (2019). The table provides no evidence that present focus negatively predicts plan engagement in the cross-sectional comparison across participation and full match take-up.

Experimental Test of Present Focus. While the survey points to the presence of at least some share of present focus in the sample, we turn to the field experiment for more direct evidence as to its causal importance. Our central test of present focus involves examining the saving response of employees to the provision of the $10 reward (implemented as either a primary or secondary treatment in either of the two study arms). For employees in the Low Arm, we can additionally compare employee responses to the small reward and the clarification of the much larger, but delayed, plan match (i.e., $\frac{\partial \Pr[\text{Increase}]}{\partial(\hat{b})}$). While the reward reflects the immediate receipt of $10, the clarification informs employees of a median (maximum) annual increase in the present value of their retirement savings equivalent to $2,000 ($3,800)—or $80 ($152) per pay period—over one year of contributions. While the precise value of the foregone match depends on assumptions about saving inertia and counterfactual saving, an acceleration in claiming of even a few months represents significant, but delayed, financial value.

Table 3 indicates that 8 to 16 percent of employees increased their contribution following exposure to the small reward across the various implementations (all, $p < 0.01$). Across all employees offered a small reward, 11.8 percent increased their contribution. Notably, many of those increasing their saving in response to the small reward increased their contributions by more than a single percentage point, as indicated by the average increases to contribution rates reported in the table. For employees who had not exhausted the plan match (i.e., employees in the low-saving arm), nearly one-half of employees increased their contribution rate by enough to fully take-up the match (47 percent of increasing employees in response to the small reward as a primary treatment, and 45 percent of increasing employees in response to the small reward as a secondary treatment). That a significant share of employees increased their contributions significantly, coupled with our strategy of inferring increases from administrative records at least one pay-period following the survey, suggests that documented response does not reflect a strategic intent to temporarily increase contributions by some nominal amount so as to claim the reward.

In contrast to the response of employees to the small reward, the table indicates a modest and relatively precise response to the clarification of the plan match ($b = 0.01$, $se = 0.01$). To better understand the potency of the immediate but small reward, in comparison to the significant financial value of the match, we can appeal once again to Figure 5. The figure shows that across wide-ranging 12-month values of an employee's unclaimed matching incentives, ranging from approximately $500 to $3500, employees were significantly more responsive to the $10 gift card than clarification of the match, despite many employees not having accurate baseline beliefs about the match (and for whom the clarification could be construed as providing novel information). The figure, and the estimates from the

table, demonstrate that employees exhibit far greater responsiveness to the reward than the plan match, regardless of the latter's potential financial value.

Differential Response by Baseline Incidence. To further interrogate the role of present focus on employee savings, we examine the differential response of employees to the small reward (and to the match clarification) across baseline indicators of present-focus from Table 5. While the restricted sample sizes diminish the precision of the analyses, the table shows that employees indicated as present-focused by the effort-allocation measure were 3.5 times more likely to respond to the reward than counterparts ($p = 0.17$). Those indicated as present-focused by the proximal savings intent measure were even more relatively responsive to the small reward than counterparts ($b = 0.26$ vs. $b = 0.03$, $p < 0.01$). Finally, employees indicated as present-focused by the measure of theoretical introspection were twice as responsive to the small reward as their counterparts ($p < 0.10$). While unreported in the table, across all measures, there were no significant differences in responsiveness to the clarification of the plan match. Ultimately, the baseline survey measures and the overall and differential response of employees to the time-varying incentives in the experiment point to the causal importance of present focus.

5.6. Synthesis of Evidence across Candidate Frictions

To help synthesize findings across the candidate frictions from the survey and the field study, we once again appeal to the summary of baseline prevalence, correlation with plan engagement, and differential employee response provided by Table 6. We see the table as offering five new insights, relative to the extant literature, as to the determinants of employee saving.

An initial insight is that the analysis does not substantiate, at least in this setting, assertions as to the causal importance of *low retirement literacy* in causing employees to undersave. Consistent with patterns documented in the literature, we do find widespread deficits in retirement literacy, whether measured through underestimation of required saving or assessments of financial literacy and some of these measures significantly predict plan engagement. Yet despite its suggestive importance in descriptive analyses, our experiment suggests that improving the accuracy of employee beliefs through personalized guidance *does not* meaningfully increase average saving across all employees or for those employees with documented deficits in retirement literacy.

What might explain why improving the accuracy of retirement-relevant beliefs may not actually lead employees to save more? We return to Figure 5 for a possible explanation. In addition to comparing the direct and indirect estimates of required saving against an actuarial benchmark, the figure also compares employee estimates to the average (black), and perceived (dashed-black), rate of actual 401(k) saving. The figure shows that while older employees, on average, underestimate how much they should save, such underestimation does little to close the large gap between perceived and actuarially

recommended saving rates. Said differently, despite many employees underestimating how much they should save, 88 percent of them actually recognize that they are presently undersaving. A simple decomposition of mean differences indicates that direct underestimation of saving needs does not explain any of the 9.7 percentage point gap between perceived actual saving and the actuarial benchmark—in fact, replacing the actuarial benchmark with the direct estimate leads to an even larger saving gap. Even among the oldest quartile of the sample, where employees most severely underestimate how much to save, direct underestimation explains less than one-quarter of the gap between the perceived actual saving and the actuarial benchmark. Ultimately, despite widespread biases in beliefs, most employees are cognizant that they are substantially undersaving for retirement.[23]

Closer inspection of employee beliefs of retirement-relevant inputs offers another possible explanation for why such pervasive bias may not cause sub-optimal saving. Specifically, the two beliefs for which there is clear evidence of systematic bias—retirement age and retirement duration—have off-setting implications for normative saving targets. That is, while over-optimism about the longevity of one's work-life implies a reduced need to save (due to a longer period of accumulation), over-optimism about one's own longevity implies a greater need to save (due to a longer period of decumulation).

A second insight from the analysis is that we offer evidence arguing against employee *confusion* about 401(k) plan details as contributing to undersaving. While we provide novel evidence as to the significant share of employees who underestimate the generosity of the plan match, and such underestimation strongly predicts lower plan engagement, we find that experimentally clarifying the value of the match does not lead to an increase in savings, on average, or differentially across employees varying in their beliefs about the match. Our results are precise enough to rule out anything larger than a modest effect of match clarification on saving. Collectively, these results may help to explain the puzzle as to why employee saving does not appear to be highly sensitive to cross-sectional variation in the generosity of matching incentives (Madrian 2013).

A third insight highlights a potentially important determinant of low plan engagement largely absent from discussion by researchers and practitioners—employee confusion regarding actual enrollment status. Specifically, we find that 37 percent of non-participants mistakenly report themselves as plan participants, often at contribution rates that would imply full match take-up. Additional analysis suggests that, conservatively, at least one-half of these discrepant reports reflect genuine plan confusion as opposed to inattention or deliberate exaggeration. Confusion about plan contribution sharply predicts lower plan engagement in the cross-section (though this is, at least in part, by construction). The presence of

[23] The figure also suggests that variation in employee beliefs does not explain much of the in-sample variation in undersaving. While the actuarial recommendation explains -0.007 of the variation between perceived actual savings, as indicated by the adjusted R-square from a simple bivariate regression, neither the addition of the direct (0.0008) or the indirect (0.0008) estimate of how much to save meaningfully increases the explanatory power of a simple, additive, linear model.

substantial employee confusion regarding one's plan status, difficult to rationalize with conventional economic models of retirement saving, may seem more reasonable in light of the institutional and procedural reality of enrollment at major employers such as our partner firm. Consider that newly hired employees at this firm were asked to make enrollment decisions for up to twelve wide-ranging benefit programs—e.g., retirement savings, life insurance, commuting benefits, short and long-term disability insurance, personal accident insurance, medical and prescription health plans, dental insurance, visual care coverage, health savings account, a wellness program. Confusion about one's plan contribution seems more plausible given the variation across these programs in eligibility and default enrollment.

Two additional patterns in our data corroborate the presence of significant confusion about enrollment status. First, the modal reported contribution rate among discrepant reports was 4 percent—the widely marketed, and at-the-time recently instituted, default contribution rate for new hires (suggesting potential confusion about whether one was automatically enrolled in the plan, either at hiring or as the result of a one-time automatic enrollment back-sweep of existing employees). Second, as reported in Table 3, employees who overestimated their contribution and who were randomized into the small reward condition were more than three times as likely to increase their contribution ($b = 0.21$) than their counterparts ($b = 0.06$) ($p_{diff} < 0.01$). This pattern of differential response is consistent with the possibility that many confused employees, were motivated to adjust their contribution to reflect their original belief after learning their actual administrative status by visiting the portal in response to the reward.[24]

A fourth insight considers the causal importance of perceived complexity on saving. While we document that about one-quarter of employees in our sample may overestimate the time-costs of administrative enrollment, only a small share of employees perceive enrollment as sufficiently time-consuming so as to conceivably affect the decision to save for an otherwise rational employee. We find that experimentally reducing perceptions of adjustment complexity does not prompt an increase in plan contribution across all treated employees or those who perceived enrollment as particularly time-consuming. We interpret this evidence as indicating that, even if one concedes the presence of psychological, or hassle, costs of enrollment that exceed its economic time-costs, enrollment complexity alone does not play substantively impede saving in this setting. Despite the focus on enrollment complexity in the literature on program take-up, our conclusion is perhaps less surprising given the proliferation of digital enrollment interfaces designed to minimize the effort required to enroll.

Finally, and perhaps most centrally, the survey and field study provide what may be the first direct evidence as to the causal influence of present focus in deterring 401(k) saving. As initial evidence

[24] The closest analogue to this finding is the work of Dushi and Honig (2015) who find discrepancies between self-reported and administrative records of savings among respondents of the Health and Retirement Study.

for present focus, we note the baseline failure of many plan-eligible employees to enroll despite established knowledge, as indicated by the survey, of the generosity of the plan match. Turning to measures of baseline incidence, our imperfectly diagnostic indicators of present focus suggest at least modest prevalence of present focus. At the same time, the experiment reveals that a significant share of employees increased contributions substantially in response to a nominal reward. Employees were not responsive to clarification of the far larger, but delayed, plan match, despite such clarification likely offering novel information for some employees. Moreover, those indicated as present-focused by baseline measures were 2 to 3.5 times more likely to respond to the small reward than those without indication. Employee willingness, particularly within this income range, to increase saving in response to the small reward is striking given the documented insensitivity of saving to cross-plan variation in match generosity (Madrian 2013; Choi 2015). In the remainder of the paper, we examine the potential theoretical mechanisms underlying employee present focus and discuss its implications for optimal policy design.

6 INVESTIGATING MECHANISMS UNDERLYING PRESENT FOCUS

We interpret two features of employee decision-making in this setting as reflecting present focus—the baseline decision by many employees to delay 401(k) enrollment despite (experimentally provided) knowledge of the foregone plan match and the willingness of some employees to increase saving in response to the experimental provision of a small immediate reward but not clarification of the much larger, but delayed, plan match (even when the latter seemingly constituted new information). In this section, we investigate the mechanisms that might explain both the present-focused decisions of employees along with their stated expectations about the timing of future savings.

We begin by formally assessing whether present-biased preferences—arguably the predominant theory for understanding present focus in economics—can account for the present findings through a series of calibrations. Specifically, we calibrate the previously introduced beta-delta model of enrollment under varying assumptions about the burden of enrollment to assess whether the model can accurately describe the behavior—and stated beliefs—of employees without assuming an implausible degree of present bias. Informed by these calibrations, we discuss the potential of other theoretical models of present focus for reconciling the present findings (including the possibility that the apparent present focus of employees may actually be driven by short-term financial illiquidity). We conclude by advancing a novel account of present focus, drawing from prior research and our own survey measures of financial well-being, that that could potentially account for the empirical findings in this setting and perhaps empirical savings puzzles from the broader literature. While a formal experimental test of this model is outside the scope of the current paper, we assess the descriptive power of the model through calibrations as well as additional empirical tests of model predictions.

6.1. Present Bias

We first investigate whether the beta-delta model from Section 3 can rationalize the baseline decision of employees in our sample to delay enrollment through a series of calibrations. To simplify matters, we again restrict our consideration to a non-participating employee's decision to enroll at the 4 percent match threshold or to delay such enrollment. For concreteness, we treat periods as business days and consider the case of 35-year-old employee with an annual income of $50,000 subject to the same effective marginal tax rate now and in retirement, $\tau_0 = \tau_R = 0.25$. We further assume an annual discount factor of $\delta^{250} = 0.93$ corresponding to a daily discount factor of δ = 0.9997 for each of the approximately 250 business days in a calendar year. As a reference comparison, we first consider the standard model case of an exponential discounter before turning to the present-biased employee.

Standard Model. Recall that the exponential discounter decides whether to enroll now or never by comparing the expected present value of future enrollment utility with enrollment costs, *k*:

$$k \leq \frac{\delta(\tau_0 s + \mu - \tau_R(s + \mu))}{(1 - \delta)}$$

Where *s* denotes the per-period plan contribution and μ the per-period match, . For this employee, *s* and μ both equal roughly 8 pre-tax dollars each business day.

Due to the generous plan match, the decision rule dictates that this employee should enroll so long as the value of enrollment disutility does not exceed $29,994—or roughly 60 percent of pre-tax income. If *k* simply reflects the opportunity time-costs of administrative enrollment, then the employee's hourly wage rate of roughly $25 and our finding that the large majority of employees perceived enrollment as requiring a few minutes to a few hours implies that an exponential discounter would immediately enroll. If the employee instead associated enrollment with psychological hassle costs whose disutility exceeds the financial value of one's time, the value of *k* could be substantially higher. We can approximate the financial value of such psychological hassle costs by appealing to an analysis by Benzarti (2015). The analysis estimates the disutility associated with itemizing deductions on federal tax filings, another (potentially) aversive financial task as equivalent to roughly four times the time-costs of itemization. Under the assumption that enrollment requires 30 minutes, applying the same hassle factor to the present setting implies a wage-based enrollment disutility of *k = 50* (i.e., 0.5 hours x $25/hour x 4 hassle factor), while assuming enrollment requires 2 hours implies *k = 200*. Even allowing for hassle costs of enrollment, so long as the disutility of such hassle approximates the estimated disutility of tax itemization, the decision rule would not predict delayed enrollment.

Present Bias with Sophistication. We now consider the enrollment decision of an otherwise identical employee with present-biased preferences ($\beta < 1$). Recall that if an employee were sophisticated about their bias ($\hat{\beta} = \beta$), the employee would delay enrollment for a maximum of t^* days:

$$t^* = k\frac{1-\beta}{\beta(\tau_0 s + \mu - \tau_R(s+\mu))}$$

Again, we consider the case where an employee perceives enrollment costs as being limited to the wage-based opportunity cost of time. The expression implies that for the model to rationalize an enrollment delay of a single two-week pay-period (i.e., ten business days), assuming enrollment requires between 30 minutes to two hours (i.e., $k \in [12.5, 50]$), one must assume $\beta \in [0.17, 0.45]$. The maximum value of beta in this interval implies a degree of present bias more severe than the range of estimates, $\beta \in [0.5, 0.9]$, typically reported in the literature (DellaVigna 2018). Rationalizing a lengthier enrollment delay of two pay periods, under the identical assumption of enrollment costs, would imply a degree of present bias even further removed from the range of typical estimates, $\beta \in [0.09, 0.29]$.

What if employees associated enrollment with hassle costs whose disutility significantly exceeds the wage-based value of time-costs? Figure 6 plots the value of beta required to rationalize enrollment delays of durations varying from a single day to one year (250 business days) assuming enrollment costs, *k*, equal to either \$10 (solid line), \$50 (long-dashed line), or \$200 (short-dashed line). The latter curve reflects the assumption that enrollment requires 2 hours and generates disutility equivalent to 4 times the value of wage-based time-costs. For reference, the red line demarcates the enrollment delay associated with $\beta = 0.7$, a substantial but plausible degree of present bias. The figure indicates that assuming $\beta = 0.7$ the beta-delta model can rationalize an enrollment delay of up to four business days assuming lengthy enrollment but no hassle costs (i.e., $k = 50$) and up to 14 days assuming lengthy enrollment with hassle costs (i.e., $k = 200$). A more reasonable beta of 0.9 implies a delay of no more than three days. Given most baseline non-participants had neglected to enroll for months prior to the study (including those with accurate beliefs regarding the plan match), the figure implies that a model of present bias with sophistication cannot explain the non-participation we document.

Naïve Present Bias. In theory, present bias might result in lengthy enrollment delays, even in the context of a plan match, if employees were at least partially naïve to their present bias (O'Donoghue and Rabin 1999a; 1999b). In practice, researchers have frequently adopted the assumption of naiveté to help explain lengthy enrollment delays within the beta-delta framework (DellaVigna 2018). The field study permits us to directly test the assumption of naiveté by examining employee intentions regarding their future saving. Figure 6 displays the cumulative distribution of the minimum intended duration of delay in 401(k) enrollment for those not presently participating in the plan. Specifically, the figure reports the earliest time-horizon by which employees indicate being either "moderately" or "very likely" to enroll. The plot shows that while most presently non-participating employees intend to enroll by one of the specified time-horizons, 91 percent of non-participants anticipate a delay of at least one month, 60 percent

anticipate a delay of at least six months, and 32 percent anticipate a delay of at least one year.[25] Overall, while employees may underestimate the duration of delay, the figure rejects the possibility that one can explain observed delays in enrollment through beta-delta preferences, even allowing for naiveté.

Experimental Response to Immediate Reward and Delayed Match. The response of a non-trivial share of employees to the experimental treatments offers another test of mechanisms, including present bias. The beta-delta framework implies that a present-biased employee compelled to save by a small immediate reward of ten dollars but not clarification of the far more valuable, but delayed, match must have originally perceived enrollment as substantially costly and further believed that such costs fell within an implausibly specific and narrow $10 margin of the present value of the plan match. To illustrate, consider the employee earning $50,000 annually with a beta of 0.9 who originally intended to enroll in six months but decided to enroll immediately after being offered the small reward. A model of sophisticated present bias could rationalize this behavior only if the employee associated enrollment with disutility whose financial value fell within the interval between $6,966 to $6,976. Even if an employee were to modestly underestimate the economic benefits of enrollment, the standard beta-delta framework cannot easily account for the experimental response of employees.

6.2 Alternative Theories of Present Focus

Are there alternative models of present focus that could more accurately account for the documented behavior and beliefs of employees? Researchers across several disciplines (e.g., psychology, neuroscience, decision science, and economics) have advanced models of intertemporal decision-making in which individuals privilege immediate over delayed outcomes. We outline several classes of these models and comment on their potential for explaining the present findings. To orient the discussion, we note that a practical difficulty for any model seeking to explain the present findings is that the model must jointly explain the propensity of many employees to significantly delay enrollment—thereby foregoing substantial matching incentives—the stated intent to enroll in the intermediate, but not immediate, future, and the affirmative response to a financially nominal reward.

Financial Illiquidity. The first alternative we consider is that employee behavior in this setting may simply reflect the widespread presence and high costs of short-term financial illiquidity. In theory, financial illiquidity may significantly raise the cost of plan contributions, thereby causing an otherwise fully-informed and utility-maximizing employee to delay enrollment despite the availability of a lucrative plan match. We sought to understand the liquidity constraints faced by employees in our sample by

[25] A second survey measure (not depicted) yields a similar pattern of anticipated delay in future increases to saving among employees participating at baseline. The measure indicates that only 21 (6) percent of employees reported at least a 50 (75) percent likelihood of increasing their contribution within three months.

asking a subsample of survey respondents questions adapted from a prominent national household survey administered by the Federal Reserve Board.[26] Specifically, we asked respondents about their capacity to pay for three months of expenses from either emergency savings, borrowing, or selling assets. As indicated in Table 1, 68 percent of respondents reported insufficient savings to cover such expenses, while 39 percent reported not having access to such liquidity through savings, borrowing, or selling. The prevalence of liquidity constraints among the employees in our field sample parallels the more general findings of contemporaneous national household surveys of financial well-being.[27] The table not only indicates a significant degree of financial illiquidity but indicates that illiquidity is moderately correlated with plan engagement.

To more directly assess the role of financial illiquidity in generating the empirical findings of the present research, we consider three arguments. First, we note that the non-participating employees at baseline delayed enrollment despite a plan match that promised a marginal return to each contributed dollar of at least 100 percent. Given the immediately vesting match, availability of 401(k) loans, and early-withdrawal options, it is unlikely that the costs of illiquidity could alone justify prolonged non-participation. Second, we consider whether the absence of a saving response to the information-based treatments in the experiment might have been due to low financial liquidity among some employees. While it is theoretically possible that liquidity constraints could have diminished response to the saving recommendation or clarification of the match, we find that employees in our sample who did not report being financially constrained were no more responsive to these two treatments than their counterparts. Finally, we note that models of illiquidity do not offer a sensible explanation for those employees who increased their saving in response to a small reward of nominal financial value.

Other Models of Present Focus. Economists have advanced several alternatives to the beta-delta framework to explain differential near-term impatience (See Frederick, Loewenstein, and O'Donoghue 2002; Ericson and Laibson 2019 for review). As with the beta-delta framework, many of these models effectively assume that present focus arises from non-standard preferences such as context-specific discount rates based on affect (e.g., Vallacher 1993; Loewenstein 1996) or income (Banerjee and Mullainathan 2010), the strategic interaction of distinct decision-making systems each with their own preferences (e.g., Shefrin and Thaler 1988; Fudenberg and Levine 2006), or present bias in the specific context of fixed decision-costs (Benhabib et al. 2010). Without additional assumptions, however, none of these approaches offers an obviously discernable strategy for reconciling the costly delays in observed enrollment with the stated intent of employees to save in the intermediate, but not immediate, future.

[26] Questions were adapted from the 2015 Survey of Household Economics and Decisionmaking (SHED).

[27] For example, the 2018 National Financial Capability Study, a national survey of over 25,000 individuals conducted every three years by FINRA, found that 31 percent of respondents could certainly, or probably, not come up with $2,000 through savings, borrowing, or selling valuables to meet an unexpected financial challenge in the next month (www.usfinancialcapability.org).

Researchers have proposed a number of mechanisms to explain present-focused behavior that do not operate via preferences. These mechanisms involve emotion or drive states (Loewenstein 1996; Shiv and Fedorikhin 1999; McClure et al. 2007), differential construal of proximal versus distal outcomes (Liberman and Trope 1998; Malkoc, Zauberman, and Ulu 2005; Malkoc and Zauberman 2006), psychological distinctions between one's present and future self (e.g., Parfit 1984); Bartels and Urminsky 2015), systematic expectations of greater resource flexibility in the future (Zauberman and Lynch 2005), or planning failures (Lynch et al. 2010) (See Urminsky and Zauberman 2015 for review). We see several of these approaches as offering promise for explaining the present findings. In the next section, we advance and formularize an alternative model of present focus that draws on these mechanisms.

6.3. Hedonic Account of Present Focus – The Serenity Model

Overview and Motivating Evidence. We propose an alternative model of present focus that offers a potentially unifying explanation of the present findings. The model builds on the promising empirical correspondence between employee saving and the central survey measure of financial well-being, financial anxiety. The surveyed revealed the widespread prevalence of high financial anxiety among the employees in the sample and some optimism regarding future reductions in anxiety in the intermediate, but not immediate, future. At first glance, this pattern of high present anxiety and forecasted reduction in anxiety, after some delay, parallels the documented dynamic of low present saving and delayed optimism regarding future saving. Specifically, 93 percent of the 575 respondents assigned to the survey module reported at least a little anxiety about their finances (i.e., 2 or higher on a 4-point scale), while 56 percent reported either a fair amount of anxiety (32 percent; 3 on the 4-point scale) or a lot of anxiety (24 percent; 4 on the 4-point scale). The prevalence of at least moderate financial anxiety resembles the 53 percent reporting moderate to high financial anxiety from the large national sample of the 2018 National Financial Capability Study administered by FINRA. Critically, when asked to forecast whether they would feel more, less, or the same amount of financial anxiety in either three or six months (horizons to which they were randomly assigned), the survey indicated considerable pessimism in the short-term but moderate optimism over the longer horizon. In particular, among employees reporting a lot of present anxiety, not a single employee expected relief over a three-month horizon (32 percent expected their situation to *worsen*), while 15 percent anticipated relief within six-months.

To corroborate this pattern of delayed optimism in a larger national sample with more granular time-horizons, within-subject elicitations, and from a distinct period in time (so as to address the possibility that the original pattern may have been specific to circumstances in July 2016), we administered a supplementary online survey to several hundred US employees in November 2019. The survey elicited baseline measures of financial anxiety (on a scale from 1 "not at all anxious" to 5

"extremely anxious") and within-subject forecasts of future anxiety over horizons from one month to one year.[28] The sample of 905 respondents, recruited from Amazon Mechanical Turk, reflected greater gender and geographic balance and a smaller share of full-time employees than the field sample but was otherwise similar with respect to age and imputed income.[29] Figure 7 describes the relevant outcomes from the survey. The first panel depicts the incidence of present financial anxiety while the second panel describes the average trajectory of hedonic forecasts for the entire sample (grey line) and separately by levels of present anxiety. Specifically, the panel reports the average net change in forecasted anxiety, generated by first scoring each employee's forecast as +1 (increase in anxiety), 0 (no change to anxiety), or -1 (decrease in anxiety) and then averaging these scores for each time horizon.[30]

The figure reaffirms and elaborates upon the hedonic patterns from the original sample. Once again, the survey revealed a high share of present financial anxiety—42 percent of respondents reported one of the two highest categories of anxiety from a five-point scale (compared to the 56 percent reporting one of the two highest categories from the four-point scale in the field). The survey also revealed considerable optimism among respondents regarding their hedonic prospects in the intermediate (more than 3 months to one year) but not immediate (within 3 months) future. Nearly one-half of respondents anticipated reduced anxiety in one year, despite only 15 percent anticipating relief in one month. Said differently, respondents were 3.8 times more likely to believe their anxiety would improve rather than worsen in one year as compared to one month. The pattern was even more pronounced among those with high present anxiety, as they were 7.4 times more likely to expect relief in one year relative to one month.

Overall, the field study, and the supplemental survey indicate a systematic pattern of high present anxiety and delayed optimism regarding future anxiety. A significant share of those with severe financial anxiety in the present actually expected their situations to deteriorate in the near-term before eventually improving. These surveys span a diverse sample of working adults across distinct points in time.[31] While the prevalence of financial anxiety has been documented in the previously discussed household surveys, and prior research has asserted a robust cognitive bias towards optimism (e.g., Sharot 2011), to our knowledge, these findings offer the first evidence regarding the phenomenon of delayed optimism with

[28] We asked all subjects to forecast the relative change in their anxiety in one month and one year and randomly assigned subjects to provide additional forecasts for three months, six months, or both. The survey also included random assignment to another task unrelated to the present study.

[29] The sample was restricted to US employees aged 25 to 55 years. Summary of demographics: (i) gender (0.53 male, 0.47 female), (ii) age (mean: 34.7 years, SD: 7.8 years), (ii) employment status (0.86 full-time, 0.14 part-time), and (iii) estimated salary imputed from categorical midpoints with bounds of $25k and $150k (mean: $53.8k, SD: $27.0k).

[30] Because respondents were asked to generate forecasts over a random subset of future horizons, comparisons across some horizons reflect compositional differences in the sample.

[31] A pilot survey conducted in 2017 showed qualitatively similar patterns of high anxiety and delayed optimism. The pilot surveyed 683 US adults from Amazon Mechanical Turk in November 2017. It revealed slightly higher rates of present anxiety than the supplementary survey but similar patterns of delayed optimism regarding future anxiety. The pilot elicited forecasts as distant as two years in the future, by which point most respondents expected their hedonic situations to improve.

respect to future financial anxiety (we note that we cannot distinguish between rational optimism and a bias towards over-optimism even though the persistence of patterns across surveys suggests the latter).

Inspired by this empirical correspondence and extensive neuroscientific, psychological, and clinical research on the effects of anxiety on decision-making, we propose a hedonic model of present-focused saving (hereafter, the "Serenity Model"). The proposed model stipulates that the presence of financial anxiety and delayed optimism regarding future anxiety might cause an otherwise well-informed and rational employee to exhibit present focus in the context of stressful financial decisions such as enrolling in a savings plan. Two features of the model distinguish it from other theoretical accounts. First, the model assumes that many employees feel anxiety about their present financial situation and that such anxiety imposes a hedonic cost to engaging financially-relevant decisions. Second, the model presumes that financial anxiety is temporary and that employees have well-defined beliefs as to when they will transition from high to low anxiety (in the model, this transition is governed by a random process). As a result, the decision to delay enrollment, according to the model, fundamentally depends on the costs of enrollment during a state of high anxiety and beliefs regarding future anxiety. If presently anxious employees are sufficiently optimistic about the future, they may rationally decide to delay enrollment until it is less hedonically costly.

The general phenomenon of anxiety—broadly defined as a mental state in which one's regulatory system cannot meet the demands of the immediate environment—has been widely studied as a neurophysiological and psychological construct with significant influence on judgment and choice. Researchers have suggested several specific cognitive and motivational channels through which anxiety influences behavior. For instance, anxiety has been linked to activity in brain regions implicated with emotional regulation (Park et al. 2016), attentional control (Eysenck et al. 2007), memory (Wolf 2009), and executive function (Arnsten 1998). One widely-theorized behavioral response to anxiety is that of avoidance (Hartley and Phelps 2012). According to a recent animal study asserting a direct neural pathway between the brain regions responsible for encoding anxiety-related information and avoidant behavior, the relationship between anxiety and avoidance may be a hard-wired feature of neural circuitry (Jimenez et al. 2018).

Researchers have suggested that anxiety specific to one's financial circumstances, or financial anxiety, may be a theoretically distinct and measurable construct, also associated with avoidant behavior (Shapiro and Burchell 2012). The construct of financial anxiety, as well as related measures of financial stress or fragility, have been documented by recent national surveys of financial well-being and have increasingly been cited in policy and media discourse as a potential explanation for low retirement savings. These national surveys indicate the prevalence of financial anxiety among US households. For example, of the over 25,000 American adults represented in the 2018 National Financial Capability

Survey (NFCS), 53 percent strongly agreed that thinking about personal finances made them feel anxious while 44 percent strongly agreed that discussing finances can make their "heart race" or make them "feel stressed." Our own analyses of these responses indicate that expressions of financial anxiety do not strongly correlate with linear indices of self-reported categorical income (corr. = -0.23), math ability (corr. = -0.15) or financial knowledge (corr. = -0.26).[32]

Model Setup. We now more formally present the proposed hedonic model of present-focused saving. To facilitate comparison with the beta-delta framework, we adopt the same simplifying assumptions and stylized decision structure. Specifically, we consider the decision of an employee to delay enrollment in a 401(k) plan at a four percent contribution rate. We assume the plan matches pre-tax contributions, dollar-for-dollar, up to four percent of salary (as before, we ignore the minimum match) and that the long-run discount rate equals the interest rate. We normalize the constant marginal utility of consumption to 1.

The innovation in the model is the inclusion, in the employee's otherwise standard utility function, of a parameter, θ_t, that represents financial anxiety. We stipulate that in each period, financial anxiety is in either a high or low state, $\theta_t \in \{\theta^H, \theta^L\}$. Given our focus on financially at-risk employees, we assume that employees are initially in a state of high anxiety and that a stochastic process determines whether the employee transitions to a state of low anxiety in each period. We further assume that the employee has well-defined beliefs over the timing of this transition, and, for simplicity, that once an employee transitions to a state of low anxiety, the state is permanent. Crucially, the costs of plan enrollment in a particular period, $f(\theta)$, are increasing in anxiety, $f(\theta^L) < f(\theta^H)$. Intuitively, one can think of $f(\theta)$ as replacing the original cost of enrollment parameter, k, in the earlier framework.

If the transition from a high to low anxiety state follows a geometric hazard function, then we can represent the duration, in days, until the transition with a positive, discrete, random variable, $t_s \sim Geo(\lambda)$. An employee should then expect to wait an average of $\hat{t}_s = E(t_s) = 1/\lambda$ days where λ denotes the per-period transition rate conditional on having not previously transitioned. For example, if the likelihood of transition to a low state of anxiety, due to a favorable change in economic circumstances or hedonic outlook, is 1/100 each day, then a well-calibrated employee would expect to wait an average of 100 days for anxiety relief. To simplify the employee's decision, in light of the uncertainty introduced by the stochastic transition process, we assume risk neutrality.

The use of a duration model, and specifically, a geometric hazard function, to represent the transition between discrete hedonic states captures several psychologically desirable features of anxiety.

[32] NFCS response statistics were retrieved in July 2020 from www.usfinancialcapability.org. Correlations based on author calculations using the state data extract. Income was measured with an 8-point categorical scale; math ability and financial knowledge were measured with 7-point scales. Figures exclude small share of "don't know" or "prefer not to say" responses.

The construction implies the non-linear influence of anxiety on behavior, the uncertainty of future anxiety, and, for those with high anxiety, the increasing likelihood of anxiety relief over time. And while the assumption of a constant per-period hazard rate is unrealistic, we speculate that it may actually approximate how employees mentally represent hedonic expectations insofar as they are internalized as beliefs about the expected timing of anxiety relief as opposed to beliefs about daily hedonic hazard rates.

Enrollment Decision Rule. An employee adhering to the proposed model would decide whether to enroll now or to delay enrollment after comparing the discounted value of utility flows associated with each option. Under the specified assumptions, and after normalizing the utility of never saving to 0, an employee's decision to enroll (*s=1*) or delay (s=0) is described by the maximization problem:

$$\max_{s\in\{1,0\}} U_t = \begin{cases} -f(\theta^H) + \sum_{t=1}^{\infty} \delta^t b & if\ s = 1 \\ -f(\theta^L)\delta^{\hat{t}_s} + \sum_{t=\hat{t}_s}^{\infty} \delta^t b & if\ s = 0 \end{cases}$$

Here, b provides the per-period utility associated with savings (identical to that specified earlier), $\hat{t}_s$ denotes the expected days until anxiety relief, and $-f(.)$ indicates the utility-cost of enrollment.

We can simplify the enrollment decision by recasting it as a comparison of the expected marginal cost and benefit of delay. The first of these empirical objects is given by the discounted present value of foregone benefits associated with the plan match, $\sum_{t=1}^{\hat{t}_s} \delta^t b$. The second is given by the discounted difference between costly and less costly enrollment, $[f(\theta^H) - f(\theta^L)\delta^{\hat{t}_s}]$. A risk-neutral employee in a high anxiety state would therefore enroll when the expected cost of delay exceeded its expected benefit:

$$f(\theta^H) - f(\theta^L)\delta^{\hat{t}_s} < \sum_{t=1}^{\hat{t}_s} \delta^t b$$

An employee choosing to delay enrollment would expect to enroll in $\hat{t}_s$ days (or potentially never in the unlikely event that they expected the transition to occur insufficiently close to, or even after, retirement). For additional tractability, we can additionally assume δ=1 and normalize the discounted cost of enrolling later—that is, in a state of low anxiety— to zero so that $f(\theta^H)$ now reflects the *difference* in expected costs of enrollment between states of anxiety. The simplified decision rule now stipulates that an employee should enroll if the expected foregone value of the plan match exceeds the expected savings from less anxious enrollment, $f(\theta^H) < \hat{t}b$.

The first panel of Figure 8 provides graphical intuition for this decision rule. The figure shows that a risk-neutral employee with well-calibrated hedonic forecasts would delay enrollment if they expected relief from their anxiety before the point at which the accumulating foregone benefits of enrollment, bt, exceeded the expected savings associated with delay, $f(\theta^H)$. That is, an employee would

delay enrollment if $\hat{t}_s < t^*$ and would enroll immediately (or potentially never) if $\hat{t}_s > t^*$ where t^* satisfies $t^* b = f(\theta^H)$. The figure also illustrates how the ease with which the model could be modified to incorporate the presence of other frictions—such as low retirement literacy or plan confusion—that effectively cause an employee to underestimate the benefits of enrollment, $\hat{b} < b$. Such bias would flatten the expected cost of delay curve, leading to a higher share of predicted delays and lengthier expected durations of such delays. Finally, we note that while the baseline version of the model does not involve an explicit error in forecasting, one could incorporate an optimism bias by assuming $\hat{t}_s < t_s$. As with benefit underestimation, over-optimism would lead to a higher share of predicted delays and lengthier expected durations. If employees were persistently overly-optimistic, then the model could help to explain very lengthy delays in actual enrollment.

Model Predictions. The model generates two testable predictions regarding financial anxiety, saving, and future forecasts. First, the model predicts that high levels of present financial anxiety should lead to less present engagement with a retirement savings plan. Empirically, the prediction implies a positive correlation between self-reported levels of baseline financial anxiety and enrollment status among the employees in our field sample. Second, the model predicts that among non-participating, financially anxious employees, beliefs about the timing of future anxiety relief should predict the anticipated duration of enrollment delay. Empirically, we should expect a correspondence in the timing of forecasted reductions in anxiety and increases in saving.

Finally, we note that beyond offering an explicit explanation for enrollment delay and future intentions to save, the proposed framework also predicts that the framing of an incentive should influence its behavioral response. Research on the neural correlates of choice in the context of an immediate or delayed incentive suggests that immediate rewards, particularly if non-monetary, activate regions of the limbic system typically associated with regulating emotion and anxiety, whereas delayed rewards engage parts of the lateral prefrontal cortex and posterior parietal cortex, regions associated with deliberative processing and cognitive control (McClure et al. 2004). This suggests that the employee response to the experimentally provided gift card may have arisen from its capacity to reframe the enrollment decision from a strenuous financial task to an opportunity to seek a desired reward (and that the prospect of a large, but delayed match, may not help to overcome the anxiety associated with enrollment).

6.4. Evidence for The Serenity Model

To evaluate the proposed model, we examine whether it can plausibly describe the saving behavior—and stated intentions—of employees in our field sample. We begin by calibrating the model to determine whether it can explain the baseline enrollment delay using plausible assumptions of the costs of enrollment. We then present correlational evidence from the field to assess key model predictions.

Calibrating the Serenity Model. To facilitate comparison with earlier calibrations, we consider the same representative employee earning $50,000 and facing the decision to enroll in the 401(k) plan at a four percent contribution rate. We adopt the previously stated assumptions regarding marginal tax rates, marginal utility, long-term discount rates. Finally, for simplicity, we normalize the costs of enrollment under low anxiety to zero (equivalently, the cost of enrollment under high anxiety can be interpreted as reflecting the difference in expected enrollment costs across states of anxiety).

The second panel of Figure 8 displays the results of the calibration and its comparison with the beta-delta model. The panel plots the enrollment disutility (y-axis) required to rationalize enrollment delays, in business days, of up to a year (x-axis) in the Serenity Model (solid line) and the beta-delta model for a beta of 0.7 (long-dashed line) and 0.9 (short-dashed line). Vertical dashed lines indicate 3, 6, and 12 calendar months. The figure reaffirms that in the beta-delta framework, for reasonable parameters of beta, rationalizing an enrollment delay of the length typically anticipated by employees requires extreme enrollment disutility. For example, an intended delay of three months, assuming a beta of 0.9, implies disutility equivalent to $3,329, while an intended delay of six months implies disutility equivalent to $6,658. In contrast, the Serenity Model implies more reasonable values of enrollment disutility—technically, differences in expected disutility across anxiety states—for similar durations of intended delay ($370 of disutility for a three-month delay; $740 of disutility for a six-month delay). It is worth noting that if one were to incorporate employee underestimation of plan benefits (e.g., due to low retirement literacy or plan confusion), the value of enrollment disutility to rationalize delayed enrollment would fall more sharply for the Serenity Model than the beta-delta model.

Evidence on Model Predictions. Figure 9 presents evidence pertaining to the two central predictions of the model. The first panel documents the negative correlation between present financial anxiety and two measures of baseline 401(k) plan engagement—the share of plan participation (left axis) and the share of full match take-up (right axis). Employees reporting no anxiety were 108 percent more likely to participate in the plan ($b = 0.22$, $p < 0.01$) and 39 percent more likely to fully take-up the plan match ($b = 0.18$, $p < 0.05$) than those reporting high anxiety.

The second panel of the figure depicts the positive correlation between the timing of forecasted reductions in anxiety and increases in saving. Pooling across the three- and six-month time-horizons (the two horizons to which employees were randomized), the figure plots the share of employees intending to increase their saving across future time-horizons separately for hedonically optimistic (black line) and non-optimistic (dashed-line) employees. We characterized savings intent by tagging employees as intending to save if they reported being either “moderately” or “very likely” to increase their saving by the specified time-horizon (ranging from one month to one year). The figure shows that while the majority of employees expected to increase their saving within a year, the timing of intended increases

varied substantially. Employees expecting relief from anxiety in either three or six months were only nominally, and insignificantly, more likely to express an intent to increase saving in one month (b = 0.04, p = 0.93) than those not expecting relief— but were more than 44 percent more likely to express an intent to save in six months (b = 0.16, p < 0.01). By one year, the gap in intended saving largely disappears.

We can more formally estimate the conditional correlation between present and forecasted anxiety and saving through regressions that control for observable demographics and, in the case of forecasts, baseline anxiety and saving. Confirming the intuition conveyed by the figure, the estimates indicate that present anxiety strongly, and negatively, predicts saving while hedonic forecasts over an intermediate horizon strongly predict the intent to increase saving.[33] Collectively, the calibrations and descriptive analyses from the field offer evidence consistent with predictions of the model.

7 CONCLUSION

We describe findings from a field study that examined the role of four psychological frictions as candidate explanations for several empirical puzzles associated with the retirement savings of US employees. The field experiment, which targeted low-saving employees at a large US firm with a generous 401(k) plan match, was embedded within a detailed survey of employee beliefs and decision-making. The research design uniquely allowed us to document the baseline incidence of each friction (and its correlation with plan engagement), estimate the causal effect of reducing a given friction through information- and incentive-based treatments on marginal employee saving changes, and to assess whether baseline incidence of a given friction predicted (differential) responses to the associated experimental treatment. Further considering the high rate at which employees engaged the experimental treatments and built-in assessments of how the treatments influenced beliefs, the field study was uniquely positioned to provide causal insight into the role of multiple candidate frictions.

The study yields four insights that contribute to the existing empirical literature on retirement saving among US employees. First, we corroborate existing evidence on the prevalence of low *retirement literacy* and the correlation between some measures of this friction and baseline saving, but find that the experimental provision of personalized recommendations did not increase saving, even among employees for whom the recommendation increased their perceived saving need. Because the interventions led to an

[33] To estimate the effect of forecast future anxiety on the saving intentions, we estimate $Pr(\text{Increase Savings in Six Months}_i) = \alpha + \gamma_1 \text{LessAnx}_i + \gamma_2 \text{MoreAnx}_i + \mathbf{X}\theta + \lambda_i + \pi_i + \varepsilon_i$, where the dependent variable indicates moderate or greater likelihood of saving in six months, X is a vector of employee demographics (a linear index in age, indicators of gender, age, marital status, education, and income category), λ_i denotes fixed for present contribution rate, and π_i denotes fixed for levels of present financial anxiety. The coefficient of interest, $\widehat{\gamma_1}$ = 0.22 (p < 0.01), suggests delayed optimism regarding one's future anxiety is associated with a 61 percent marginal increase in an employee's six-month intent to save. An analogous model estimating the relationship between present financial anxiety and present saving, excluding controls for present contribution rate and present financial anxiety, suggests that high present anxiety is associated -0.14 change in the likelihood of present plan participation (p < 0.10), and a -0.19 change in the likelihood of present match take-up (p < 0.05).

improvement in the accuracy of average beliefs about how much to save, we interpret our precise estimates as rejecting any meaningful causal influence of low retirement literacy on undersaving in this setting. This finding contradicts the widely-held belief among researchers and those in the industry that deficits in retirement and financial literacy are a key deterrent to saving. We suggest that one could make sense of our findings in the context of these beliefs by noting that while deficits in retirement literacy may be widespread—many employees directly or indirectly underestimate how much they should save—most employees nevertheless appear to recognize that they are undersaving, often by a substantial margin.

Second, in an analysis of *plan confusion*, we find that a nontrivial share of employees exhibit confusion about plan details, with one in five underestimating plan match incentives. While match underestimation negatively correlates with baseline saving, experimentally clarifying the generosity of the plan match does not lead to an increase in saving, even among biased employees. In an unplanned analysis, we do present evidence for a potentially first-order impediment to saving—confusion about one's enrollment status—that has been largely ignored in the academic literature. That is, we find a remarkable number of discrepancies between self-reported and administrative enrollment status and conclude that 20 to 37 percent of 401(k) non-participants in our sample mistakenly believed they were enrolled (often at substantial contribution rates). Consistent with this interpretation, these non-participating employees were far more likely to enroll than their counterparts when prompted to observe their actual enrollment status by the small reward treatment. Third, we find no evidence that *enrollment complexity* impedes savings in this setting. Few employees perceived enrollment (or adjustment to contributions) as prohibitively time-consuming, and simplifying enrollment did not increase saving despite reducing perceptions of its time-costs. From conversations with those in the industry and our partner firm, we speculate that recent trends in the administration of employee benefit programs could help clarify both our findings regarding employee confusion and enrollment complexity. That is, while employees at this firm, and increasingly at other firms, could expect to adjust their 401(k) plan contribution via a simple, accessible, and streamlined digital interface, such employees (especially new hires) were also tasked with making enrollment decisions for up to twelve distinct benefit programs. Considering the proliferation of employee benefit programs more broadly, particularly at larger US firms, and the non-standardized rules that likely govern their eligibility and (automatic) enrollment, fundamental confusion about one's enrollment status seems understandable, even in the absence of 401(k) enrollment complexity.

Finally, we present novel evidence directly implicating *present focus* as a cause of low plan engagement by documenting the willingness of employees to increase saving in response to a nominally valued immediate reward but not to clarification of the much larger, but delayed, plan match. Through a series of calibrations, we assess whether the commonly invoked beta-delta model of present bias could

plausibly account for the baseline reluctance of employees to enroll, their response to the experiment, and their stated intentions to save in the future. The exercise, and our explicit data on employee beliefs, suggest that even allowing for extreme present bias and substantial psychological disutility of enrollment, a beta-delta model cannot account for both the observed behavior and stated beliefs of employees.

Motivated by a promising empirical correspondence between employees' present and intended future saving and levels of present and forecasted future financial anxiety, we propose an alternative hedonic model of present-focused saving. The model stipulates that if enrollment is hedonically costly for employees in a state of high anxiety and employees expect relief from such anxiety in the intermediate future, they may rationally delay enrollment despite a generous plan match. We suggest that this model can account for baseline delays in enrollment and match take-up, and the experimental response of employees, without implausible assumptions about the degree of present bias or the magnitude of enrollment disutility. Moreover, we see the model as offering a possible explanation for other empirical puzzles in the literature. For example, in the domain of savings, if one interprets automatic enrollment as a mechanism through which to bypass enrollment disutility, given that most non-participating employees expect to enroll in the intermediate future, the model offers an explanation for the widely-documented increase in participation following automatic enrollment (and the subsequent satisfaction of employees after their enrollment). And, particularly if assumes that employees may be over-optimistic about future anxiety, the model could help to explain the documented insensitivity of employees to increases in matching incentives and the persistent gap between intended and actual saving behavior.

We highlight important limits to the present research. First, our experimental results are restricted to predominantly low-saving employees at a single large US firm. In theory, our findings, particularly those regarding the role of enrollment complexity and plan confusion may be firm-specific. While we cannot rule out this possibility, we note that our employee sample is diverse and approximately representative of national samples (apart from being more female and oversampling those of low-to-moderate income). Our partner firm also resembles other large employers in offering a 401(k) plan with streamlined digital enrollment and a generous plan match in the context of several other benefit programs. Second, our visibility into employee saving extends to the four months following the field study and does not include financial assets outside the 401(k) plan. As such, we cannot observe if employees offset their increased contributions by reducing saving elsewhere, reducing their contributions several months after the field study, or perhaps most plausibly, increasing their debt (e.g., Beshears et al. 2019).

In spite of these limitations, this paper offers at least two practical prescriptions for the optimal design and marketing of retirement savings plans. First, in the near-term, our findings should encourage employers and plan administrators to reconsider presumptions about the impact of providing financial education at the time of enrollment. Our findings imply that even though deficits in literacy may be

widespread, if most low-saving employees already believe they are saving too little, then the decision aids and financial education modules that many plans provide to employees may not be effective and could even deter employees from engaging the enrollment decision (we note that this implication may not apply to interventions acting via persuasion). On the other hand, if our conjecture is correct that the high number and non-standardization of broader benefit program offerings contribute to enrollment confusion, then one could potentially increase plan engagement through integrated enrollment portals or standardized plan communications. Finally, our results position immediate (non-monetary) rewards as a cost-effective alternative, relative to increases in matching incentives, for increasing plan engagement.

We see this research as offering a roadmap for more fundamental reform. Specifically, if financial anxiety and (overly) optimistic hedonic forecasts deter savings, then there may be a rationale for reforming the basic structure of retirement savings plans. One promising example are the recently proposed dual-account plans that link traditional illiquid accounts, such as the 401(k), with a second, more liquid account intended to accumulate assets until an employee achieves some threshold of short-term liquidity (Beshears et al. 2015; 2020; Gruber 2016; D. S. Mitchell and Lynne 2017). While dual-account plans have recently gained traction as a potential strategy for addressing short-term illiquidity and long-term financial security, our findings provide a psychological rationale for the dual-account structure and suggest lessons for optimal design. Indeed, we speculate that a dual-account plan that leverages small immediate rewards to encourage initial engagement, markets itself as a program to secure both near- and long-term financial security (e.g., "A Serenity Plan"), and offers additional services to improve financial capability could advance retirement security by first addressing proximal financial anxiety. In this sense, we regard the present research as emphasizing the fundamental value of informing policy design with both an economic and psychological understanding of how individuals engage policy-relevant decisions.

REFERENCES

Arnsten, Amy F. T. 1998. "Catecholamine Modulation of Prefrontal Cortical Cognitive Function." *Trends in Cognitive Sciences* 2 (11): 436–47. https://doi.org/10.1016/S1364-6613(98)01240-6.

Banerjee, Abhijit, and Sendhil Mullainathan. 2010. "The Shape of Temptation: Implications for the Economic Lives of the Poor," NBER Working Paper #15973, . https://doi.org/10.3386/w15973.

Bartlett, Susan, Nancy Burstein, William Hamilton, Ryan Kling, and Margaret Andrews. 2004. "Food Stamp Program Access Study: Final Report," USDA Economic Research Service, . http://www.ers.usda.gov/publications/pub-details/?pubid=43407.

Benhabib, Jess, Alberto Bisin, and Andrew Schotter. 2010. "Present-Bias, Quasi-Hyperbolic Discounting, and Fixed Costs." *Games and Economic Behavior* 69 (2): 205–23. https://doi.org/10.1016/j.geb.2009.11.003.

Bernheim, B. Douglas. 1995. "Do Households Appreciate Their Financial Vulnerabilities? An Analysis of Actions, Perceptions, and Public Policy." *Tax Policy and Economic Growth* 3: 11–13.

Bertrand, Marianne, Sendhil Mullainathan, and Eldar Shafir. 2004. "A Behavioral-Economics View of Poverty." *American Economic Review* 94 (2): 419–23. https://doi.org/10.1257/0002828041302019.

Beshears, John, James J Choi, Christopher Harris, David Laibson, Brigitte C Madrian, and Jung Sakong. 2015. "Self Control and Commitment: Can Decreasing the Liquidity of a Savings Account Increase Deposits?," NBER Working Paper #21474, . https://doi.org/10.3386/w21474.

Beshears, John, James J. Choi, J. Mark Iwry, David C. John, David Laibson, and Brigitte C. Madrian. 2020. "Building Emergency Savings through Employer-Sponsored Rainy-Day Savings Accounts." *Tax Policy and the Economy* 34: 43–90. https://doi.org/10.1086/708170.

Beshears, John, James J. Choi, David Laibson, and Brigitte C. Madrian. 2013. "Simplification and Saving." *Journal of Economic Behavior & Organization* 95 (November): 130–45. https://doi.org/10.1016/j.jebo.2012.03.007.

———. 2018. "Behavioral Household Finance." In *Handbook of Behavioral Economics: Applications and Foundations 1*, edited by B. Douglas Bernheim, Stefano DellaVigna, and David Laibson, 1:177–276. Handbook of Behavioral Economics - Foundations and Applications 1. North-Holland. https://doi.org/10.1016/bs.hesbe.2018.07.004.

Beshears, John, James J Choi, David Laibson, Brigitte C Madrian, and William L Skimmyhorn. 2019. "Borrowing to Save? The Impact of Automatic Enrollment on Debt," NBER Working Paper #26876, . https://doi.org/10.3386/w25876.

Bhargava, Saurabh, Lynn Conell-Price, Rick Mason, and Shlomo Benartzi. 2021. "Save(d) by Design." mimeo.

Bhargava, Saurabh, and Dayanand Manoli. 2015. "Psychological Frictions and the Incomplete Take-Up of Social Benefits: Evidence from an IRS Field Experiment." *American Economic Review* 105 (11): 3489–3529. https://doi.org/10.1257/aer.20121493.

Blumenstock, Joshua, Michael Callen, and Tarek Ghani. 2018. "Why Do Defaults Affect Behavior? Experimental Evidence from Afghanistan." *American Economic Review* 108 (10): 2868–2901. https://doi.org/10.1257/aer.20171676.

Brown, Jeffrey R., and Alessandro Previtero. 2018. "Saving for Retirement, Annuities and Procrastination." mimeo.

Bryan, Gharad, Dean Karlan, and Scott Nelson. 2010. "Commitment Devices." *Annual Review of Economics* 2 (1): 671–98. https://doi.org/10.1146/annurev.economics.102308.124324.

Chetty, Raj, John N. Friedman, and Emmanuel Saez. 2013. "Using Differences in Knowledge across Neighborhoods to Uncover the Impacts of the EITC on Earnings." *American Economic Review* 103 (7): 2683–2721. https://doi.org/10.1257/aer.103.7.2683.

Choi, James J., Emily Haisley, Jennifer Kurkoski, and Cade Massey. 2017. "Small Cues Change Savings Choices." *Journal of Economic Behavior & Organization* 142 (October): 378–95. https://doi.org/10.1016/j.jebo.2017.08.010.

Choi, James J, David Laibson, and Brigitte C Madrian. 2009. "Reducing the Complexity Costs of 401 (k) Participation through Quick Enrollment." In *Developments in the Economics of Aging*, 57–82. University of Chicago Press.

Choi, James J., David Laibson, Brigitte C. Madrian, and Andrew Metrick. 2002. "Defined Contribution Pensions: Plan Rules, Participant Choices, and the Path of Least Resistance." *Tax Policy and the Economy* 16 (January): 67–113. https://doi.org/10.1086/654750.

DellaVigna, Stefano. 2018. "Structural Behavioral Economics." In *Handbook of Behavioral Economics: Applications and Foundations 1*, edited by B. Douglas Bernheim, Stefano DellaVigna, and David Laibson, 1:613–723. Handbook of Behavioral Economics - Foundations and Applications 1. North-Holland. https://doi.org/10.1016/bs.hesbe.2018.07.005.

Diamond, Peter, and Botond Köszegi. 2003. "Quasi-Hyperbolic Discounting and Retirement." *Journal of Public Economics* 87 (9): 1839–72. https://doi.org/10.1016/S0047-2727(02)00041-5.

Domurat, Richard, Isaac Menashe, and Wesley Yin. 2019. “The Role of Behavioral Frictions in Health Insurance Marketplace Enrollment and Risk: Evidence from a Field Experiment,” NBER Working Paper 26153, . https://doi.org/10.3386/w26153.

Duflo, Esther, William Gale, Jeffrey Liebman, Peter Orszag, and Emmanuel Saez. 2006. “Saving Incentives for Low- and Middle-Income Families: Evidence from a Field Experiment with H&R Block.” *The Quarterly Journal of Economics* 121 (4): 1311–46. https://doi.org/10.1093/qje/121.4.1311.

Ericson, Keith Marzilli, and David Laibson. 2019. “Intertemporal Choice.” In *Handbook of Behavioral Economics: Applications and Foundations 1*, edited by B. Douglas Bernheim, Stefano DellaVigna, and David Laibson, 2:1–67. Handbook of Behavioral Economics - Foundations and Applications 2. North-Holland. https://doi.org/10.1016/bs.hesbe.2018.12.001.

Eysenck, Michael W., Nazanin Derakshan, Rita Santos, and Manuel G. Calvo. 2007. “Anxiety and Cognitive Performance: Attentional Control Theory.” *Emotion* 7 (2): 336–53. https://doi.org/10.1037/1528-3542.7.2.336.

Financial Engines. 2015. “Americans Likely Leaving $24 Billion in Unclaimed 401(k) Company Matching Contributions on the Table Annually, Financial Engines Finds.” https://corp.financialengines.com/press/press-releases/2015/051215_Financial_Engines_Americans-Leave-Billions-Unclaimed-401k.pdf.

Frederick, Shane, George Loewenstein, and Ted O’Donoghue. 2002. “Time Discounting and Time Preference: A Critical Review.” *Journal of Economic Literature* 40 (2): 351–401.

Fudenberg, Drew, and David K. Levine. 2006. “A Dual-Self Model of Impulse Control.” *American Economic Review* 96 (5): 1449–76. https://doi.org/10.1257/aer.96.5.1449.

GAO. 2017. “The Nation’s Retirement System: A Comprehensive Re-Evaluation Is Needed to Better Promote Future Retirement Security. Report to the Ranking Member, Subcommittee on Primary Health and Retirement Security, Committee on Health, Education, Labor, and Pensions, U.S. Senate GAO-16-242.” https://www.gao.gov/products/GAO-18-111SP.

Goda, Gopi Shah, Matthew Levy, Colleen Flaherty Manchester, Aaron Sojourner, and Joshua Tasoff. 2019. “Predicting Retirement Savings Using Survey Measures of Exponential-Growth Bias and Present Bias.” *Economic Inquiry* 57 (3): 1636–58. https://doi.org/10.1111/ecin.12792.

Goda, Gopi Shah, Colleen Flaherty Manchester, and Aaron J. Sojourner. 2014. “What Will My Account Really Be Worth? Experimental Evidence on How Retirement Income Projections Affect Saving.” *Journal of Public Economics* 119 (November): 80–92. https://doi.org/10.1016/j.jpubeco.2014.08.005.

Gruber, Jonathan. 2016. “Security Accounts as Short Term Social Insurance and Long Term Savings,” Aspen Institute. Future of Work Initiative, .

Hartley, Catherine A., and Elizabeth A. Phelps. 2012. “Anxiety and Decision-Making.” *Biological Psychiatry* 72 (2). https://doi.org/10.1016/j.biopsych.2011.12.027.

Hastings, Justine S., Brigitte C. Madrian, and William L. Skimmyhorn. 2013. “Financial Literacy, Financial Education, and Economic Outcomes.” *Annual Review of Economics* 5 (1): 347–73. https://doi.org/10.1146/annurev-economics-082312-125807.

Hung, Angela, Andrew M. Parker, and Joanne Yoong. 2009. “Defining and Measuring Financial Literacy.” SSRN Scholarly Paper. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.1498674.

Jimenez, Jessica C., Katy Su, Alexander R. Goldberg, Victor M. Luna, Jeremy S. Biane, Gokhan Ordek, Pengcheng Zhou, et al. 2018. “Anxiety Cells in a Hippocampal-Hypothalamic Circuit.” *Neuron* 97 (3): 670-683.e6. https://doi.org/10.1016/j.neuron.2018.01.016.

John, David. 2015. “Adding Auomatic Emergency Savings to Retirement Savings Plans.” AARP. 2015. https://blog.aarp.org/thinking-policy/making-retirement-saving-even-more-valuable-by-adding-automatic-emergency-savings.

Kusko, Andrea L, James M Poterba, and David W Wilcox. 1994. “Employee Decisions with Respect to 401(k) Plans: Evidence From Individual-Level Data,” NBER Working Paper #4635, . https://doi.org/10.3386/w4635.

Laibson, David. 1997. “Golden Eggs and Hyperbolic Discounting.” *The Quarterly Journal of Economics* 112 (2): 443–77.

———. 1998. “Life-Cycle Consumption and Hyperbolic Discount Functions.” *European Economic Review* 42 (3): 861–71. https://doi.org/10.1016/S0014-2921(97)00132-3.

Levy, Matthew R., and Joshua Tasoff. 2020. “Exponential-Growth Bias in Experimental Consumption Decisions.” *Economica* 87 (345): 52–80. https://doi.org/10.1111/ecca.12306.

Liberman, Nira, and Yaacov Trope. 1998. “The Role of Feasibility and Desirability Considerations in near and Distant Future Decisions: A Test of Temporal Construal Theory.” *Journal of Personality and Social Psychology* 75 (1): 5–18. https://doi.org/10.1037/0022-3514.75.1.5.

Loewenstein, George. 1996. “Out of Control: Visceral Influences on Behavior.” *Organizational Behavior and Human Decision Processes* 65 (3): 272–92. https://doi.org/10.1006/obhd.1996.0028.

Lusardi, Annamaria. 2004. “Saving and the Effectiveness of Financial Education.” In *Pension Design and Structure: New Lessons from Behavioral Finance*, edited by Olivia S. Mitchell and Stephen P. Utkus, 157–84. New York: Oxford University Press. https://doi.org/10.1093/0199273391.001.0001.

Lusardi, Annamaria, and Olivia S. Mitchell. 2007. “Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth.” *Journal of Monetary Economics*, Carnegie-Rochester Conference Series on Public Policy: Economic Consequences of Demographic Change in a Global Economy April 21-22, 2006, 54 (1): 205–24. https://doi.org/10.1016/j.jmoneco.2006.12.001.

Lusardi, Annamaria, and Olivia S Mitchell. 2011. “Financial Literacy and Planning: Implications for Retirement Wellbeing.” In *Financial Literacy. Implications for Retirement Security and the Financial Marketplace*, edited by Annamaria Lusardi and Olivia S Mitchell, 17–39. Working Paper Series. Oxford: Oxford: Oxford University Press. https://doi.org/10.3386/w17078.

Lusardi, Annamaria, and Olivia S. Mitchell. 2014. “The Economic Importance of Financial Literacy: Theory and Evidence.” *Journal of Economic Literature* 52 (1): 5–44. https://doi.org/10.1257/jel.52.1.5.

Lynch, John G., Richard G. Netemeyer, Stephen A. Spiller, and Alessandra Zammit. 2010. “A Generalizable Scale of Propensity to Plan: The Long and the Short of Planning for Time and for Money.” *Journal of Consumer Research* 37 (1): 108–28. https://doi.org/10.1086/649907.

Madrian, Brigitte C. 2013. “Matching Contributions and Savings Outcomes: A Behavioral Economics Perspective.” *Matching Contributions for Pensions: A Review of International Experience*, 289–310.

Madrian, Brigitte C., and Dennis F. Shea. 2001. “The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior.” *The Quarterly Journal of Economics* 116 (4): 1149–87. https://doi.org/10.1162/003355301753265543.

Malkoc, Selin A., and Gal Zauberman. 2006. “Deferring versus Expediting Consumption: The Effect of Outcome Concreteness on Sensitivity to Time Horizon.” *Journal of Marketing Research* 43 (4): 618–27. https://doi.org/10.1509/jmkr.43.4.618.

Malkoc, Selin A., Gal Zauberman, and Canan Ulu. 2005. “Consuming Now or Later?: The Interactive Effect of Timing and Attribute Alignability.” *Psychological Science* 16 (5): 411–17. https://doi.org/10.1111/j.0956-7976.2005.01549.x.

McClure, Samuel M., Keith M. Ericson, David Laibson, George Loewenstein, and Jonathan D. Cohen. 2007. “Time Discounting for Primary Rewards.” *Journal of Neuroscience* 27 (21): 5796–5804.

Mitchell, David S, and Gracie Lynne. 2017. “Driving Retirement Innovation: Can Sidecar Accounts Meet Consumers’ Short- and Long-Term Financial Needs?,” Aspen Institute Issue Brief, , 13.

Modigliani, Franco, and Richard Brumberg. 1954. “Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data.” In *Post Keynesian Economics*, edited by K. K. Kurihara, 1:388–436. New Brunswick, NJ: Rutgers University Press.

O’Donoghue, Ted, and Matthew Rabin. 1999a. “Procrastination in Preparing for Retirement.” In *Behavioral Dimensions of Retirement Economics*, edited by Henry J. Aaron, 118–55. Washington, D.C.: Brookings Institution Press and Russell Sage Foundation.

O’Donoghue, Ted, and Matthew Rabin. 1999b. “Doing It Now or Later.” *American Economic Review* 89 (1): 103–24.

Papke, Leslie E., and James M. Poterba. 1995. “Survey Evidence on Employer Match Rates and Employee Saving Behavior in 401(k) Plans.” *Economics Letters* 49 (3): 313–17. https://doi.org/10.1016/0165-1765(95)00683-7.

Parfit, Derek. 1984. *Reasons and Persons*. Oxford: Oxford University Press.

Park, Junchol, Jesse Wood, Corina Bondi, Alberto Del Arco, and Bita Moghaddam. 2016. “Anxiety Evokes Hypofrontality and Disrupts Rule-Relevant Encoding by Dorsomedial Prefrontal Cortex Neurons.” *Journal of Neuroscience* 36 (11): 3322–35. https://doi.org/10.1523/JNEUROSCI.4250-15.2016.

Rooij, Maarten van, Annamaria Lusardi, and Rob Alessie. 2011. “Financial Literacy and Stock Market Participation.” *Journal of Financial Economics* 101 (2): 449–72. https://doi.org/10.1016/j.jfineco.2011.03.006.

Sharot, Tali. 2011. “The Optimism Bias.” *Current Biology* 21 (23): R941-R945.

Shapiro, Gilla K., and Brendan J. Burchell. 2012. “Measuring Financial Anxiety.” *Journal of Neuroscience, Psychology, and Economics* 5 (2): 92–103. https://doi.org/10.1037/a0027647.

Shefrin, Hersh M., and Richard H. Thaler. 1988. “The Behavioral Life-Cycle Hypothesis.” *Economic Inquiry* 26 (4): 609–43. https://doi.org/10.1111/j.1465-7295.1988.tb01520.x.

Shiv, Baba, and Alexander Fedorikhin. 1999. “Heart and Mind in Conflict: The Interplay of Affect and Cognition in Consumer Decision Making.” *Journal of Consumer Research* 26 (3): 278–92. https://doi.org/10.1086/209563.

Stango, Victor, and Jonathan Zinman. 2009. “Exponential Growth Bias and Household Finance.” *The Journal of Finance* 64 (6): 2807–2849.

Thaler, Richard H., and Shlomo Benartzi. 2004. “Save More Tomorrow™: Using Behavioral Economics to Increase Employee Saving.” *Journal of Political Economy* 112 (S1): S164–87. https://doi.org/10.1086/380085.

Urminsky, Oleg, and Gal Zauberman. 2015. “The Psychology of Intertemporal Preferences.” In *The Wiley Blackwell Handbook of Judgment and Decision Making*, 141–81. John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118468333.ch5.

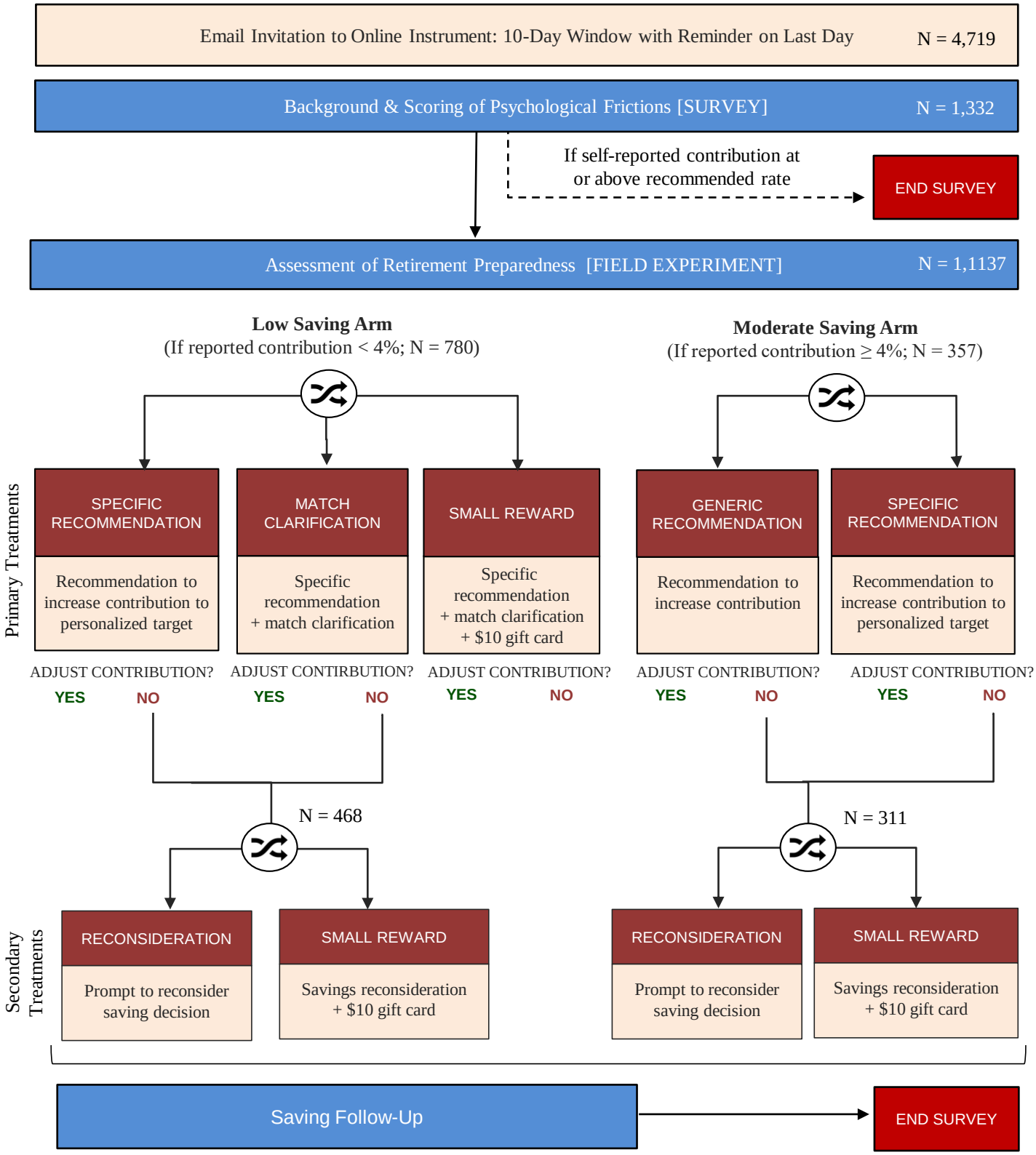
Vallacher, Robin R. 1993. “Mental Calibration: Forging a Working Relationship between Mind and Action.” In *Handbook of Mental Control*, 443–72. Century Psychology Series. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Wolf, Oliver T. 2009. “Stress and Memory in Humans: Twelve Years of Progress?” *Brain Research, Stress, Coping, and Disease* 1293: 142–54. https://doi.org/10.1016/j.brainres.2009.04.013.

Xiao, Jing Jian, and Nilton Porto. 2019. “Present Bias and Financial Behavior.” *Financial Planning Review* 2 (2): e1048. https://doi.org/10.1002/cfp2.1048.

Zauberman, Gal, and John G. Lynch. 2005. “Resource Slack and Propensity to Discount Delayed Investments of Time Versus Money.” *Journal of Experimental Psychology: General* 134 (1): 23–37.

Figure 1.
Schematic Research Design for Survey and Field Study

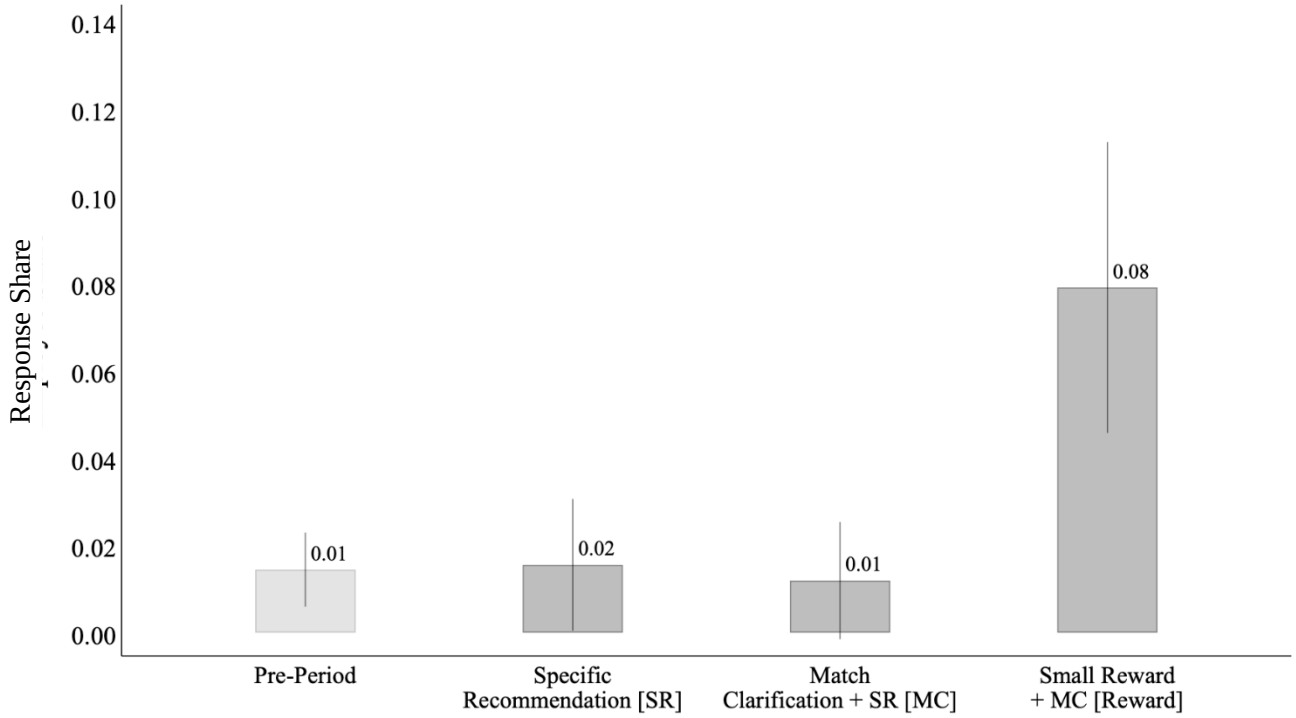


Note: This figure schematically depicts the research design and general procedure for the survey and field study. The figure charts the progression of qualified employees from an email invitation to participate in the survey to an initial module designed to collect background information and score each respondent on measures associated with the candidate frictions. The figure then describes a second module of the survey which provides respondents with an assessment of their retirement preparedness in the context of several randomized elements that constitute the field study (randomization denoted by pictograph). While the module informed all respondents as to their lack of preparedness, respondents proceeded through a subsequent web-flow determined by their study arm and assignment to a primary experimental treatment as shown in the figure. Respondents who did not report changing their plan contribution after the initial set of treatments were then asked to reconsider their decision in the context of a secondary set of treatments. Finally, the survey presented respondents with follow-up questions about their savings decision and future intentions to save. Inferences about any change in employee contribution, in response to the field study, rely on administrative data from the pay dates following the end of the survey period and preceding the survey invitation.

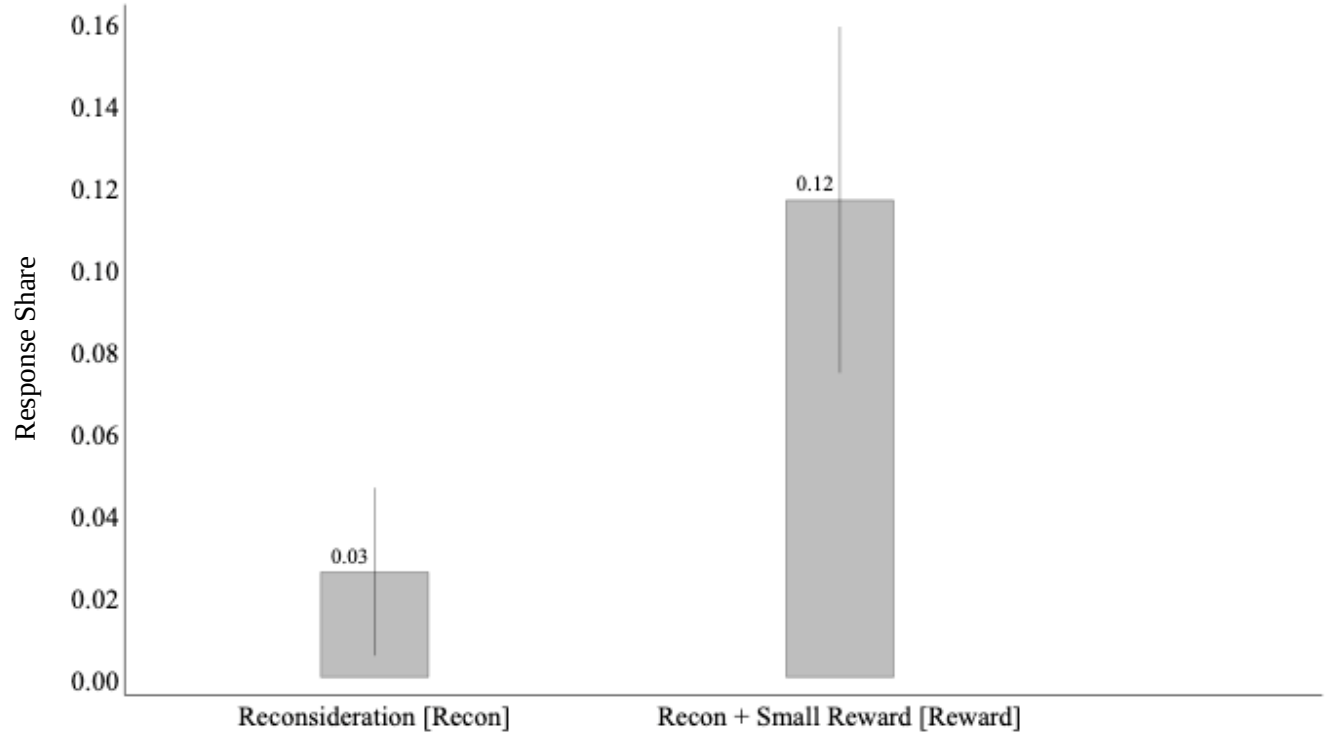
Figure 2.

Share of Increased 401(k) Plan Contributions by Experimental Treatment – Low Saving Arm

Panel A. Primary Experimental Treatments



Panel B . Secondary Experimental Treatments

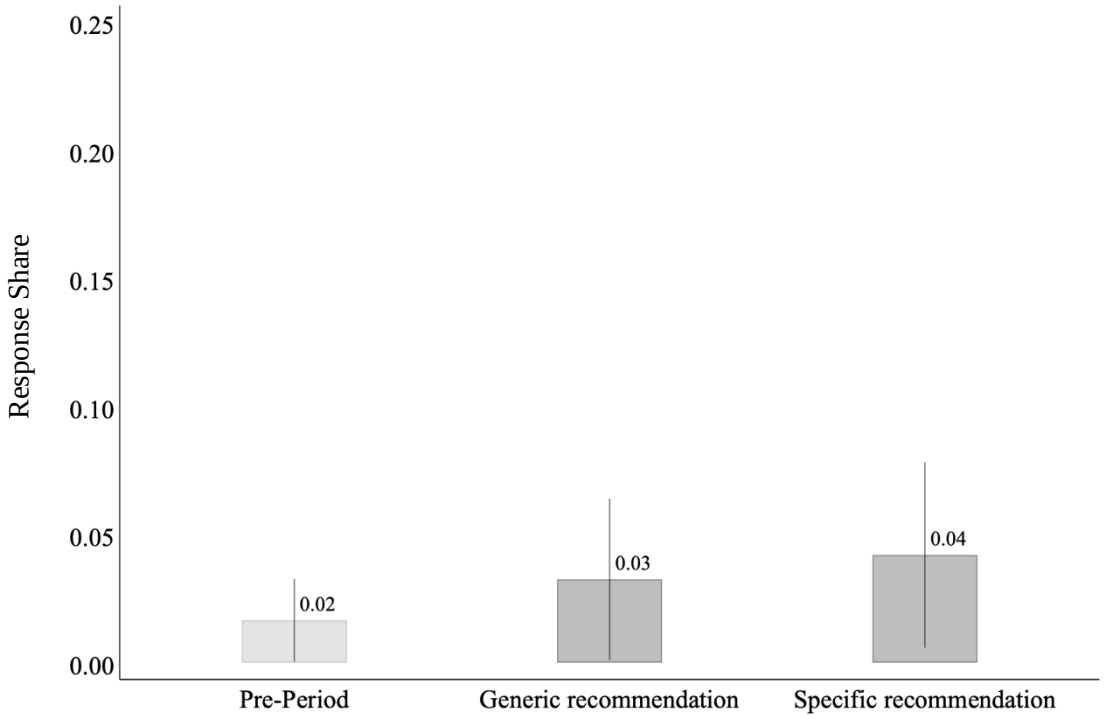


Note: This figure depicts the share of increased 401(k) plan contributions among employees assigned to each primary (Panel A) and secondary (Panel B) treatment in the Low Arm. Panel A additionally reports the average share of increased contributions by in-sample employees during a specified period prior to the study. Inferences about any change in employee contribution, in response to the field study, rely on administrative data from the pay dates following the end of the survey period and preceding the survey invitation. Error bars reflect 95 percent confidence intervals.

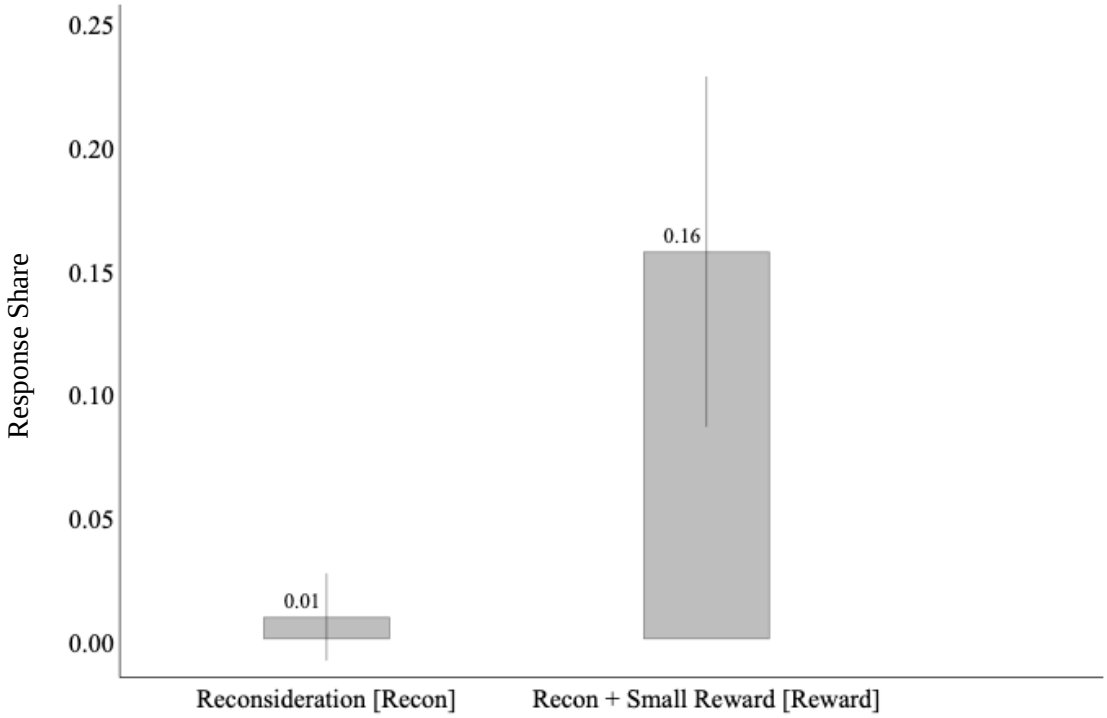
Figure 3.

Share of Increased 401(k) Plan Contributions by Experimental Treatment – Moderate Saving Arm

Panel A. Primary Experimental Treatments



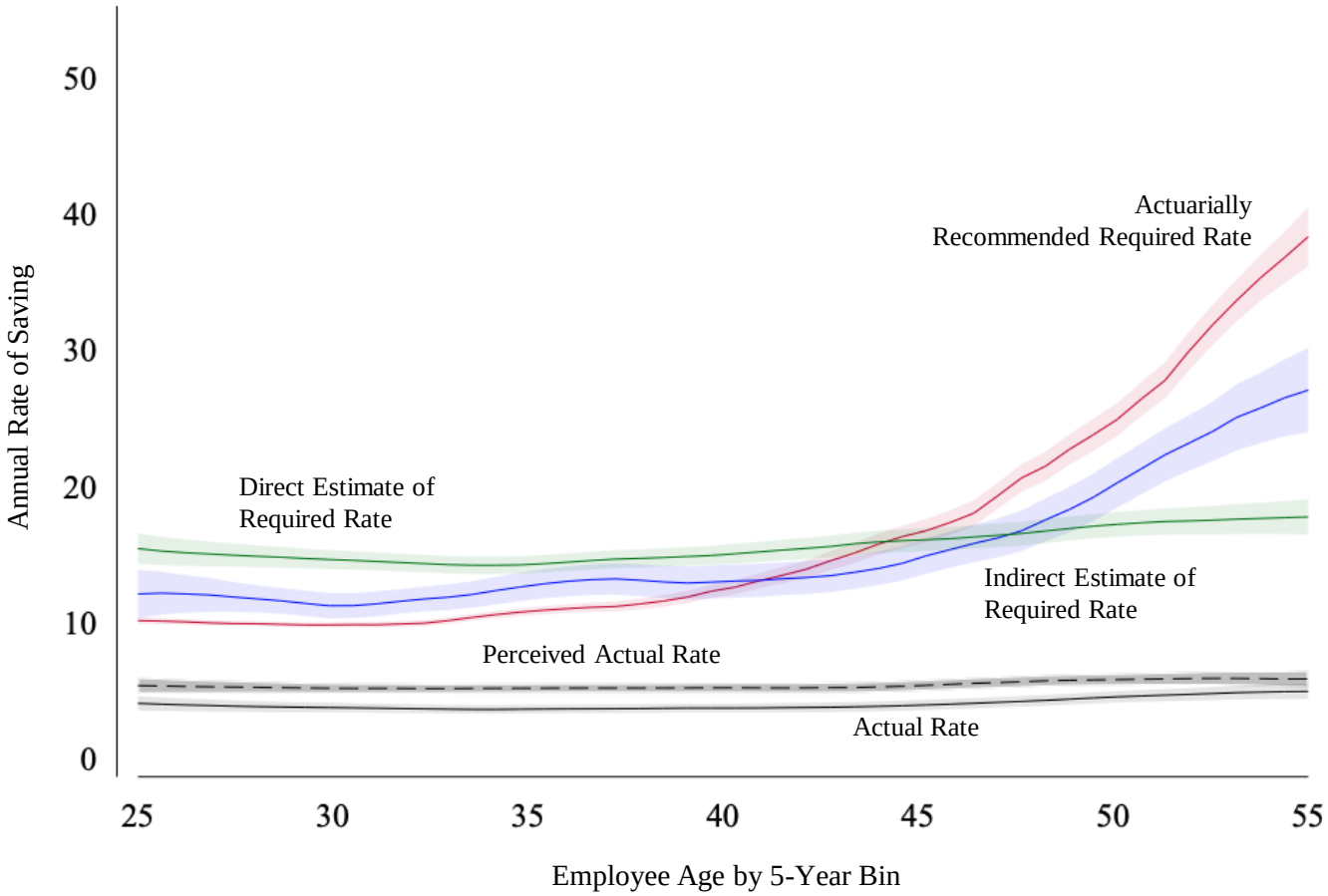
Panel B. Secondary Experimental Treatments



Note: This figure depicts the share of increased 401(k) plan contribution among employees assigned to each primary (Panel A) and secondary (Panel B) treatment in the Moderate Arm. Panel A additionally reports the average share of increased contributions by in-sample employees during a specified period prior to the study. Inferences about any change in employee contribution, in response to the field study, rely on administrative data from the pay dates following the end of the survey period and preceding the survey invitation. Error bars reflect 95 percent confidence intervals.

Figure 4.

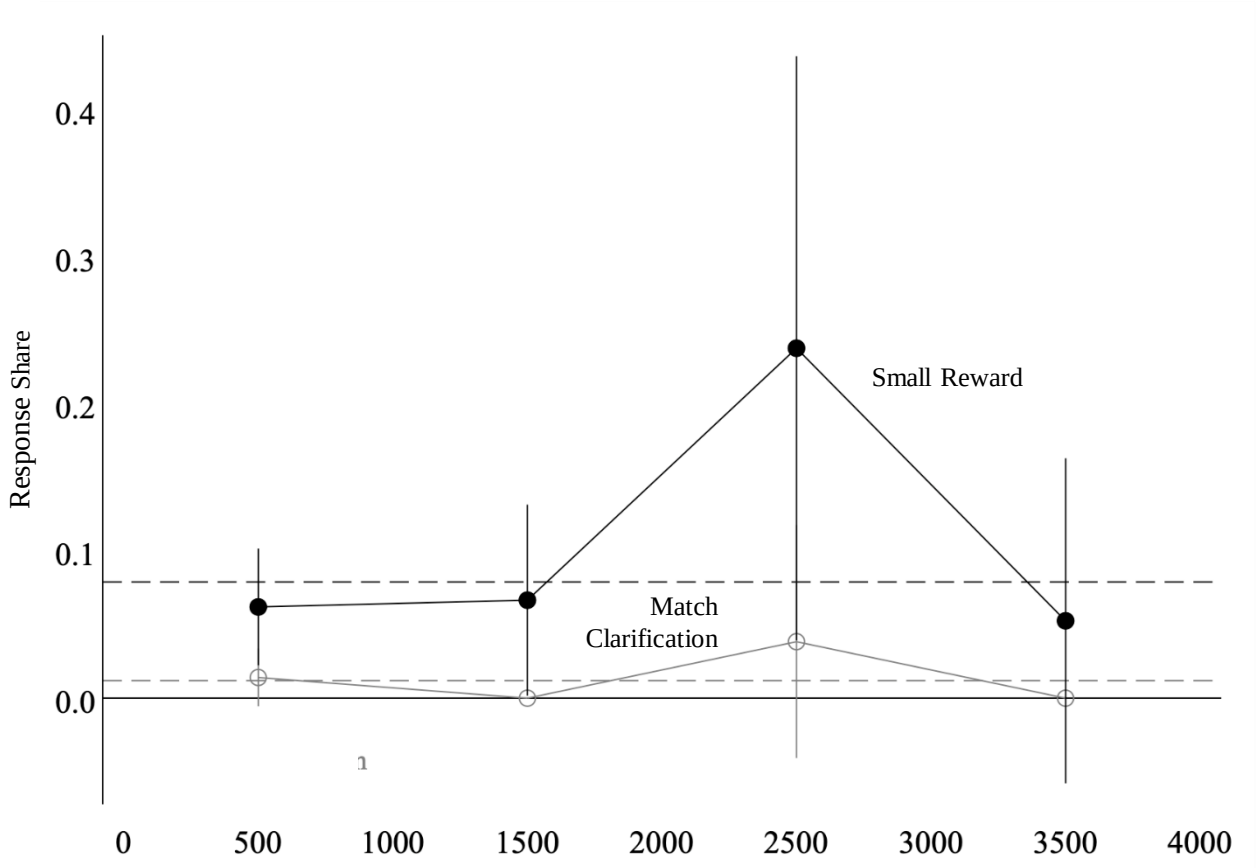
Recommended, Actual and Perceived Annual Rate of 401(k) Plan Saving by Employee Age



Note: This figure summarizes recommended, actual, and perceived 401(k) annual saving rates by age for surveyed employees. Specifically, the plot depicts the local moving average of the actuarially recommended rate of annual required saving (red), the direct estimate of the required annual saving rate (green), and the indirect estimate of the required annual saving rate (purple) by employee age. The plot also depicts the actual (black) and perceived actual (dashed black) annual saving rates by employee age. Each linear smoother is estimated using a bandwidth of 50 basis points and the shaded region reflects the 95 percent confidence interval for the local mean. Saving rates reflect total 401(k) plan contributions (inclusive of the plan match). Please refer to the text for details underlying the calculation of the actuarial recommendation.

Figure 5.

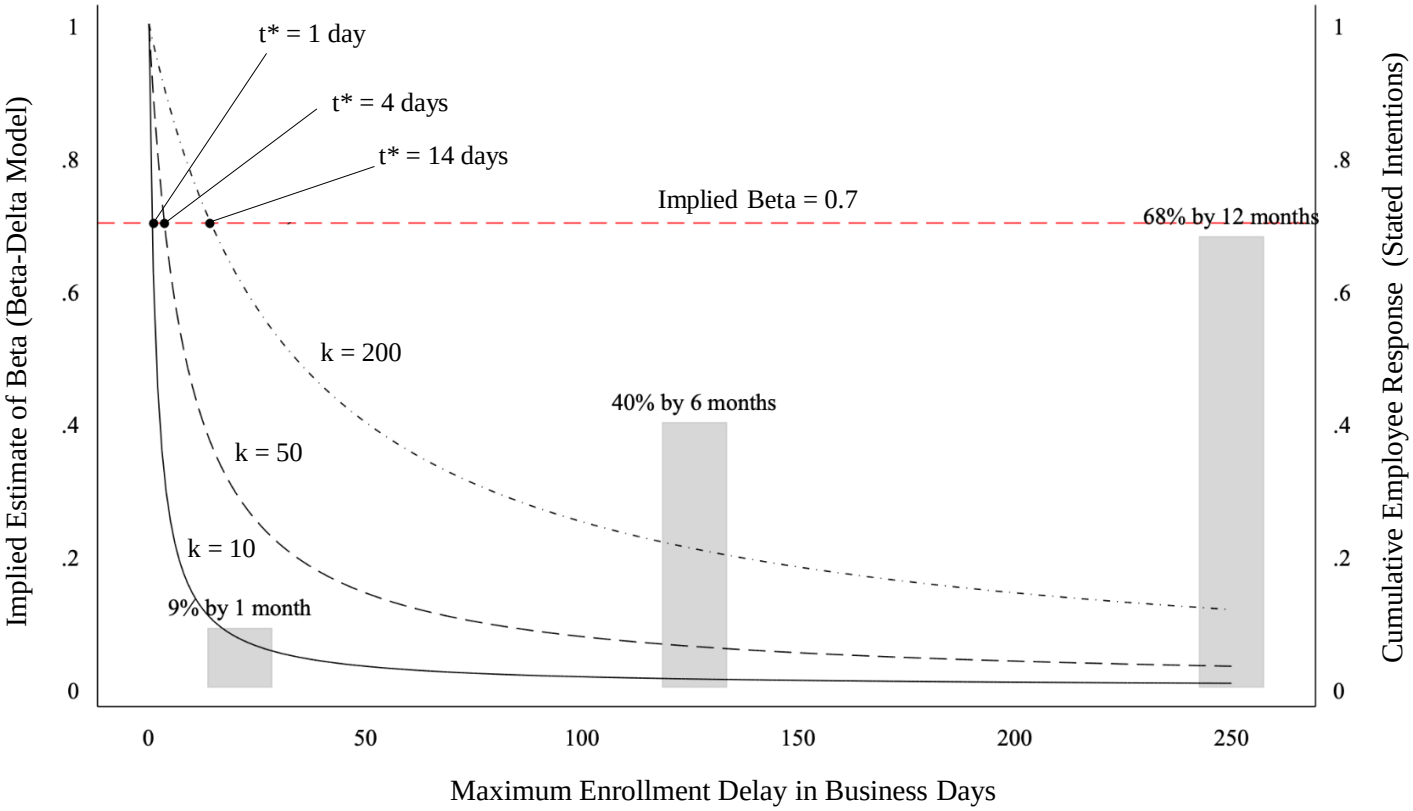
Share of Increased 401(k) Plan Contributions in Response to Match Clarification and Small Reward by 12-month Value of Foregone Match - Low Saving Arm



Note: This figure depicts the average share of increased 401(k) plan contributions in response to the small reward (black line) and the match clarification (grey line) as a function of the estimated 12-month value of an employee's foregone plan match ($500-bins). To facilitate comparison, the plot reflects the primary response of employees in the Low Arm. The estimated value of the foregone plan match assumes a constant salary and full inertia in contributions as described in the text. The dashed lines depict the average experimental response associated with each treatment.

Figure 6.

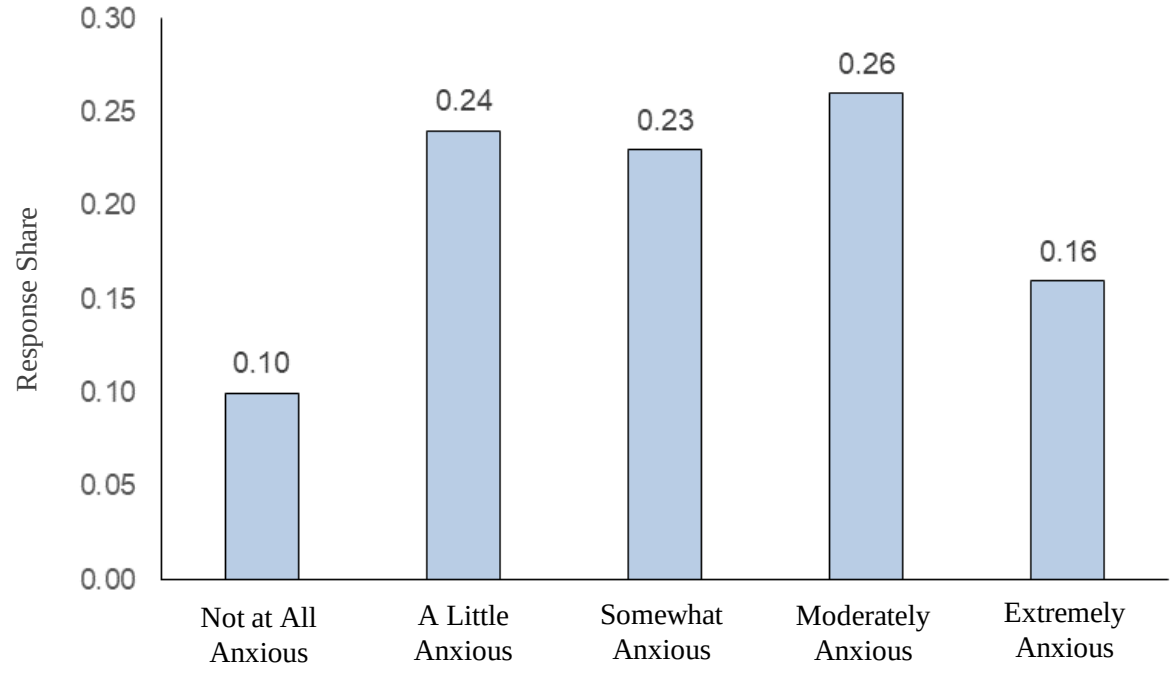
Delay in 401(k) Plan Enrollment Implied by Beta-Delta Model and Stated Intentions of Employees



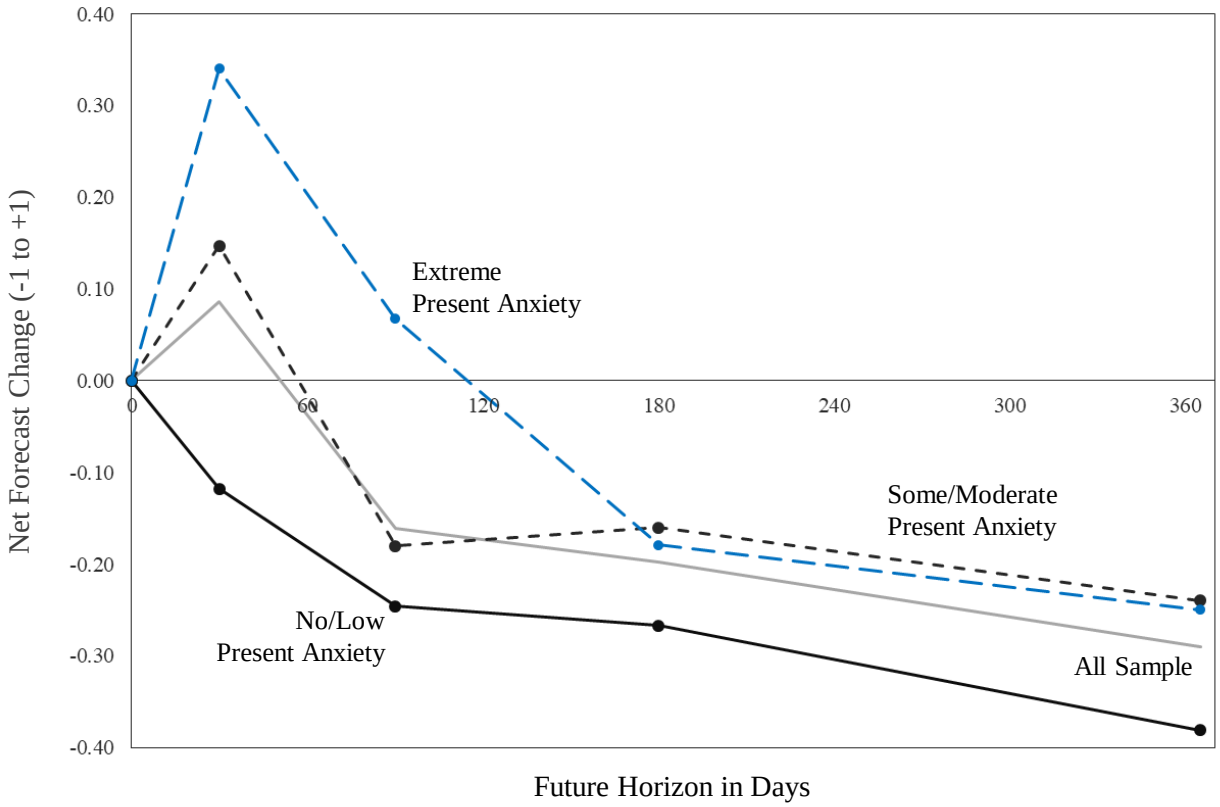
Note: This figure reports the value of beta required to rationalize varying durations of delay in 401(k) plan enrollment as implied by the beta-delta model (assuming sophistication). The plot separately displays estimates of beta assuming enrollment costs of k = 10, 50, and 200 and annotates the delay associated with a beta of 0.7 for each cost curve. The estimates pertain to an employee earning $50k in annual salary and assumes enrollment at a contribution rate of 4 percent. The plot also depicts the distribution of intended enrollment delay among non-participating employees across various future horizons. Specifically, the grey bars indicate the earliest time horizon by which an employee expresses a moderate, or greater, intent to enroll. Note that the stated intentions of employees to enroll were elicited in calendar days while the enrollment delay associated with each implied beta is indexed in business days.

Figure 7.
Present and Forecasted Change in Financial Anxiety– Supplementary Sample

Panel A. Present Financial Anxiety



Panel B. Net Forecasted Change in Financial Anxiety across Future Horizons

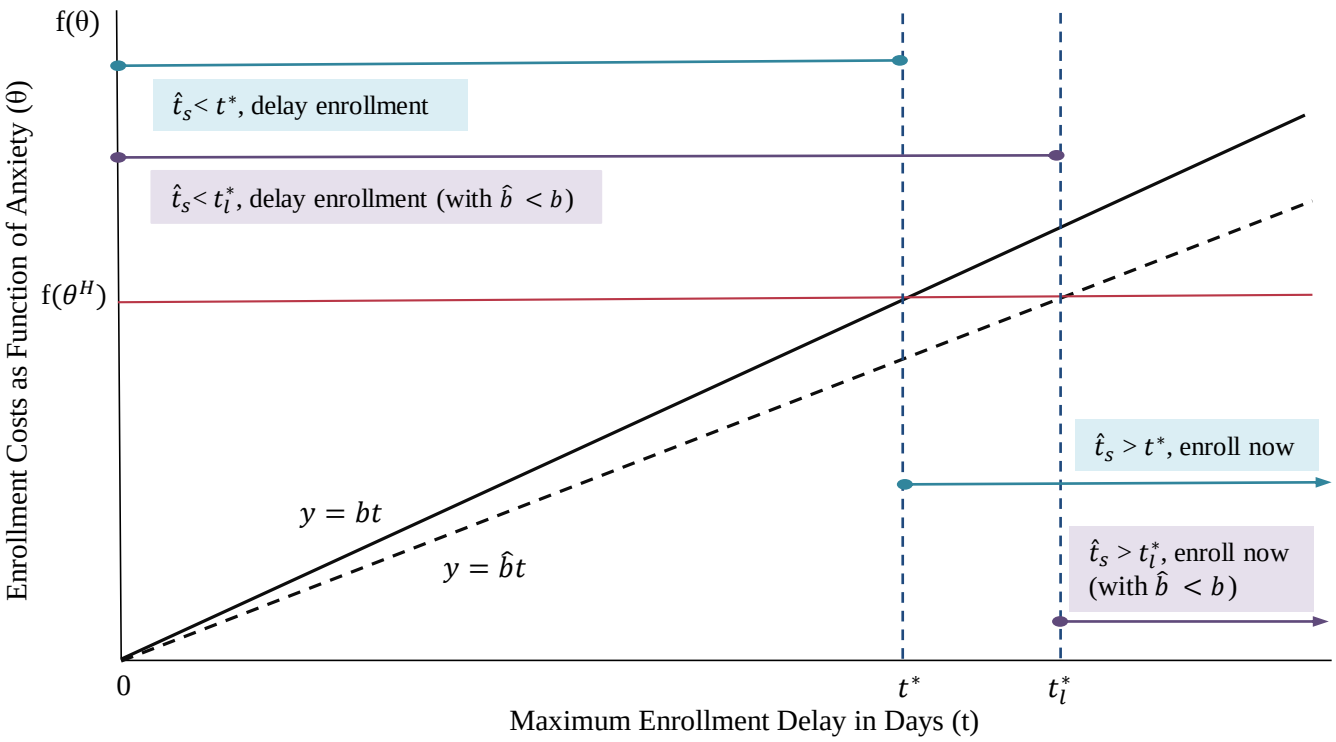


Note: This figure describes present and forecasted change in financial anxiety among a supplementary survey sample of US employees. Panel A depicts the distribution of self-reported present financial anxiety on a scale ranging from not at all to extremely anxious. Panel B reports the net forecast change in future financial anxiety for the same sample across varying future horizons. We calculated the forecast change measure by first scoring each employee's forecast as +1 (increase in anxiety), 0 (no change to anxiety), or -1 (decrease in anxiety) and then averaging these scores for each time horizon. The panel presents the average net forecast change for the entire sample (grey line) and separately by levels of present anxiety. Because respondents were asked to generate forecasts over a random subset of future horizons, comparisons across horizons reflect compositional differences in the sample.

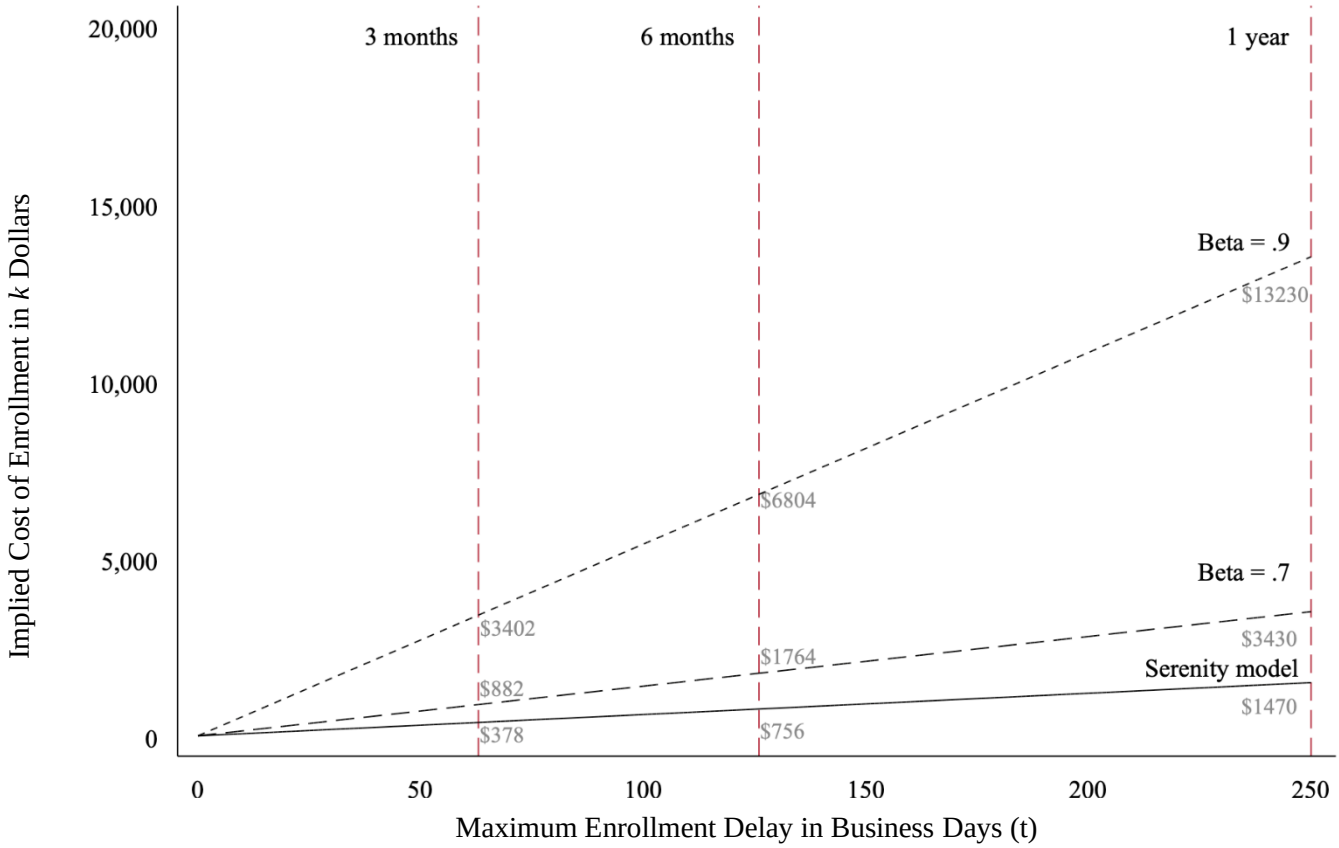
Figure 8.

Delay in 401(k) Plan Enrollment implied by the Serenity Model

Panel A. Stylized Costs and Benefits of Enrollment Delay



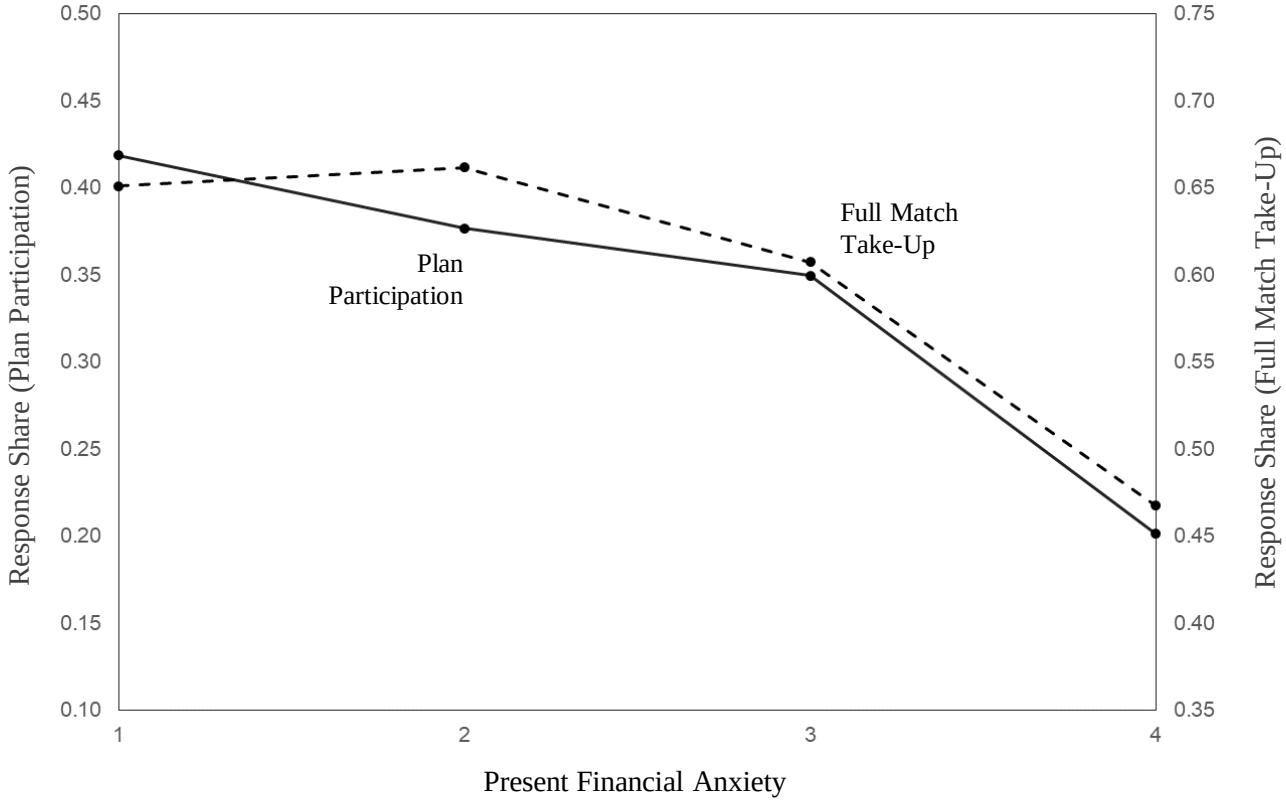
Panel B. Implied Enrollment Costs by Duration of Delay in Beta-Delta and Serenity Models



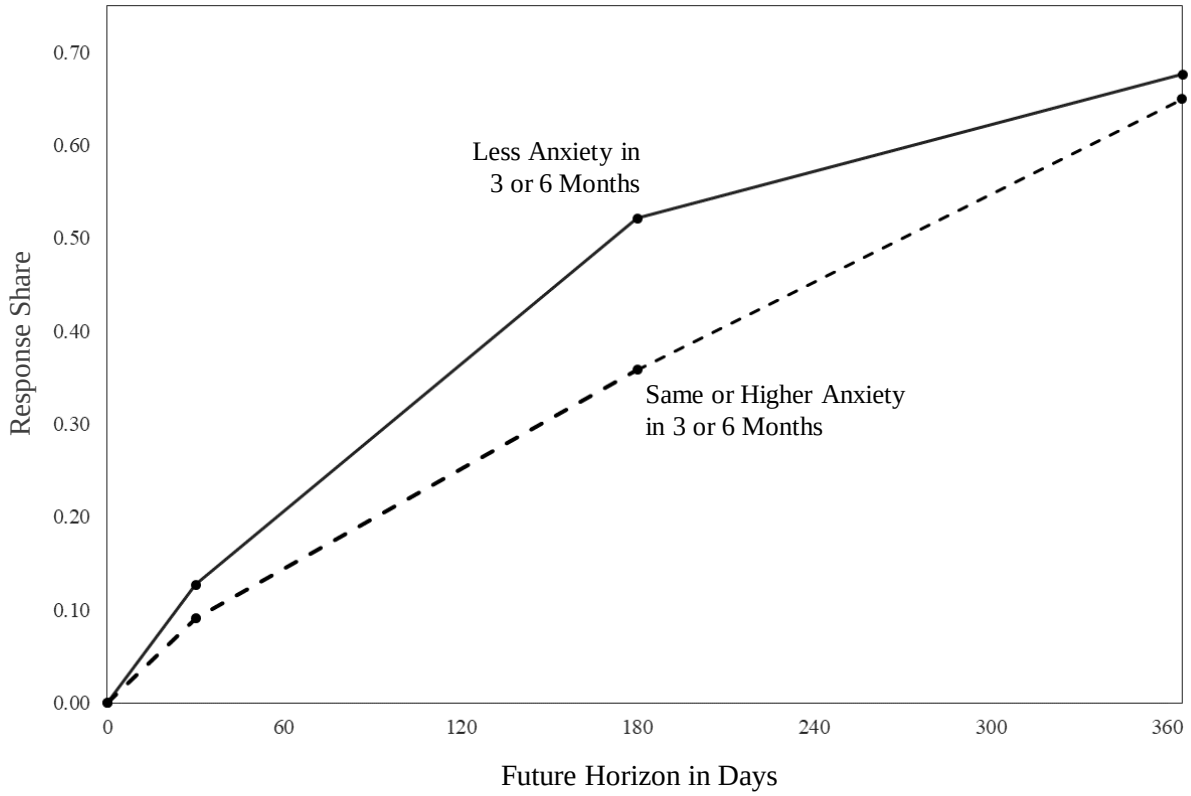
Note: This figure describes the delay in 401(k) plan enrollment implied by the Serenity Model. Panel A depicts the marginal cost (due to the foregone plan match) and benefits (due to potential reductions in anxiety costs) of enrollment delay for the model. The graph separately plots the cost of delay assuming accurate (solid line) or downward-biased (dashed line) beliefs regarding plan match generosity. Panel B compares the enrollment costs as a function of delay length for the beta-delta model assuming beta of 0.9 (short-dashed line) or 0.7 (long-dashed line), and the Serenity Model (solid line) (normalizing low-anxiety costs to zero). The estimates pertain to an employee earning $50k annually and enrollment at a contribution rate of 4 percent.

Figure 9.
Financial Anxiety and Employee Savings

Panel A. 401(k) Plan Enrollment and Present Financial Anxiety



Panel B. Intent to Save across Future Horizons by Forecasted Change in Financial Anxiety



Note: This figure depicts the relationship between present and forecasted change in financial anxiety and 401(k) plan savings among employees in the field study. Panel A depicts the baseline share of employees who did not participate in the 401(k) plan and did not fully take-up the plan match at the time of the study by self-reported level of financial anxiety (1 = "None", 2 = "Very Little", 3 = "Fair Amount", 4 = "A Lot"). Panel B reports the share of employees expressing at least a moderate likelihood of increasing their savings across future time horizons for those anticipating less (solid line), or more/the same amount of (dashed line), financial anxiety over the next 3 to 6 months. Data is restricted to the sub-sample of employees answering the pertinent questions.

Table 1.
Summary of Employee Demographics and 401(k) Plan Engagement

	All Sample		401(k) Non-Participants		401(k) Participants		Difference Test
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	(p-value)
Panel A. Invited Employee Sample							
Employee Characteristics							
N =	4,719	-	2,261	-	2,458	-	-
Male [1,0]	0.35	0.48	0.36	0.48	0.34	0.47	0.35
Age [Yrs]	38.8	8.34	38.49	8.2	39.0	8.46	0.05
Tenure [Yrs]	7.8	6.96	7.38	6.64	8.1	7.22	0.00
Income (imputed) [$ thousands]	51.0	21.31	49.23	20.59	52.63	21.83	0.00
401(k) Saving Behavior							
Participation [1,0]	0.52	0.50	0.0	-	1.0	0	-
Contribution Rate [% annual pay]	1.7	2.4	0.0	-	3.2	2.5	-
Saving Rate (inclusive of plan match) [% annual pay]	3.3	4.2	0.0	-	6.3	3.8	-
Full Match Take-Up [1,0]	0.24	0.43	0.0	-	0.46	0.50	-
Panel B. Respondent Employee Sample							
Employee Characteristics							
N =	1,332	-	559		773	-	-
Male [1,0]	0.33	0.47	0.35	0.48	0.32	0.47	0.28
Age [Yrs]	39.5	8.3	39.1	8.0	39.8	8.4	0.11
Tenure [Yrs]	8.4	7.4	7.93	6.9	8.8	7.7	0.03
Income (imputed) [$ thousands]	52.4	21.5	50.0	20.6	54.0	22.0	0.00
Married [1,0]	0.58	0.49	0.55	0.50	0.60	0.49	0.09
Any Children [1,0]	0.69	0.46	0.71	0.46	0.67	0.47	0.17
Non-white [1,0]	0.29	0.46	0.33	0.47	0.27	0.44	0.01
College Degree [1, 0]	0.53	0.50	0.52	0.50	0.54	0.50	0.33
Accumulated Savings							
Less than $10k [1,0]	0.53	0.50	0.59	0.49	0.48	0.50	0.00
$10k - $75k [1,0]	0.31	0.46	0.26	0.44	0.36	0.48	0.00
$75k or more [1,0]	0.16	0.36	0.14	0.35	0.16	0.37	0.37
Financial Liquidity (N = 227)							
Emergency Savings < 3-Month Expenses [1,0]	0.68	0.47	0.75	0.43	0.63	0.48	0.05
Emergency Liquidity < 3-Month Expenses [1,0]	0.39	0.49	0.48	0.50	0.32	0.47	0.01
401(k) Savings Behavior							
Participation [1,0]	0.58	0.49	0.00	-	1.00	-	-
Contribution Rate [% annual pay]	1.9	2.3	0.0	-	3.3	2.1	-
Self-Reported Contribution Rate [% annual pay]	2.6	2.4	1.4	2.2	3.5	2.1	-
Saving Rate (including plan match) [% annual pay]	3.8	4.2	0.00	-	6.48	3.54	-
Full Match Take-Up [1,0]	0.28	0.45	0.00	-	0.48	0.50	-

Note: This table summarizes available demographic, financial, and plan engagement details for employees in two analytic samples. Panel A describes employees invited to participate in the field study as of July 2016 while Panel B describes employees who responded to the invitation and at least partially completed the online survey (see text for inclusion criteria). The varying sample sizes across measures reflect the random assignment of respondents to select survey modules (e.g., financial liquidity). We imputed income from administrative data on salary decile and used the imputed income to calculate matching contributions for any employee presumed to be eligible for the minimum match.

Table 2.
Survey Evidence on Prevalence of Psychological Frictions by 401(k) Plan Engagement

	Full Sample		Plan Participation		Full Match Take-Up		Difference Tests (p-value)	
Friction Indicator	N	Mean	No	Yes	No	Yes	Participation	Full Match
1. Low Retirement Literacy								
Direct Underestimation of Required Savings	1321	0.47	0.45	0.49	0.48	0.45	0.18	0.26
Indirect Underestimation of Required Savings	1332	0.43	0.45	0.42	0.47	0.33	0.27	0.00
Financial Literacy - Zero Score on 2-Item Assessment	305	0.20	0.24	0.16	0.23	0.11	0.06	0.02
2. Plan Confusion								
Underestimation of Plan Eligibility	1332	0.02	0.03	0.01	0.02	0.01	0.10	0.43
Underestimation of Plan Match	1332	0.20	0.27	0.16	0.24	0.13	0.00	0.00
Overestimation of Plan Contribution Rate	1306	0.24	0.36	0.13	0.30	0.09	0.00	0.00
3. Enrollment Complexity								
Overestimation of Adjustment (> few minutes)	577	0.23	0.26	0.21	0.22	0.24	0.18	0.74
Prohibitive Estimation of Adjustment (> few hours)	577	0.11	0.14	0.09	0.12	0.11	0.04	0.76
Theory of Automatic Enrollment - Complexity	503	0.10	0.10	0.09	0.10	0.09	0.79	0.74
4. Present Focus								
Present Focus Implied by Effort Allocation Choice	305	0.10	0.10	0.10	0.11	0.09	0.93	0.60
Theory of Automatic Enrollment - Present Focus	503	0.60	0.49	0.68	0.55	0.74	0.00	0.00

Note: This table summarizes the baseline prevalence of survey-based indicators of each candidate friction across levels of 401(k) plan engagement. Specifically, for the friction indicator described in each row, the first two columns report the sample size and prevalence for the full employee survey sample as of the last payroll date preceding the survey; the second set of columns reports prevalence by plan participation, and the third set of columns reports prevalence by full match take-up. The final two columns report p-values from a t-test of mean differences in prevalence across plan participation and full match take-up. The varying sample sizes across measures reflect the random assignment of respondents to select survey modules.

Table 3.
Marginal Effect of Experimental Treatments on 401(k) Plan Engagement

	Low-Saving Arm			Moderate-Saving Arm	
	Dependent Variable			Dependent Variable	
Experimental Treatment	Contribution Rate Increase (1,0)	Δ Contribution Rate	Δ Full Match Take-Up (1,0)	Contribution Rate Increase (1,0)	Δ Contribution Rate
Panel A. Primary Treatments					
Generic Recommendation [GR]	--		--	0.03**	0.09
				(0.02)	(0.05)
Specific Recommendation [SR]	0.02	0.02*	0.00	0.04**	0.07**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Match Clarification + SR [MC]	0.01*	0.02	0.01	--	--
	(0.01)	(0.02)	(0.01)		
Small Reward + MC [Reward]	0.08***	0.15***	0.04***	--	--
	(0.02)	(0.04)	(0.01)		
N	763	763	763	242	242
F-Tests of Coefficient Equality (p-value)					
SR v. GR	--		--	0.70	0.722
MC v. SR	0.73	0.822	0.157	--	--
Reward v. MC	0.00	0.004	0.033	--	--
Pre-Study Comparison	0.014	-0.037	0.000	0.017	-0.029
	(0.004)	(0.017)	--	(0.008)	(0.031)
Panel B. Secondary Treatments					
Reconsideration [Recon]	0.03**	0.03	0.01*	0.01	-0.03
	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)
Small Reward + Recon [Reward]	0.12***	0.18***	0.04***	0.16***	0.19***
	(0.02)	(0.06)	(0.01)	(0.04)	(0.05)
N	455	455	455	213	213
F-Test of Coefficient Equality (p-value)					
Reward v. Recon	0.00	0.00	0.07	0.00	0.00

Note: This table summarizes marginal changes in plan contributions in response to the experimental treatments as estimated through a series of regressions predicting saving outcomes—contribution rate increase (1,0), contribution rate change (percent of salary), and contribution rate increase resulting in full match take-up (1,0)—as a function of indicators for treatment assignment, with a suppressed constant. Panel A summarizes the response of employees to the primary treatments while Panel B summarizes response to the secondary treatments. To facilitate comparisons between treatments, both panels report p-values from pairwise F-tests of coefficient equality, and Panel A additionally reports an out-of-sample reference of plan contribution changes by in-sample employees during the period prior to the study. The first three columns report the share of increased plan engagement among employees in the Low Arm while the final two columns describe the increase in plan engagement for employees in the Moderate Arm. Inferences about any change in employee contribution rates in response to the field study rely on administrative data from the pay dates following the end of the survey period and preceding the survey invitation. Robust standard errors are displayed parenthetically (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table 4.

Marginal Effect of Experimental Treatments on Retirement Literacy and Perceived Complexity

	Retirement Literacy Δ I(perceived required savings ≥ recommendation)		Enrollment Complexity Δ I(perceived time-cost of enrollment = minutes)	
Experimental Treatment	Low Arm	Moderate Arm	Low Arm	Moderate Arm
Generic Recommendation	--	0.09***	--	0.05*
		(0.03)		(0.03)
Specific Recommendation	0.24***	0.17***	0.03*	0.08**
	(0.03)	(0.04)	(0.01)	(0.03)
Match Clarification	0.20***	--	0.07***	
	(0.03)		(0.02)	
Small Reward	0.19***	--	0.07***	
	(0.03)		(0.03)	
Base Rate Prior to Interventions	0.50	0.40	0.78	0.77
N	704	228	328	123

Note: This table summarizes changes in employee retirement literacy and perceptions of enrollment complexity before and after experimental treatments as estimated through a series of linear probability models (with suppressed constants). The first two columns estimate the change in the share of employees who perceive a required rate of annual savings at or above the recommended rate for the Low and Moderate Arms. The next two columns estimate the change in the share of employees who perceive enrollment to require only "a matter of minutes." Finally, the table reports baseline values for each of the two beliefs. The varying sample sizes across measures reflect the random assignment of respondents to select survey modules. Robust standard errors are displayed parenthetically (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table 5.
Synthesis of Survey and Field Evidence on Psychological Frictions and 401(k) Plan Engagement

		Cross-Sectional Difference in Engagement by Indicator			Differential Experimental Response I[Contribution Rate Increase] by Indicator		
Friction Indicator	Baseline Incidence	E(Δ Participation)	E(Δ Match Take-Up)	Treatment [Low Arm if unspecified]	Not Indicated	Indicated	Difference Test (p-value)
1. Low Retirement Literacy							
Direct Underestimation of Required Savings	0.47	0.04	-0.03	Specific Recommendation	0.02	0.01	0.48
Indirect Underestimation of Required Savings	0.43	-0.03	-0.11***	Specific Recommendation	0.01	0.02	0.95
Financial Literacy - Zero Score on 2-Item Assessment	0.20	-0.13*	-0.14**	Specific Recommendation	0.02	0.00	0.72
2. Plan Confusion							
Underestimation of Plan Match	0.20	-0.16***	-0.14***	Match Clarification	0.02	0.00	0.55
Overestimation of Plan Contribution Rate	0.24	-0.29***	-0.24***	Small Reward	0.06	0.21	0.00
3. Enrollment Complexity				[Moderate Arm]			
Overestimation of Adjustment (> few minutes)	0.23	-0.07	0.02	Generic Recommendation	0.02	0.00	0.73
Prohibitive Estimation of Adjustment (> few hours)	0.11	-0.13**	-0.02	Generic Recommendation	0.02	0.00	0.81
Theory of Automatic Enrollment - Complexity	0.10	-0.02	-0.02	Generic Recommendation	0.02	0.00	0.81
4. Present Focus							
Present Focus Implied by Effort Allocation Choice	0.10	0.01	-0.04	Small Reward	0.04	0.14	0.17
Theory of Automatic Enrollment - Present Focus	0.60	0.20***	0.15***	Small Reward	0.06	0.12	0.08

Note: This table synthesizes evidence from the survey and field for the four candidate psychological frictions. For each dichotomous friction indicator, the first column reports the baseline prevalence (also reported in Table 2), while the next set of columns summarizes the cross-sectional difference in plan engagement conditioned on whether the friction is indicated or not. The final set of columns report the differential share of employees increasing their contribution rate depending on whether the friction is indicated in response to the specified experimental treatment targeting that friction (each pair of coefficients were estimated from a single regression model with separate treatment indicators for employees with and without the friction indicated). All of the estimates involve treatments in the Low Arm with the exception of the Generic Recommendation, intended to reduce perceptions of enrollment complexity, which was only administered in the Moderate Arm. Robust standard errors are displayed parenthetically (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

Table 6.
Discrepant Employee Reports of 401(k) Plan Engagement

Type of Discrepancy	All Sample	Plan Participation		Difference Tests
		No	Yes	(p-value)
Discrepant Contribution [1,0]				
Any Discrepant Contribution	0.28	0.37	0.22	0.00
Self-Reported Contribution Rate > Actual Rate	0.24	0.37	0.15	0.00
Self-Reported Contribution Rate < Actual Rate	0.07	--	0.07	--
Discrepant Enrollment Status [1,0]				
Discrepant Self-Report of Participation	0.37	0.37	--	--
Discrepant Self-Report of Non-Participation	0.01	--	0.01	--
Discrepant Self-Report of Full Match Take-Up	0.19	0.26	0.10	0.00
Discrepant Self-Report of Less Than Full Match Take-Up	0.04	--	0.04	--
Average Rate Discrepancy | Discrepant Overreport [%]	3.17	3.81	2.03	0.00

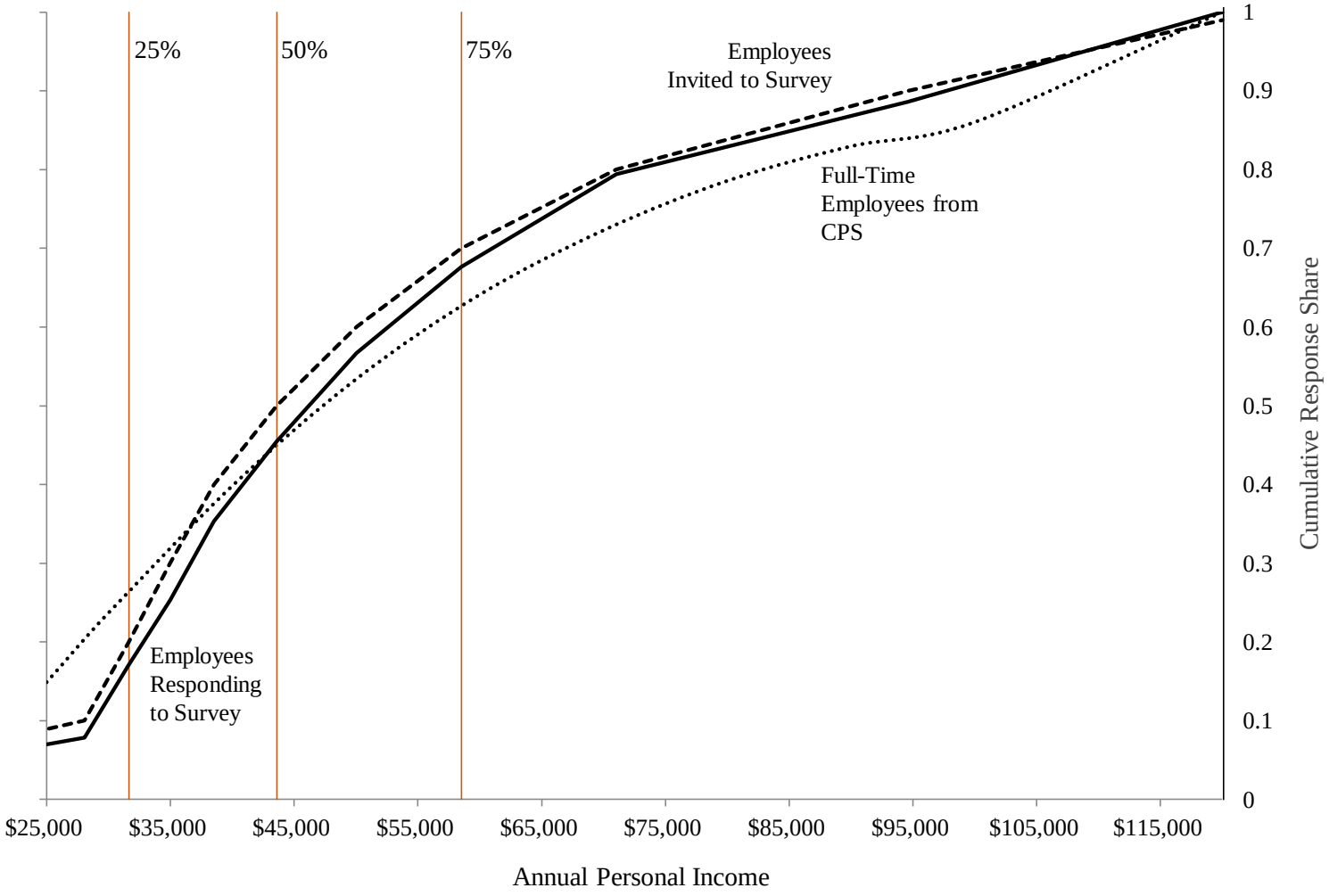
Note: This table summarizes discrepancies between the self-reported and administrative 401(k) plan engagement of employees. Each row reports the average discrepancy associated with the indicated measure for the entire employee sample and for subsamples distinguished by administrative participation. The final column reports a p-value from a t-test of mean differences in discrepancy across plan participation. We identify participation and discrepancies based on administrative records as of the last pay date prior to the survey invitation.

Table 7.
Discrepant Employee Reports of 401(k) Plan Engagement Adjusted for Inattention and Exaggeration

	Discrepant Report Type	
	Participation	Full Match
Discrepant Reporting Share of Non-Participants	0.37	0.26
Panel A. Inattention Adjustment		
Discrepant Report Share | Passing Attention Check	0.34	0.24
Panel B. Exaggeration Adjustment		
Discrepant Report Share, Adjusted for Exaggeration by:		
Over-Reported Salary	0.33	0.24
Reported highest salary option ($75k or above)	0.30	0.20
Reported highest contribution option (10% or more)	0.36	0.25
Reported highest accumulated savings option ($75k or more)	0.32	0.23
Reported highest education option (Graduate school)	0.33	0.23
Reported highest confidence in retirement preparation	0.35	0.25
Any of the above	0.21	0.14
Panel C. Inattention and Exaggeration Adjustment		
Discrepant Report Share Adjusted for Exaggeration | Attention Check	0.20	0.13

Note: This table assesses the potential role of inattention and exaggeration in explaining discrepant employee reports of 401(k) plan participation and full match take-up. Panel A adjusts for inattention by reporting the rate of discrepancies for highly attentive employees as indicated by whether an employee passed an "attention check" within the survey (see Section 4 for details). Panel B adjusts for deliberate exaggeration by reporting the discrepancy rate after excluding employees whose response elsewhere in the survey indicated potential exaggeration. Specifically, the panel reports discrepancy rates after excluding employees (i) whose self-reported salary range was inconsistent with administrative records, (ii) whose response reflected the most socially desirable item on a response menu for each of the five questions for which one could reasonably identify the most socially desirable response (i.e., questions regarding salary, 401(k) contribution, accumulated savings, educational attainment, and confidence in retirement preparation), or (iii) who satisfied any of the six aforementioned exclusion screens. Panel C reports the residual discrepancy rates after adjusting for both inattention and exaggeration—i.e., discrepancies due to potential employee confusion—by reassigning employees satisfying any of the exaggeration screens and conditioning on passing the attention check.

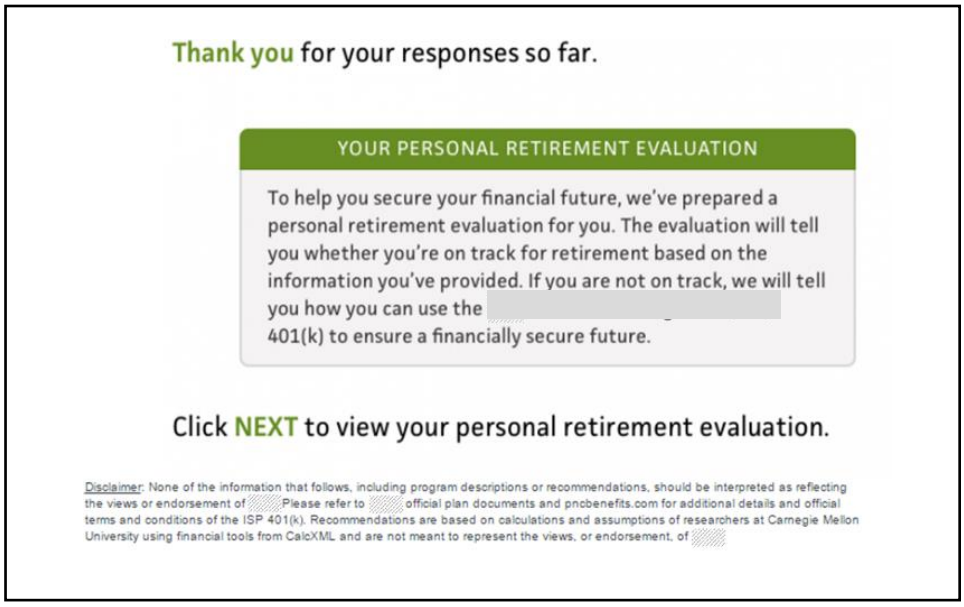
Appendix Figure A1.
Comparison of Income Distribution from Field Study and Employees in 2015 Current Population Survey



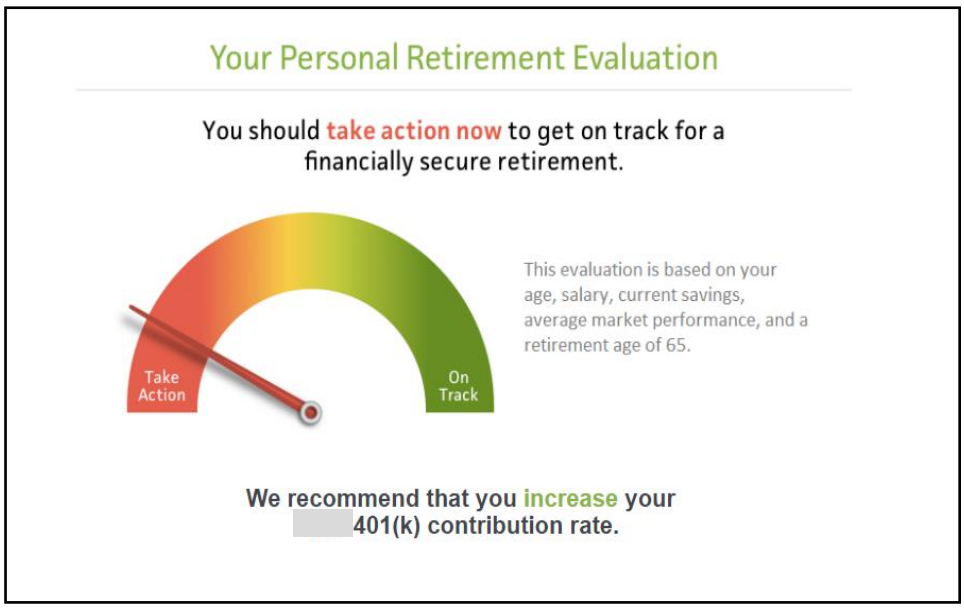
Note: This figure compares the distribution of annual salary of employees from the field study with annual salary for a national sample of employees from the Current Population Survey (CPS). Specifically, the plot depicts the cumulative distribution of annual salary for employees responding to the field survey (solid line), employees invited to participate in the field survey (dashed line), and full-time adult employees included in the 2015 CPS (dotted line). To facilitate comparisons, the vertical drop lines depict the 25th, 50th, and 75th percentiles of salary for employees invited to the field survey.

Appendix Figure A2.

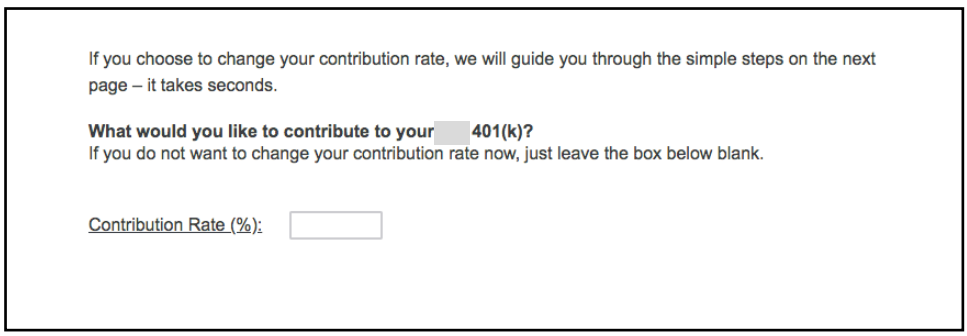
Screenshots of Baseline Retirement Assessment Web-Flow from Field Study
(Generic Recommendation)



Introductory Screen



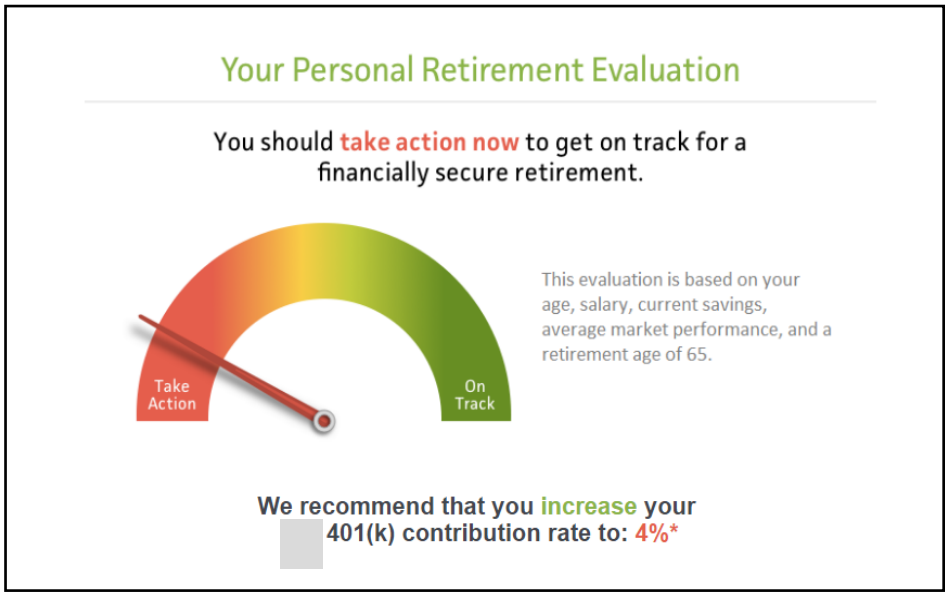
Retirement Assessment
(Generic Recommendation)



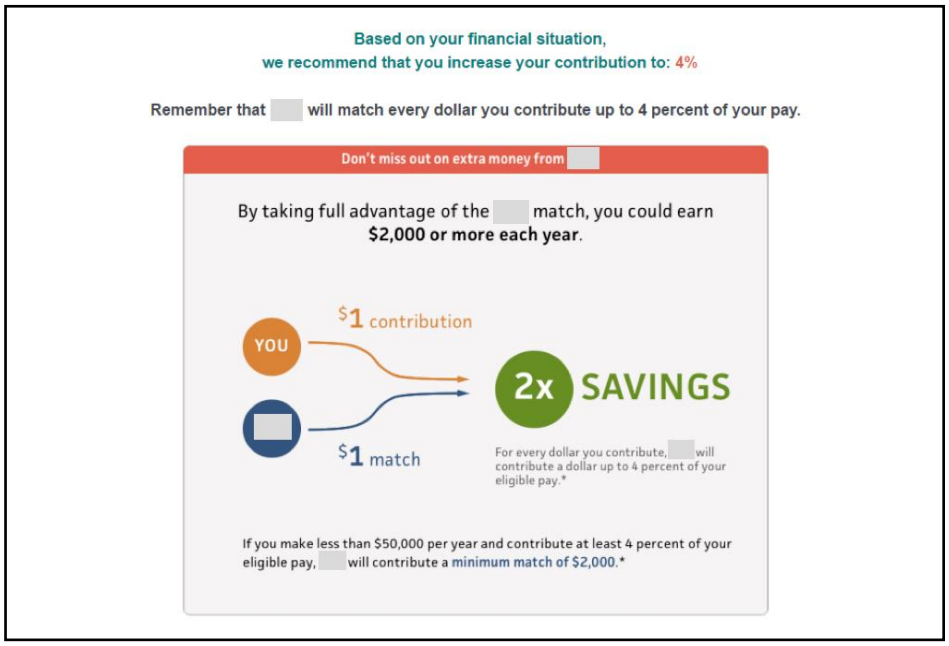
Saving Prompt
(Prior to Benefit Portal Link)

Appendix Figure A3.

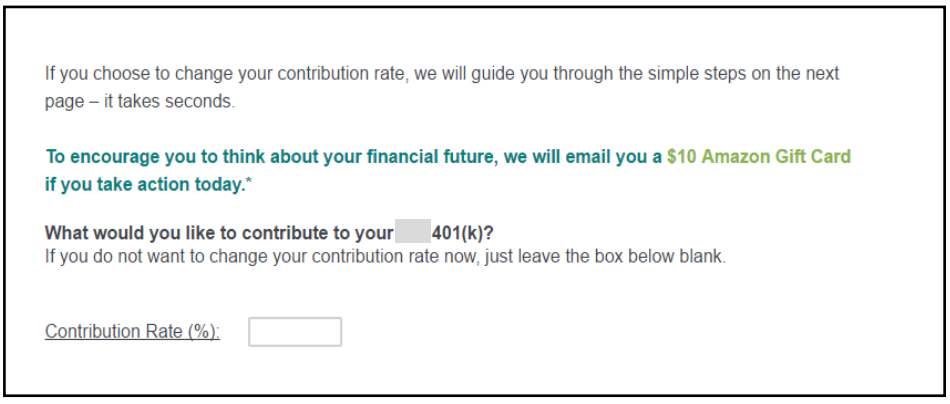
Screenshots of Experimental Variation in Retirement Assessment Web-Flow from Field Study



Specific Recommendation

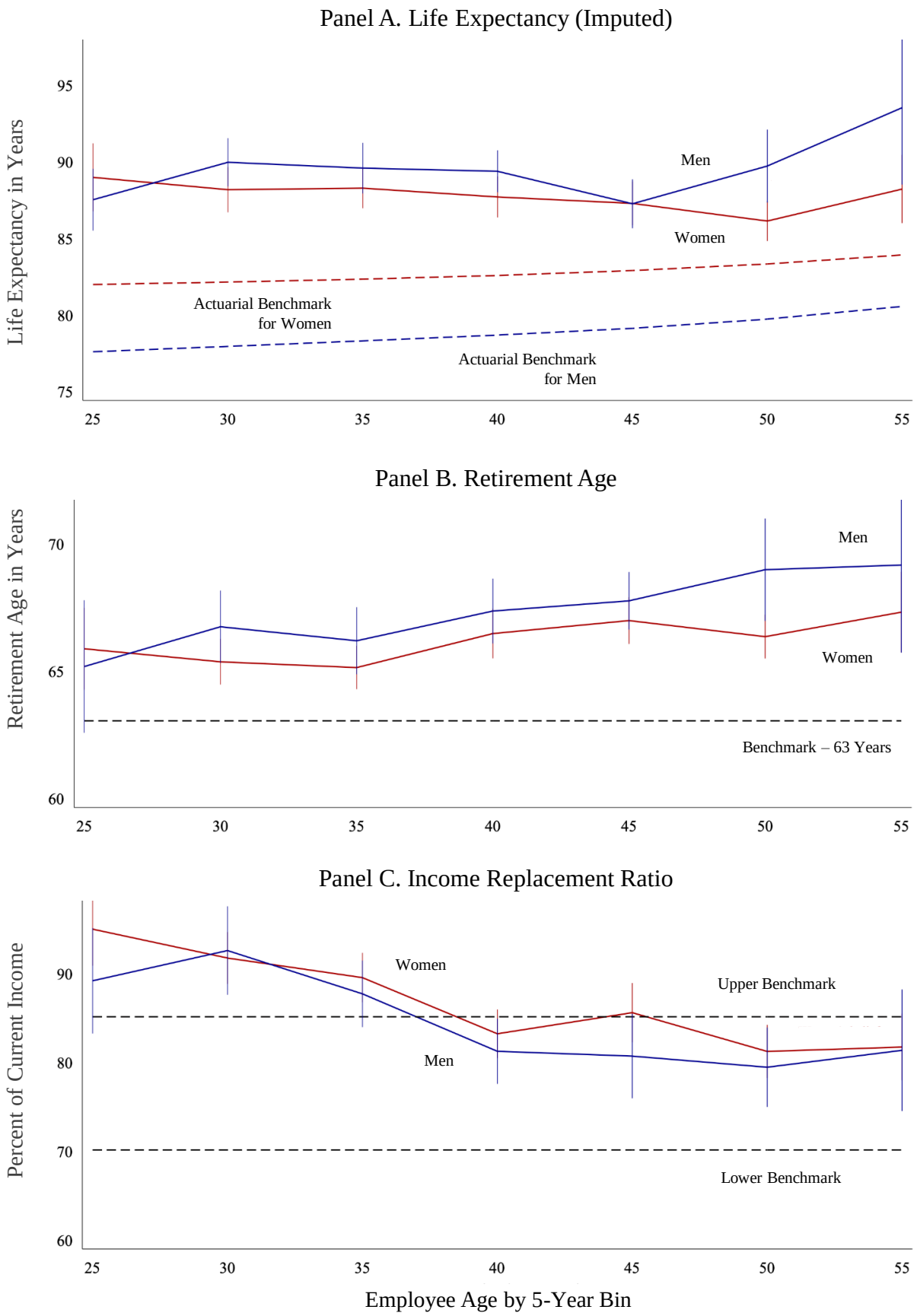


Match Clarification



Small Reward

Appendix Figure A4.
Employee Beliefs and Benchmarks by Age for Three Retirement Inputs



Note: This figure compares surveyed employees' beliefs regarding three retirement-relevant inputs, averaged by gender and five-year age bins, with actuarial or normative benchmarks. Panel A compares employee beliefs regarding life expectancy—imputed from reported beliefs regarding retirement length and retirement age—with age-specific actuarial projections from the SSA. Panel B compares employee beliefs regarding the age of retirement with the median age of new retirees from the 2017 Survey of Household Economics and Decision-making. Panel C compares employee beliefs regarding the minimum (current) income replacement ratio required for a financially secure retirement to the range of benchmarks commonly suggested by financial planners, according to a 2016 GAO Report.

Appendix Table A1.
Tests of Covariate Balance across Experimental Treatments

	Low-Saving Arm				Moderate-Saving Arm		
	Specific Recommendation	Match Clarification	Small Reward	Difference Test (p-value)	Generic Recommendation	Specific Recommendation	Difference Test (p-value)
Employee Characteristics							
N =	262	262	256	-	179	178	-
Male [1,0]	0.33	0.35	0.33	0.89	0.31	0.34	0.63
	(0.03)	(0.03)	(0.03)		(0.03)	(0.04)	
Age [Yrs]	39.6	38.8	38.8	0.39	43.63	43.7	0.94
	(0.50)	(0.51)	(0.51)		(0.52)	(0.51)	
Tenure [Yrs]	8.1	7.8	8.2	0.82	10.9	10.5	0.66
	(0.47)	(0.39)	(0.45)		(0.64)	(0.65)	
Income (imputed) [$ thousands]	50.1	48.7	49.2	0.73	59.5	59.1	0.87
	(1.21)	(1.22)	(1.25)		(1.71)	(1.77)	
401(k) Savings Behavior							
Participation [1,0]	0.49	0.48	0.46	0.76	0.78	0.75	0.52
	(0.03)	(0.03)	(0.03)		(0.03)	(0.03)	
Contribution Rate [% annual pay]	0.88	0.91	0.81	0.59	3.49	3.49	0.99
	(0.07)	(0.08)	(0.06)		(0.18)	(0.19)	

Note: This table summarizes the characteristics of the employees across assigned experimental treatment groups, separately for the Low-Saving arm and Moderate-Saving arm by mean with standard errors displayed in parentheses. We also report test statistics (chi-squared statistic for binary variables and F-statistics for all others) for the null hypothesis that the outcome variable is distributed equally across the treatment groups in the relevant experimental arm. The sample described here includes all employees in the Low-Saving or Moderate-Saving Arm assigned based on self-reported contribution rate, including 132 employees with discrepant self-reported contribution rates who would have been assigned to the other arm based on contribution rates observed in administrative data at the last pay date before the study.

Appendix Table A2.
Extended Survey Evidence on Prevalence of Psychological Frictions by 401(k) Plan Engagement

	Full Sample		Plan Participation		Full Match Take-Up		Difference Test (p-value)	
Friction Measure ([1,0] unless specified)	N	Mean	No	Yes	No	Yes	Participation	Full Match
1. Low Retirement Literacy								
Retirement Beliefs								
Retirement Age [Years]	1332	66.4	67	65.9	66.6	65.7	0.00	0.01
Imputed Life Expectancy [Years]	1332	88.2	88.3	88.1	87.9	88.9	0.70	0.05
Income Replacment Ratio [%]	1330	86.2	88	84.9	87.1	83.8	0.00	0.00
Perceived Minimal Sufficient Savings Rate [%]	1321	13.9	15	13	14.1	13.3	0.02	0.42
Direct Underestimation of Required Savings	1321	0.47	0.45	0.49	0.48	0.45	0.18	0.26
Indirect Underestimation of Required Savings	1332	0.43	0.45	0.42	0.47	0.33	0.27	0.00
Financial Literacy								
Financial Literacy: Interest	305	0.52	0.57	0.48	0.50	0.57	0.11	0.33
Financial Literacy: Inflation	305	0.62	0.52	0.70	0.58	0.73	0.00	0.02
Financial Literacy 2-Item Score [0-2]	305	1.14	1.09	1.18	1.08	1.3	0.31	0.02
Expected 20-Yr Annual Return [%]	300	7.47	8.02	7.01	8.01	5.99	0.27	0.05
Two-Item Financial Literacy Score Equals Zero	305	0.20	0.24	0.16	0.23	0.11	0.06	0.02
2. Plan Confusion								
Confusion about Plan Detail								
Incorrect Match Limit	1332	0.30	0.36	0.26	0.34	0.19	0.00	0.00
Underestimation of Eligibility	1332	0.02	0.03	0.01	0.02	0.01	0.10	0.43
Underestimation of Match Limit	1332	0.20	0.27	0.16	0.24	0.13	0.00	0.00
Confusion about Plan Contribution								
Overestimation of Match Take-Up	937	0.19	0.26	0.10	0.19	-	0.00	-
Overestimation of Current Participation	559	0.38	0.38	-	0.38	-	-	-
Overestimation of Contribution Rate	1306	0.24	0.37	0.15	0.3	0.09	0.00	0.00
3. Enrollment Complexity								
Adjustment (few minutes)	577	0.77	0.74	0.79	0.78	0.76	0.18	0.74
Overestimation of Adjustment (> few minutes)	577	0.23	0.26	0.21	0.22	0.24	0.18	0.74
Prohibitive Estimation of Adjustment (> few hours)	577	0.11	0.14	0.09	0.12	0.11	0.04	0.76
Theory of Automatic Enrollment - Complexity	503	0.10	0.10	0.09	0.10	0.09	0.79	0.74
4. Present Focus								
Present Focus Not Ruled Out by Allocation Choice	305	0.78	0.79	0.76	0.78	0.77	0.54	0.77
Present Focus Implied by Effort Allocation Choice	305	0.10	0.10	0.10	0.11	0.10	0.93	0.60
Theory of Automatic Enrollment - Present Focus	503	0.60	0.49	0.68	0.55	0.74	0.00	0.00

Note: This table summarizes the baseline prevalence of survey measures related to each candidate psychological friction—including both our main binary friction indicators from Table 2 and the underlying survey measures used to construct those indicators—across levels of 401(k) plan engagement. Specifically, for the survey measure described in each row, the first two columns report the sample size and prevalence for the full employee survey sample as of the last payroll date preceding the survey; the second set of columns reports prevalence by plan participation, and the third set of columns reports prevalence by full match take-up. The final two columns report p-values from a t-test of mean differences in prevalence across plan participation and full match take-up. The varying sample sizes across measures reflect the random assignment of respondents to