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

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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 high-compliance field experiment randomizing undersaving employees to information- and incentive-based treatments linked to a survey assessing each friction's baseline incidence. We report four findings: (1) We corroborate evidence of pervasive deficits in *retirement literacy* and their correlation with saving but precisely reject any meaningful increase in saving from personalized recommendations that demonstrably improve literacy. (2) In (unplanned) analyses 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 plan 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) We directly implicate *present focus* as a cause of undersaving by showing a significant share of employees increased saving in response to a small but immediate $10 gift card but not to clarification of the dramatically larger, but delayed, plan match. A survey of policy/industry stakeholders suggests these findings challenge perceived plan engagement best-practices. Finally, calibrations indicate a beta-delta model of present bias cannot account for the observed behavior and beliefs of employees. We propose an alternative model of anxiety-based present focus and deferred optimism that does explain our findings—and possibly other retirement savings puzzles—and offers a psychological rationale for the use of microincentives to increase engagement and for more structural reforms seeking to link traditional saving accounts to more liquid accounts designed to relieve near-term anxiety.

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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 plan structure or administration such as the presence of automatic enrollment (AE) (Madrian and Shea 2001), variation in the non-economic design of a plan's digital enrollment interface (Bhargava et al. 2021), and framing (e.g., Choi et al. 2017).

Economists have advanced a number of potential departures from the standard economic framework—or psychological frictions—to explain these empirical anomalies. Four of these have come to occupy a central role in the academic literature, policy discourse, and industry best-practices for plan administration. The first, which we refer to as low *retirement literacy*, encompasses both low financial literacy (inadequate understanding/misapplication of financial concepts) and biases in retirement-relevant beliefs that might lead an employee to underestimate the need to save. An extensive literature has documented widespread deficits in various measures of literacy, correlations between such measures and saving, and experiments asserting causal links between financial education and various downstream financial behavior (e.g., Hastings et al. 2013; Lusardi and Mitchell 2014; Kaiser et al. 2022). Accordingly, industry surveys allude to the centrality of financial education as a tool for increasing 401(k) plan engagement. The second, *plan confusion*, refers to the possibility that confusion about plan detail, such as underestimation of eligibility or the plan match, might deter saving. While evidence on confusion in the context of 401(k) plans is limited, studies have cited confusion as a barrier to take-up across a range of benefit programs.[1] The third friction, *enrollment complexity*, describes the possibility that the economic and psychological costs of complicated administrative enrollment could impede saving.[2] A fourth friction, *present focus*, implies that undersaving may reflect the tendency to disproportionately privilege immediate, relative to delayed, flows of experienced 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).[3] In the context of savings, economists have invoked present bias to explain low plan participation, the persistent gap between actual and intended saving, and the success of AE in increasing

[1] For example, see Domurat, Menashe, and Yin (2019), Bhargava and Manoli (2015), and Chetty, Friedman, and Saez (2013).
[2] For example, see Choi, Laibson, and Madrian (2009), Beshears et al. (2013), Bertrand, Mullainathan, and Shafir (2004).
[3] As suggested by Ericson and Laibson (2019), we adopt the term "present focus" to encompass both present-biased preferences and alternative mechanisms that could lead to behavior disproportionately favoring the present.

participation (e.g., Laibson 1997; 1998; O'Donoghue and Rabin 1999a). While measures of present bias have been shown to predict saving (Goda et al. 2019; Brown and Previtero 2018) and response to plan defaults (Blumenstock, Callen, and Ghani 2018), arguably the most direct evidence on present bias and saving is the demand for commitment found in development contexts (Bryan, Karlan, and Nelson 2010).

Despite the regularity with which these four frictions are discussed, evidence as to their causal role in the saving of US employees remains scarce.[4] We attempt to provide such evidence via a high-compliance online field experiment through which we administered incentive- and information-based treatments to 1,137 undersaving, 401(k) plan-eligible, employees at a large US firm with a generous plan match. We embedded the treatments within a broader survey intended to assess the employee-specific incidence of the four frictions along with an exploratory friction, *financial anxiety*, increasingly cited by stakeholders and psychologists as an important determinant of financial decisions.[5] After summarizing evidence from the survey-linked field study, supplemented with data from additional national employee samples, we attempt to reconcile the findings with existing economic models via calibrations. We conclude by advancing a new hedonic model of saving that offers a unifying framework from which to understand employee decisions and beliefs in the present setting and savings puzzles more broadly.

Several features of the research design contribute to its distinctive potential for clarifying how psychological frictions affect saving. First, by situating the field experiment within a detailed survey of beliefs and decision-making, we can estimate the baseline prevalence of each friction (and its naïve correlation with saving), the average effect of reducing a specific friction on saving, and the differential effect of reducing a specific friction on saving across baseline incidence. Where possible, we also sought to measure how interventions changed employee beliefs. Taking the case of retirement literacy as example—while the survey documents the baseline prevalence of low literacy and its correlation with saving, the field experiment shows how increasing our specific conceptualization of literacy (via personalized guidance) affects average saving, and jointly, the survey and experiment reveal the heterogeneous effect of increasing literacy across employees varying in baseline measures. Second, the sample is credibly representative of the estimated millions of employees at-risk for retirement insecurity despite 401(k) (AE) eligibility. The generalizability stems from the nature of the sample—we target the universe of plan non-participants and a random sample of other undersaving employees at a large US firm with a typical 401(k) AE plan—and an implementation strategy fostering unusually high compliance.

[4] In commenting on 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."

[5] For example, several national household financial surveys, such as the National Financial Capability Survey, now measure financial anxiety; researchers have asserted the relationship between anxiety and avoidant behavior (e.g., Hartley and Phelps 2012) including in the context of financial decisions (e.g., Choi and Robertson 2020).

That is, in contrast to interventions by email, text, or letter where (non-)response to an intervention could reflect low or non-representative engagement, our design involves minimal discernable selection into an online setting where employee engagement with interventions is observable and high. Finally, we examine behavior in a setting where the costs of delayed enrollment are substantial. That is, due to the generous plan match—a dollar-for-dollar match up to four percent of annual salary with a $2,000 minimum—the return to an additional contribution dollar ranged from 100 to 367 percent for the many employees contributing below the match. In the literature on 401(k) savings, we believe this is the first field study to integrate experimental reductions of frictions with measures of baseline incidence and to experimentally test the role of retirement literacy, present focus, and microincentives on plan engagement.

We administered the field study by inviting qualified employees to participate in an online survey marketed as an opportunity to provide confidential workplace feedback. Beyond capturing demographic and financial background, the first instrument module included questions diagnosing each candidate friction. Employees were then randomized to one of several experimental variants of a second module promising a personalized assessment of retirement preparedness. Across variants, the assessment truthfully conveyed that the employee was not "on track" for retirement security with an accompanying graphic, advised the employee to increase their contribution rate, provided simple instructions to do so, and, finally, asked the employee about their future saving expectations. To 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, reward ($10 Amazon gift card) to encourage employees to visit the enrollment portal and engage the decision to save.

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—nearly half of employees underestimated how much they should save to ensure retirement security and many scored poorly on a financial literacy assessment—and a correlation between at least some measures of literacy and baseline saving, the field experiment implies that these deficits *do not* themselves cause undersaving. We find that providing a concrete, personalized recommendation had a small, precisely estimated, effect on saving, even among employees with baseline literacy deficits, despite substantially improving the accuracy of beliefs. Additional analyses help reconcile this finding with the emphasis on literacy in the literature—e.g., most employees underestimating how much they needed to save nevertheless recognized they were undersaving and intended to save more soon.

Second, we offer new evidence that employee confusion may explain a significant share of undersaving. We distinguish between two specific types of plan confusion: confusion about plan details, such as eligibility or the plan match, and an unanticipated dimension of confusion about one's enrollment

status. Regarding the former, we find that while nearly all employees knew they were plan-eligible, a significant share of employees underestimated the generosity of the match. Despite a 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 among underestimating employees (for whom such information could be interpreted as novel). However, in an unplanned analysis, we discovered a striking share of non-participants who nonetheless reported being enrolled. After adjusting for potential survey inattention or willful exaggeration, we conclude that 20 to 37 percent of non-participants were genuinely confused about their status. Consistent with this interpretation, those presumably confused employees assigned to the small reward (and thus more likely to observe their actual contribution status), were three times as likely as counterparts to increase saving. While such widespread confusion about enrollment may seem incredible, we speculate it arises from the broader complexity of benefit program offerings at large firms—e.g., new hires at our firm were asked to make enrollment decisions for up to twelve benefit programs, varying in rules of eligibility and enrollment. To assess the generalizability of the phenomenon, we found a comparable degree of uncertainty about 401(k)/403(b) plan status in a separate survey of 500 plan-eligible employed adults.

Third, we present evidence that perceptions of enrollment complexity are not likely to inhibit plan engagement in this setting. While a small share of employees likely overestimate the time required to adjust their contribution, few perceived enrollment as prohibitively costly, even allowing for enrollment disutility substantially exceeding wage-based time-costs. Moreover, assignment to the baseline condition, which conveyed the ease of plan adjustment and step-by-step instructions (and verifiably reduced perceptions of enrollment time), did not increase saving relative to pre-study controls, even for employees perceiving enrollment complexity at baseline. We speculate that the apparent absence of deterrent complexity in our setting may reflect the ease with which employees can routinely make 401(k) plan changes through digital enrollment portals in most major plans.

Finally, we present some of the first evidence directly implicating present focus as a barrier to 401(k) saving. We find that 8 to 16 percent of employees increased their contribution rate in response to the $10 reward across implementations of the treatment, despite not responding to clarification of the far larger, but delayed, plan match. And employees tagged as present-focused in the survey were 2 to 3.5 times more responsive to the reward than counterparts. The effect of the small reward persisted over the subsequent four months for which we observed administrative data, and over half of adjustments entailed more than the minimal possible increase of one percent of salary, suggesting responses did not reflect strategic gaming. For those who hadn't exhausted the match, the response to the $10 reward implied an average (maximum) gain from the match of $677 ($1,583) in the remaining months of the year and

$2,632 ($5,383) in the next year. In additional evidence consistent with present focus—at baseline, a substantial share of employees undersave and fail to take up the match, despite a stated preference to save more soon, confirmed match knowledge, and the absence of liquidity constraints.

To investigate the mechanisms underlying the present focus reflected in the experiment and the baseline decision of many employees to delay enrollment, we initially consider the economic model of present bias. Adapted from DellaVigna (2018), the model describes the decision of a utility-maximizing employee with beta-delta 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 one would need to assume an implausible degree of present bias or enrollment disutility to rationalize a delay exceeding a few days. While a well-known approach in the literature to explain lengthier delays is to assume employee naïveté (O'Donoghue and Rabin 1999b; DellaVigna 2018), our survey data on saving expectations casts doubt on this possibility—most employees expect to save more in the future, but only after a delay of weeks to months. Without invoking data on beliefs, calibrations also suggest the improbability of explaining employee response to the small reward through beta-delta preferences alone.

After reviewing similar challenges to other approaches for modeling present focus, we conclude by proposing a novel account informed by an intriguing correspondence between employee saving and financial anxiety, the exploratory friction assessed in the survey. Specifically, most employees reported substantial anxiety about their financial situation yet were optimistic about their anxiety subsiding in the intermediate (weeks to months) but not immediate (days) future. This pattern of high present anxiety and deferred optimism parallels the dynamic of low present saving and delayed intent to increase future saving. Prompted by this correspondence, and evidence on the avoidant effects of stress/ anxiety, we specify a hedonic model of present-focused savings. The model stipulates that the financial anxiety felt by undersaving employees generates a hedonic cost to engaging consequential financial decisions, such as 401(k) enrollment. Crucially, employees believe their anxiety is temporary and have well-defined (possibly over-optimistic) beliefs about their eventual transition to a low-anxiety state. The model predicts a well-informed and utility-maximizing employee, with anxiety, could delay enrollment if the expected benefit of delay (less anxious enrollment) exceeds its cost (foregone match). In this framework, a micro-incentive—which we define as an immediate, unexpected, modestly-valued incentive likely encoded and processed through the dopamine reward pathways of the brain—motivates employees not through its monetary value but by defusing the costs of anxiety and/or by reframing enrollment as an exercise in reward-seeking. In addition to neuroscientific support for this interpretation, a scenario-based experiment administered to several hundred at-risk employees suggests that the (replicated) effect of a small reward

on enrollment appears invariant to reward size and is entirely driven by the more than half of employees reporting baseline anxiety (and for whom the reward substantially increased enrollment).

Calibrations indicate the model can explain lengthy enrollment delays and employee expectations to increase saving in the intermediate future without implausible enrollment costs. Consistent with model predictions, present anxiety also negatively correlates with plan engagement and the timing of forecasted reductions in anxiety predict the timing of future intentions to save. Beyond offering a coherent account for the present findings, we describe how this framework could explain other puzzles such as the documented insensitivity of employees to increases in matching incentives, the efficacy of AE, and persistent gaps in actual and intended saving. Given the descriptive accuracy of the model hinges on the specific phenomenon of high present anxiety and expectation of deferred hedonic relief, we corroborated the hedonic patterns from the field with a new sample of employed adults—indeed, the most anxious respondents expected their hedonic situation to *worsen* before eventually improving. We believe this is the first evidence for a systematic delay in optimism in forecasts of future emotional well-being.

We see the present research as offering practical lessons for improving retirement security. To better understand how such lessons depart from the prevailing sentiments of industry and policy stakeholders, we surveyed participants of a savings policy workshop—high-ranking leadership in federal and state governments, financial service firms, and policy organizations. The survey confirmed that our findings challenge current best-practices for increasing plan engagement—personalized guidance/ education at the time of enrollment, simplification, and increases to the plan match. We note that our findings do not rule out the varied benefits of such interventions outside of plan engagement (e.g., Kaiser et al. 2022) nor do they reject the promise of financial education acting through alternative channels like persuasion, social norms, or identity. Instead, our results spotlight strategies receiving less attention, such as the use of participatory rewards, and, suggestively, reforms aimed at increasing overall benefit program transparency. With respect to the former, we see microincentives as a potentially powerful tool, largely unexplored within economics, through which to increase take-up across a range of benefit programs.

More fundamentally, our hedonic account of present focus alludes to the value of restructuring savings plans to better reflect the psychology underlying the decision to save. An example of such structural reform are the dual-account proposals that would direct initial contributions to a liquid buffer account before automatically transferring above-threshold savings into a less-liquid account. The dual-account model has been advocated in recent years by stakeholders galvanized by concerns over short-term liquidity (Beshears et al. 2015; 2020; Gruber 2016; John 2015; Mitchell and Lynne 2017). Our findings offer a psychological rationale for this type of proposal 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 emerged as the primary channel, excepting Social Security, through which US employees at for-profit establishments save for retirement. These plans, named after the sub-section of the 1978 legislation from which they originated, permit qualified employees to contribute a share of pre-tax salary via automatic deduction into a portable savings account. As of 2019, 401(k) plans comprised 82.4 percent of all employee pension plans, covering 90.7 million participants with $6.2 trillion in assets.[6] In recent years, many plans adopted two structural innovations intended to increase plan participation—matching incentives and automatic enrollment. According to a prominent industry benchmarking survey in 2020, 73 percent of all plans, and 81 percent of larger plans offered a plan match.[7] While widely varying, the modal plan match entails a dollar-for-dollar employer contribution for up to 3 percent of an employee's annual salary. A majority of plans, including 76 percent of large plans, now automatically enroll employees at a default contribution rate and investment allocation. Industry reports suggest the increasing adoption of other automatic plan features such as automatic escalation, occasional re-enrollment sweeps, and the use of target-date investment funds.

Plan Engagement. We appeal to three metrics to characterize the engagement of plan-eligible employees—the participation rate, the average participant contribution rate, and the share of full match take-up. According to the same industry survey, the average plan participation rate was 80 percent with an average participant contribution rate of 7.4 percent. A significant share of 401(k) eligible employees, however, fail to fully claim available matching incentives. According to one analysis of the universe of several thousand small-to-midsize plans administered by a large record-keeper, 73 percent of employees failed to fully take-up an available plan match (Bhargava et al. 2021). Although one might expect engagement to rise with the match generosity, several studies have documented a modest relationship between plan engagement and the presence and magnitude of the match (e.g., Papke and Poterba 1995; Choi et al. 2002; Duflo et al. 2006; see Madrian 2013 for review).

Retirement Preparedness. While much of the discourse around retirement preparedness among US employees has seemingly prioritized the expansion of plan access and increases to plan participation, recent industry surveys and academic studies suggest that a significant share of 401(k) enrollees may be insufficiently prepared for retirement. One study, conducted prior to the COVID-19 pandemic, sought to estimate the share of 401(k) enrollees at risk of retirement insecurity—i.e., a level of savings at retirement

[6] Table A1(a) of the Private Pension Plan Bulletin, 2019 Abstract Form 5500 Annual Reports, EBSA (2021), retrieved 12/2021.
[7] Statistics from the annual defined-contribution plan benchmarking survey administered by PLANSPONSOR magazine in 2020. Of the 2,097 surveyed plans, 89 percent were 401(k) plans. Larger plans refer to those with $200+m in assets.

(inclusive of Social Security) insufficient to sustain a modest standard of living without return to the workforce or means-tested benefits—through simulations using administrative records for 186k enrollees across 840 automatic-enrollment plans (Bhargava et al. 2021). While the precise share of at-risk employees depends on one's preferred assumptions, the authors suggest that, conservatively, 44 percent of current enrollees have a non-trivial risk (i.e., 25+ percent) of retirement insecurity.

2.2. 401(k) Plan at the Partner Firm

Our field partner offered its more than 40,000 benefit-eligible employees a 401(k) plan with several features representative of large 401(k) AE plans – a category roughly comprising 2,000 plans, 35 million employees, and $2.5+ trillion in assets.[8] The firm began automatically enrolling new hires in 2015 at a default rate of 4 percent and a default target date investment fund, and, in June 2015, administered an "enrollment sweep" of tenured employees contributing less than 4 percent. Increasingly common at large plans, the sweep entailed automatic enrollment of tenured employees at the default rate following a lengthy promotional campaign during which employees could opt-out (they could opt-out after the sweep as well).[9] At the time of the study, approximately 10 to 15 percent of eligible-employees at our partner firm were not participating in the plan—a rate typical of plans with automatic enrollment. Elective enrollment, or contribution adjustments, could be accomplished in a few steps via the firm's online benefit portal. Plan adjustments were processed in one to a few days and implemented the next pay-cycle.

As noted, the firm offered a plan match more generous than a typical firm. 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 for a calendar year. For those with an annual salary of less than $50k contributing below the threshold, the minimum match implied a marginal return to the next contributed dollar ranging from 100 to 367 percent over the following calendar year. Despite these matching incentives, a significant share of plan-eligible employees did not fully claim 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 costs of

[8] We arrived at these rough estimates by scaling the approximately 55 million enrollees, $4.2 trillion in assets, and 3,000 defined-contribution plans with at least 5,000 employees (Abstract of the 2019 Form 5500 Annual Reports) by the estimated 401(k) plan-share and the estimated share of large 401(k) plans with automatic enrollment.

[9] Based on conversations with industry partners and trade reports, we estimate that between a quarter and half of large firms with automatic enrollment conduct regular or one-time re-enrollment sweeps.

enrollment. While stylized, the model captures several relevant features of the enrollment decision including the central tradeoff between its immediate costs and delayed benefits. After describing the decision environment, we consider the case of a fully-informed, utility-maximizing, exponential employee before considering departures from this baseline corresponding to the frictions 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 business days. For simplicity, we restrict our attention to the decision to enroll at a 4 percent contribution rate in a plan that matches contributions up to 4 percent (as with the partner firm). We implement present focus into the framework as present bias, specifically in the form of beta-delta preferences.

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

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

where $U_t = (u_t, u_{t+1}, \ldots)$ represents the present discounted value of experienced utility associated with future periods, t, indexed in business days. $\beta\delta$ denotes the employee's discount factor between today and tomorrow, while δ denotes the discount factor between any two periods in the future ($\beta, \delta \in (0,1]$). For additional tractability, and in recognition of contribution inertia, we assume that once an employee decides to enroll, they continue to contribute at 4 percent each year until retirement at time, T, when they can redeem a lump-sum of accumulated savings. We normalize the utility of never saving to 0.

For the utility-maximizing employee, the enrollment decision reflects a comparison of the costs and benefits of enrollment. We denote the costs of enrollment by k and initially interpret such costs as the opportunity time-costs of administrative enrollment (including time to deliberate one's contribution rate).[10] We denote the benefit of enrollment, b, as the net utility gained from contributing s dollars in each period of enrollment. After normalizing constant marginal utility of consumption to 1 and setting the long-term discounting factor to offset the interest rate, $\delta = 1/(1+r)$, we can write b as: $b = \tau_0 s + \mu - \tau_R(s+\mu)$. Here, μ is the effective return on savings from the employer match, τ_0 is the tax rate today, and $\tau_R \leq \tau_0$ is the tax rate in retirement. The expression implies that motive to save is due to the financial value of the match and tax-related benefits of delayed consumption.

[10] While we interpret enrollment costs as fixed for tractability, one could instead model such costs as being randomly drawn each period from a distribution of potential costs without materially affecting model predictions so long as employees have accurate beliefs about the cost distribution and the cost distribution does not change over time.

3.2. Standard Model ($\beta = 1$)

We first consider the baseline case of an exponential discounter. A utility-maximizing employee with time-consistent (delta) preferences will enroll immediately, or never, if the discounted expected benefits from enrollment exceed its perceived disutility: $-k + \sum_{t=1}^{\infty} \delta^t b \geq 0$. Given the Taylor series expansion for $\frac{\delta}{1-\delta}$, we can rewrite the decision rule as: $k \leq \frac{\delta b}{1-\delta}$. The probability of enrollment for an exponential discounter increases in b and decreases in k.

3.3. Psychological Frictions

<u>Friction 1: Present Bias ($\beta \in (0,1)$)</u>. The first friction we consider is present focus, modeled here as present bias with beta-delta preferences. While present bias can generate delay in beneficial actions, a key insight from O'Donoghue and Rabin (1999b) is that a present-biased agent with sophistication will not delay indefinitely because they expect to be similarly tempted to delay in the future. As such we can derive the maximum potential delay, T^*, for a sophisticate by calculating the indifference point between acting today and T days in the future. To derive this bound, we note that a sophisticated employee with present bias prefers to enroll today, rather than delay T days, if: $-k + \beta\delta \frac{b}{1-\delta} \geq \beta\delta^T \left(-k + \frac{\delta b}{1-\delta}\right)$. We can rewrite the expression by approximating for $(1-\delta^T)$ as $\delta \to 1$ with $(1-\delta^T) \approx (1-\delta)T$ using a Taylor expansion, such that: $k \lesssim \frac{\beta\delta(1-\delta^T)b}{(1-\beta\delta^T)(1-\delta)} = \frac{\beta b}{1-\beta} T$. This implies that a sophisticated employee with present bias will delay no more than $T^* = k\frac{1-\beta}{\beta b}$ days. In contrast, a fully naïve employee with present-bias expects to behave as an exponential discounter in the future, and will enroll (today) if: $k \lesssim \frac{\beta b}{1-\beta}$. We assume sophistication for the remainder of section and revisit the possibility of naiveté later in the paper. For a sophisticate with present-bias, maximum enrollment delay rises in k and falls in β and b.

<u>Friction #2: Retirement Literacy ($\hat{b} < b$)</u>. The next friction we consider captures the possibility that an employee underestimates the minimum level of required saving to ensure retirement security due to a deficit in retirement literacy. This deficit could entail biases in retirement-relevant beliefs (e.g., the length of working life, the investment returns to saving) or financial illiteracy (e.g., a lack of numeracy, misunderstanding of inflation). For simplicity, we model the underestimation of how much to save as equivalent to underestimation of the benefits of saving, $\hat{b} < b$.[11] This implies that an exponential

[11] While the model treats enrollment as a binary decision to enroll at the fixed rate of 4 percent one could generalize the framework so that an employee must decide to enroll or not enroll at some personal utility-maximizing rate, s^*. If one were to further abandon the simplifying assumptions of constant marginal utility and the assumed offset between the long-run discount rate and interest rate, an employee's decision to enroll would effectively reflect the employee's belief in factors such as the rate of savings growth, the minimum costs of a secure retirement, and the timing and duration of retirement. In this generalized

discounter with deficits in literacy will enroll today if: $k \leq \frac{\delta \hat{b}}{1-\delta}$. An employee with present bias (and sophistication) will delay enrollment by no more than $T^* = k\frac{1-\beta}{\beta \hat{b}}$ days. The likelihood of enrollment for an exponential employee increases in $\hat{b}$ (equivalently, as one reduces benefit underestimation). The maximum delay for a sophisticate with present bias decreases in $\hat{b}$.

<u>Friction #3: Plan Confusion ($\hat{\mu} < \mu$)</u>. The third friction we consider captures the possibility that an eligible employee underestimates the plan match. This could reflect an underestimation of its generosity, a lack of awareness as to its existence, or an underestimation of plan eligibility. We model this friction as $\hat{\mu} < \mu$, or equivalently, $\hat{b} < b$, implying that the decision rule, maximum delay, and predictions for an employee with confusion are identical to those associated with a deficit in retirement literacy.

<u>Friction #4: Enrollment Complexity ($\tilde{k} > k$)</u>. A final friction captures the possibility that employees, due to the perceived complexity of enrollment, associate enrollment with disutility, $\tilde{k} > k$. Perceived complexity could heighten the expected enrollment costs by causing an employee to overestimate the time/effort required to enroll or by causing the employee to associate enrollment with psychological costs. This implies that an exponential employee who perceived enrollment as complex will enroll today if: $\tilde{k} \leq \frac{\delta b}{1-\delta}$. A sophisticated employee with present bias, perceiving enrollment complexity, will delay enrollment by no more than $T^* = \tilde{k}\frac{1-\beta}{\beta b}$ days. The likelihood of enrollment for the exponential employee decreases in enrollment disutility, $\tilde{k}$, while the maximum delay under perceived enrollment complexity increases in $\tilde{k}$.

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 field experiment, embedded in an online survey, to undersaving employees at a large US financial services firm.[12] We marketed the online instrument as an employer-sponsored opportunity for employees to provide confidential feedback regarding the workplace and benefit programs. The first module of the instrument featured a survey that, beyond capturing relevant background information, assessed the employee-specific incidence of each candidate friction. The second module promised employees to assess their retirement preparedness and, if necessary, provide guidance to improve their preparedness. This module implemented the field experiment by randomizing employees to

framework, we could then model deficits in retirement literacy as an underestimation of the personally-optimal saving rate, $\hat{s}^* < s^*$, or equivalently as $\hat{b}^* < b^*$, where b^* refers to the benefits of enrollment at the personally-optimal rate.

[12] The anonymized firm is a national financial services provider routinely ranked among the nation's top 150 firms by revenue.

one of several information- and/or incentive-based treatments. While the survey provided evidence as to the baseline prevalence of each friction and the field experiment provided evidence as to the average effect of reducing/engaging each friction on saving, jointly, the survey and field experiment clarify the heterogeneous importance of frictions across baseline incidence (see Figure 1 for a schematic overview).

4.2. Email Invitation and Employee Sample

On July 19, 2016, we invited a pre-specified sample of undersaving employees of low-to-moderate income by email to participate in a ten- to fifteen-minute survey marketed as an opportunity to provide confidential feedback on the workplace and employee benefit programs. The email explained that while the survey was part of a broader partnership with the firm to help improve employee well-being, it was independently designed and administered by academic researchers from Carnegie Mellon University. Employees were directed to participate in the survey, hosted on the Qualtrics platform, by clicking a personalized link within the ten-day survey period. To encourage a high response rate, survey respondents were entered into a raffle for an Apple iPad and were reminded to complete the survey via email.

The construction of the invitation sample was shaped by two considerations—a desire to target undersaving employees of low-to-moderate income and the firm's request to limit invitations to 5,000 employees. To differentiate between employees who did and did not fully claim the plan match, we ultimately invited two non-overlapping samples of undersaving employees to the survey. The primary sample (the "Low Arm") comprised the universe of 3,719 401(k) plan-eligible employees who, as of late June 2016, were 25 to 55 years of age, earned less than $100k annually and contributed less than 4 percent to their 401(k) plan (inclusive of non-participants). A second sample of 1,000 (the "Moderate Arm") comprised a random draw of plan-eligible employees who, as of late June 2016, were 25 to 55 years of age, earned less than $100k annually and contributed 4 to 9 percent to their 401(k) plan. Twenty-eight percent of invited employees participated in the study. We attribute the relatively high response rate for an email solicitation to the lottery-based incentive, email reminder, and sponsorship/promotion by the employer. After excluding those who exited the survey prematurely or were already contributing at or above their recommended rate, we randomly assigned 1,137 employees to an experimental treatment within one of two study arms (780 in the Low Arm; 357 in the Moderate Arm).[13]

Table 1 describes the demographic, financial, and savings background for the invited and respondent samples. The table offers two insights pertinent to sample representativeness and potential generalizability of the research. First, the table shows substantial sample diversity across demographic

[13] We excluded and did not assign to a treatment: 165 respondents who reported a contribution rate that either met or exceeded the recommended rate or was in excess of 9 percent and 30 respondents who dropped out of the survey prior to the treatments. Because assignment was determined by self-reported contribution rather than administrative data, 17 employees contributing at or above 4 percent were assigned to the Low Arm and 115 low-saving employees were assigned to the Moderate Arm.

categories (notably, the sample is disproportionately female, like the broader firm). With respect to income, Appendix Figure A1 indicates the resemblance of the samples to a national cross-section (drawn from the 2015 CPS) but for a modest low-to-moderate income over-representation. Second, the table (and appendix figure) convey the demographic similarity between the respondent and invited samples, suggesting limited observable selection. While both samples had low levels of plan engagement, respondents were modestly more engaged than invitees by participation (0.58 versus 0.52), average contribution rate (1.9 versus 1.7 percent) and rate of full match take-up (0.28 versus 0.24).

4.3. Survey of Candidate Frictions

The first module of the instrument was a survey intended to collect background detail and to assess the employee-specific incidence of the frictions. The survey was identical for all respondents excepting questions customized for personalization, prior response, or randomization to manage survey length.[14] The background questions captured a range of demographic (e.g., age, gender, approximate income, household status, education, tenure) and financial (e.g., accumulated savings, financial liquidity, subjective financial well-being) variables.[15] Table 3 summarizes the primary measures of incidence for each friction while Appendix Table A1 summarizes an extended set of measures.

Retirement Literacy. We characterized the first candidate friction, deficits in *retirement literacy*, using three distinct measures. Two of these measures indicated whether an employee underestimated how much to save each year to ensure retirement security (defined as a scenario in which a retiree could meet their basic needs without a return to the labor force or reliance on means-tested benefits).[16] Specifically, we generated a first, direct, measure of employee underestimation by asking employees to estimate the minimum annual contribution rate from the present until retirement that would deliver retirement security assuming no change in their employer or in the terms of the plan match. We then compared this estimate of required plan contribution to a benchmark rate generated from the retirement savings calculator, available to employees in their enrollment portal, using what we deemed to be conservative inputs (and accounting for social security benefits and the plan match).[17] Recognizing the widespread use of third-

[14] To limit survey length, we randomized employees to subsets of questions pertaining to other benefit programs, financial literacy, financial liquidity, present focus, and financial anxiety. Due to unexpectedly high response, on the fourth day of the survey, we expanded the rotation to include an additional module that we had previously excluded.

[15] Of particular note, to assess financial illiquidity, we asked respondents whether they had sufficient resources via emergency savings, borrowing, or liquid assets to accommodate three months of expenses in the event of an unexpected loss of income. The language was adapted from the Federal Reserve Board's 2015 Survey of Household Economics and Decision-making.

[16] Our definition of retirement security borrows The Elder Index, conceived by Mutchler, Li, and Xu (2016).

[17] We used the plan's savings calculator to generate recommended contribution rates intended to deliver a minimal level of sustenance during retirement. Specifically, the recommended rates assumed 20 years of retirement income for a single employee beginning at age 65 at an income replacement ratio of either 125 (current income less than $25k), 100 (current income between $25 and $55k), or 80 (current income above $55k) percent after accounting for Social Security and the plan match. We separately calculated recommendations for each income category x 5-year age bin. Informed by external data and industry projections, we

party retirement savings calculators by employees, we generated a second, indirect, measure of underestimation by asking employees to estimate the inputs common to most calculators—the expected age of retirement, the expected duration of retirement, and the income replacement ratio (i.e., the minimum income, as a share of current income, required to sustain oneself during retirement). We then used the same calculator to translate these inputs (accounting for social security benefits and the plan match) into an annual contribution rate and compared this rate against the benchmark. We interpret these indicators of underestimation as a lower-bound given the use of conservative inputs in the benchmark calculation and because we ignore the potentially substantial diminution of savings due to leakage due to loans, early withdrawal, or job transitions. Finally, prompted by the literature asserting the relationship between financial literacy and saving, we constructed a third measure of retirement literacy from two commonly-used questions on inflation and compound interest (Lusardi and Mitchell 2007).

We measured the incidence of a second candidate friction, *plan confusion*, through questions intended to assess employee awareness and/or knowledge of 401(k) plan details such as eligibility and the match. Given the potential link between perceived plan benefits and saving, we specifically sought to measure whether an employee underestimated plan benefits either by failing to recognize their eligibility or by underestimating the magnitude of the match (including a lack of awareness of its existence). To help differentiate confusion from survey inattention, we included an "attention check" to test whether the respondent carefully read each survey question.[18] Next we assessed the incidence *enrollment complexity* by asking respondents to estimate the time required to adjust their contribution rate, or to newly enroll, via the enrollment portal (inclusive of any time required to deliberate). Recognizing that, excluding deliberation, one could adjust their plan contribution in less than a minute given the simplicity of the webflow. we constructed an indicator of likely overestimation of enrollment/adjustment (i.e., more than several minutes) and an indicator for the perception of enrollment/adjustment as prohibitively time-consuming (i.e., more than a few hours). As an alternative strategy for measuring whether perceived complexity might impede saving, we asked respondents to speculate as to explanations for the success of automatic enrollment in increasing plan participation from a menu including enrollment complexity, procrastination, and low plan awareness. We then tagged employees who cited complexity as their favored explanation under the rationale that such response might reflect personally-relevant mechanisms.

Finally, we characterized the incidence of a fourth friction that has been widely discussed as an explanation for undersaving, *present focus*, with two measures. The first followed the literature in asking

assumed no accumulated savings for those under 50 and $50k otherwise, and conservatively assumed a 5 percent investment real rate of return (see Bhargava et al. 2021 for discussion). Finally, we constrained recommendations between 4 and 25 percent.

[18] The attention-check was a generic question on work-life balance instructing attentive respondents to proceed to the next page without selecting a response.

employees to make a pairwise choice between a hypothetical sooner-smaller (25 minutes) or larger-later (30, 40, 50 minutes; 1 month later) effort task, with and without a one-month front-end delay. As an alternative measure of present focus, as with enrollment complexity, we tagged employees who cited procrastination as their preferred explanation for the success of automatic enrollment.

4.4 Field Experimental Tests of Candidate Frictions

Following the survey, employees progressed to a second module that evaluated retirement preparedness based on an employee's earlier responses and administrative data and promised to facilitate any desired change in plan contribution. In practice, this module implemented the field experiment by varying the webflow encountered by employees. As depicted in Figure 1, this webflow was determined by non-random assignment to a study arm (i.e., based on self-reported contribution rate) and random assignment to a primary, and for many, a secondary, experimental treatment within a study arm. More concretely, employees reporting a contribution rate below the match threshold were assigned to the Low Arm while remaining employees were assigned to the Moderate Arm. Within each arm, employees were randomized to one of three (Low Arm) or two (Moderate Arm) primary experimental treatments after which they were given the opportunity to increase their contribution. Declining employees who had not been offered a small reward via the primary treatment were then randomized to one of two versions of a prompt asking them to reconsider their decision (other employees were assigned to a baseline version of the this prompt). Randomizations were conducted with equal probability and balancing tests indicate observationally similar subsamples across conditions (Appendix Table A1).

4.4.1 Baseline Condition – Generic Recommendation

To streamline the description of the experiment, we first describe a baseline webflow which served as one of the experimental conditions of the Moderate Arm (generic recommendation) and constituted a departure point from which we constructed the remaining treatments. The baseline webflow comprised the following four segments (see Appendix Figure A2 for associated screenshots):

- Retirement Assessment. After completing the survey module, a screen welcomed employees to the retirement assessment. Specifically, the screen conveyed that employees would now be provided an evaluation of their retirement preparedness based on prior responses and guidance to improve their preparedness. Employees then progressed to a page that prominently displayed a red-to-green gauge, resembling an odometer, with the needle resting on red. Above the graphic, text read: "You should take action now [red type] 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 [green type] your [redacted] 401(k) contribution rate."

- Saving Decision. The next screen asked respondents if they desired to increase their contribution rate and communicated that plan changes would require only seconds. Anyone indicating an

interest in changing their contribution proceeded to a screen that provided simple instructions and directed them to the firm's benefit portal via a hyperlink.[19] To encourage follow-through, employees were not allowed to proceed from this screen for one minute. Employees were then asked to confirm that they implemented the plan change.

- Saving Reconsideration. Employees who declined to change their contribution rate, or did not confirm implementation, were asked to reconsider their decision: "Are you sure you don't want to change your rate?" Those responding affirmatively were provided the instructions above.

- Saving Follow-up. Finally, we asked respondents a series of follow-up questions regarding their saving decision, intent to save in the future (specifically, the likelihood that they would increase their contribution by future horizons ranging from 1 to 12 months), and, in some instances, updated beliefs about plan features and retirement (as in the survey module, employees were randomized to some questions to limit survey length).

4.4.2. Low Saving Arm (0 to 3 percent contribution)

We randomized employees in the Low Arm to one of three primary treatments: Specific Recommendation, Match Clarification, or Small Reward. We describe each treatment by noting how it departed from the baseline webflow and indicate the friction the treatment was intended to test in brackets (see Appendix Figure A3 for screenshots of treatments across both study arms).

- Specific Recommendation [Retirement Literacy]: A first treatment adapted the baseline webflow by including a specific, personalized, recommended contribution rate: "We recommend that you increase [green type] your [redacted] 401(k) contribution rate to: <x>% [red type]". For respondents who reached the instruction screen, the recommended rate was displayed again. The treatment was designed to test whether improving retirement literacy (i.e., reducing potential underestimation of how much to save) would result in increased contributions relative to the pre-study comparison period. The treatment also served as the control for the match clarification.

- Match Clarification [Plan Confusion]: A second treatment resembled the specific recommendation condition but for the addition of another screen that clarified 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 provisions of the $2,000 match minimum. The treatment was designed to test whether increasing the perceived generosity of the plan match (i.e., reducing potential underestimation of the match) would result in increased contributions relative to the specific recommendation. (Alternatively, the clarification could have increased saving by heightening the salience of the plan match, even for employees with accurate beliefs). The treatment also served as the control for the small reward.

[19] 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."

- Small Reward [Present Focus]: A third treatment resembled the match clarification but for the introduction of a small reward—a $10 Amazon Gift Card—to encourage employees to engage their enrollment decision. The reward offer was conveyed by text above the savings prompt: "To encourage you to think about your financial future, we will email you a $10 Amazon Gift Card [green type] 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 or by contacting the researchers via a provided email address to indicate that they had considered the decision but decided against increasing their contribution. The small reward was designed to test for present focus by revealing whether employees were more responsive to a small but immediate reward relative to clarification of the far larger, but delayed, plan match.

To increase the statistical power of the test of microincentives, we independently randomized select employees who declined to increase their contribution to one of two versions of the saving reconsideration prompt—the version from the baseline webflow or an amended version which offered a small reward using the same language as described above. We restricted this second randomization to employees who had not initially been assigned to the small reward as a primary treatment (so as not to offer employees the small reward twice). Employees in the small reward condition who declined to increase their contribution were assigned to the baseline reconsideration prompt.

4.4.3. Moderate Saving Arm (4 to 9 percent contribution)

We randomized employees in the Moderate Arm to one of two primary treatments: Generic or Specific Recommendation. Once again, we describe each treatment by noting how it departed from the baseline webflow below and indicate the friction the treatment was intended to test in brackets.

- Generic Recommendation [Enrollment complexity]: The generic recommendation treatment was identical to the baseline webflow. The treatment was designed to test whether reducing perceived enrollment complexity—through generic guidance to increase one's contribution, communication that adjusting one's contribution takes a minimal amount of time, and a promise of step-by-step instructions—would result in increased contributions relative to a pre-period comparison period. The treatment also served as the control for the specific recommendation.

- Specific Recommendation [Retirement Literacy]: The specific recommendation treatment was identical to the homonymous treatment in the Low Arm. The treatment was designed to test whether improving retirement literacy (i.e., reducing potential underestimation of how much to save), would result in increased contributions relative to the generic recommendation.

Finally, as an additional test for the role of present focus in undersaving, we once again randomized employees, initially declining to increase their contribution, to one of two versions of the reconsideration prompt—the baseline version or an amended version offering the small reward.

4.5. Data and Empirical Outcomes

Our empirical analysis draws on administrative data provided by the firm linked to survey data collected directly from employees. The administrative data described employee demographics (gender, age, office zip code, income decile within the invited sample) and plan enrollment/contribution detail for each two-week pay-cycle from January through November 2016. Specifically, to gauge the experimental response of employees, we compared administrative records from the pay-cycles immediately preceding and following the study to generate three outcomes: an indicator for an increase in plan contribution (inclusive of new enrollments), the change in annual contribution rate as a percent of salary, and an indicator denoting an increase in contribution resulting in full match take-up (e.g., from 0 to 4 percent).

While we interpret employee response to several of the interventions in explicit comparison with response to a within-study control (Low Arm: match clarification, small reward; Moderate Arm: specific recommendation, small reward), for two interventions (Low Arm: specific recommendation; Moderate Arm: generic recommendation), we compare employee response to their saving during a pre-study comparison period. To avoid potential sample selection, we chose as the control period the two pay-cycles between the June identification of the experimental sample and the July launch of the study. In theory, this pre-study period constitutes a reasonable control for the experiment so long as it was not associated with an idiosyncratic shock to saving relative to other pay-cycles.[20] As a practical alternative, given the low rate of plan engagement during a typical pay-cycle including the control period, one could abandon the comparison altogether and interpret the experimental response to these two interventions as upper bounds of the associated treatment effects, effectively assuming a no-saving control.

5 EVIDENCE ON CANDIDATE FRICTIONS

We now present findings from the field study. After briefly summarizing the overall response to the survey and field experiment, we detail evidence on each friction, and synthesize key lessons with respect to the broader literature. Specifically, for each of the four frictions, we document its baseline incidence as inferred from surveyed measures, the naïve correlation between incidence and baseline saving, the average saving increase 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. To facilitate analysis and exposition, we constructed several dichotomous measures to capture employee-specific incidence for each friction. Table 2 organizes these measures by

[20] The design for these two conditions resembles the case-crossover method popularized in epidemiology. Other strategies of selecting the pre-study control include randomly selecting a period from those available or taking the average of such periods. Given consistently low plan engagement outside the experiment, the results are not sensitive to the choice of control.

friction and summarizes them for the full sample of surveyed employees and separately by two plan engagement outcomes—plan participation and full match take-up. The final two columns convey how these measures correlate with engagement by reporting p-values for tests of mean differences. We present data on an extended set of survey measures in Appendix Table A2.

Overall, more than three-quarters of employees indicated at least one friction as judged by primary measures.[21] The table reports the most pervasive friction is that of low retirement literacy, followed by a more moderate degree of plan confusion, specifically match underestimation. While nearly one-quarter of employees likely overestimated the time required to enroll, few perceived it as prohibitively time-consuming. The table is less diagnostic as to the prevalence of present focus. Several indicators were naively correlated with plan engagement in a direction consistent with the literature. The survey also alludes to the demanding financial circumstances faced by sampled employees, as 68 percent reported insufficient savings to cover emergency expenses, while 39 percent reported insufficient access to liquidity via savings, borrowing, or the sale of assets. The prevalence of illiquidity in our sample parallels the findings of contemporaneous national household surveys of financial well-being.[22]

Experimental Response. Turning to the field experiment, a non-trivial share of employees modified their contribution during the study period. During the two pay-cycle duration of the study, 10.5 percent of employees modified their contribution. Eighty-seven percent of these modifications involved contribution increases of which nearly half entailed an increase of more than one percentage point—a significant share of increases resulted in full take-up of the plan match. As a point of comparison, employees were 6.5 times more likely to increase saving during the study than the pre-study period.

We estimate employee response to the experimental treatments more formally through a series of simple regressions. Table 3 summarizes regression estimates for the primary (Panel A) and secondary (Panel B) treatments corresponding to each saving outcome of interest. For example, for each saving outcome, s_i, the first three columns of Panel A report estimates of the following model: $s_i = \gamma\, SR_i + \theta\, MC_i + \beta\, Reward_i + \varepsilon_i$, 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 interactions between the interventions, (θ - γ) captures the marginal effect of clarifying the generosity of the plan match on saving while (β - θ) captures the marginal effect of providing a small reward. For employees in the Low Arm, γ denotes the marginal effect of the specific recommendation relative to the pre-study comparison period. The final two columns of the table report

[21] Primary measures refer to direct underestimation of saving, match underestimation, perception of enrollment as prohibitively time-consuming, and present focus as implied by the effort allocation. Each employee was assessed for 3 of the 4 frictions.
[22] The 2018 National Financial Capability Survey, administered by FINRA, found that 31 percent of respondents could certainly/probably not produce $2,000 to meet an unexpected financial challenge via savings, borrowing, or selling valuables.

estimates for the relevant saving outcomes from regression models adapted to the Moderate Arm.[23] Panel B reports analogous estimates for the secondary treatments.[24] Figures 2 and 3 graphically depict the rate of contribution increase in response to each of the experimental treatments. Collectively, the estimates convey that employee within the experiment was predominantly driven by the small reward and not the provision of recommendations or clarification of the match. For those who had previously not exhausted the match (Low Arm), many of the contribution increases resulted in full match take-up.

Finally, the follow-up survey questions from the end of the second module, indicated that a majority of employees intended to save more in the foreseeable future. Specifically, 67 percent of employees, including 63 percent of plan non-participants, express they were moderately to very likely to increase their contribution within 12 months. Notably, most employees expected to do so only after some delay. That is, of employees committed to increased saving within a year, 84 percent anticipated a delay of at least 1 month, while 44 percent anticipated a delay of at least 6 months.

5.2. Low Retirement Literacy - Candidate Friction #1

Baseline Incidence and Saving Correlation. Table 2 indicates widespread deficits in retirement literacy. Nearly half of employees in the sample directly or indirectly underestimated how much they should contribute, relative to the benchmark, to ensure retirement security. In practice, the table likely understates the degree of underestimation due to the conservatism of the benchmark, ignorance of leakage, and the implicit assumption of accurate plan match knowledge. A third measure of low retirement literacy—defined as a score of zero on the two-question assessment of financial literacy—indicates a more moderate incidence than the underestimation measures, though we note that 66 percent of employees earned a score of one or less.[25] The table also corroborates assertions in the academic literature regarding the relationship between financial literacy and plan engagement, while evidence on the correlation between saving underestimation and engagement is more mixed. Indirect underestimation predicts lower participation but without statistical significance ($p = 0.27$) and negatively predicts full match take-up ($p < 0.01$) while direct underestimation does not clearly predict lower engagement.

We gain additional insight into the dynamics of literacy across the sample in Figure 4. The figure, which compares the average direct (green) and indirect (blue) beliefs of the annual required saving rate

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

[24] For employees treated with a secondary intervention, we estimate the following model 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 the small reward relative to the baseline prompt without a reward.

[25] 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). Performance on the two-question assessment in our sample of undersaving employees is somewhat lower than more representative national samples (see Hastings, Madrian, and Skimmyhorn 2013).

with the recommended benchmark rate by employee age, indicates that underestimation is primarily concentrated among employees in their 40s and 50s (consistent with the possibility that people misunderstand the effects of compounding on savings growth, e.g., Stango and Zinman 2009). If younger undersaving employees transition into older undersaving employees, the figure implies underestimation may eventually afflict an even greater employee share than reported in the table. Further decomposing the indirect bias into its component parts suggests two primary sources of systematic bias—employees exhibit over-optimism about both life expectancy and the duration of working-life relative to actuarial benchmarks and the conservative assumptions underlying the recommended benchmark (Appendix Figure A4).[26] Given the offsetting implications of these two biases, the figure implies that employee beliefs about saving may be less inaccurate than specific biases in beliefs might suggest.

Experimental Test of Low Retirement Literacy. Given evidence for low retirement literacy from the survey and the correlation between at least some literacy measures and plan engagement, we appeal to the field experiment to test whether improving the accuracy of beliefs leads to increased saving. On average, we find that employees did not substantively increase contributions in response to a specific personalized recommendation (the precision of the estimates permit us to reject anything more than a modest positive response). Specifically, as reported in Table 3, and depicted in Figures 2 and 3, employees assigned to the specific recommendation in the Low Arm did not meaningfully increase their contribution rate ($b = 0.02$, $se = 0.01$) relative to the pre-study control ($b = 0.014$, $se = 0.004$), while employees in the Moderate Arm were not differentially responsive to the specific ($b = 0.04$, $se = 0.02$) relative to the generic ($b = 0.03$, $se = 0.02$) recommendation ($p = 0.70$).

To address the reasonable possibility that employees did not respond to the provided recommendation due to inattention, skepticism as to its credibility, or other factors diminishing specific to our implementation, we tested whether assignment to the recommendation shifted employee beliefs. The results, reported in Table 4, indicate that the specific recommendation substantially increased the share of employees in the field sample whose direct estimate met or exceeded the benchmark recommendation in both the Low ($b = 0.24$, $p < 0.01$) and Moderate ($b = 0.17$, $p < 0.01$) Arms.

Differential Response by Baseline Incidence. While average employee response to the specific recommendation offers little support for a causal pathway between retirement literacy and saving, Table 5 summarizes tests of heterogeneous response across baseline incidence (the table also summarizes the

[26] The figure depicts actuarial benchmarks for age-specific life expectancy (Panel A) from the SSA's 2014 Actuarial Life Table (averaged across 5-year age bins), a benchmark retirement age of 63-years (Panel B) which reflects the median living age of recent retirees as reported in the 2017 SHED, and benchmark income replacement ratios between 70 to 85 percent (Panel C) which reflect consensus recommendations of industry experts as per a 2016 GAO Report on retirement security. See Footnote 18 for calculation detail for the recommended saving rate.

cross-sectional and experimental evidence). Consistent with the absence of an average treatment effect, the first three rows of the table suggest no discernable differences in response to the specific recommendation across employees varying in their baseline literacy.

5.3. Plan Confusion - Candidate Friction #2

Baseline Incidence and Saving Correlation. The second friction we consider is employee confusion about 401(k) plan details such as plan eligibility or the magnitude of the plan match. In theory, underestimation of eligibility or match generosity could result in an otherwise rational employee delaying enrollment. The survey indicates that while nearly all surveyed employees correctly believed themselves to be plan eligible, 30 percent had inaccurate beliefs about the match threshold (including those unaware of the existence of a match altogether). The majority of employees with inaccurate beliefs—20 percent of all surveyed employees—underestimated its generosity. This figure almost surely understates the true degree of underestimation as we did not ask about the $2,000 minimum match, a provision that effectively increased match generosity for a majority of our sample. Consistent with the possibility that underestimating the match results in undersaving, the table reveals a strong, negative, correlation between underestimation and plan engagement (of course, this correlation could reflect reverse causation).

Experimental Test of Plan Confusion. We test the causal effect of reducing plan confusion, or more specifically, reducing underestimation of the plan match, by documenting how employees in the Low Arm (who had not exhausted their match) responded to the treatment clarifying match generosity. The differential response to the match clarification and specific recommendation, reported in Table 3, indicates that clarifying the substantial benefit of the match did not lead to an increase in employee saving. The estimates are, again, sufficiently precise to reject anything more than a modest experimental response. To better understand the relationship between employee response to match clarification and the size of the unclaimed match, Figure 5 plots the average response to match clarification (grey line) across employees ordered by the estimated 12-month financial value of their unclaimed match. The value represents the gain in match dollars an employee would accrue over a calendar year if they were to increase their contribution to the 4 percent match limit and maintain full match take-up (assuming no salary change). Ignoring potential compositional differences, the figure implies that response to match clarification was not sensitive to the potential value of the unclaimed match.

Differential Response by Baseline Incidence. Finally, we examine the differential response to match clarification across baseline underestimation of the match. Table 5 reveals that employees who underestimated the plan match at baseline did not increase contributions in response to clarification, nor were they differentially more responsive to clarification than employees not prone to underestimation. Integrating evidence across the survey and field experiment, we conclude that while many employees

underestimated match generosity, and such underestimation correlates with poor saving outcomes, in this context, underestimation itself did not result in undersaving.[27]

Confusion about Plan Contribution. Our analysis revealed an unanticipated dimension of confusion beyond plan eligibility and the plan match—28 percent of respondents reported a contribution rate inconsistent with administrative records. Most of these discrepancies—24 percent of the overall sample—involved employees *overestimating* their actual plan contribution (Table 2). Strikingly, 37 percent of non-participants in our sample incorrectly reported a nonzero contribution while 26 percent of non-participants incorrectly reported full match take-up. Over-reporting one's contribution rate strongly predicted low plan participation and full match take-up (in part by construction). Table 6 provides a more detailed characterization of discrepant self-reported contributions across employee subgroups.

We see at least two plausible alternative explanations for the unexpectedly high share of discrepant reports that do not involve genuine employee confusion. A first is that the errors were due to employees who were inattentive to the survey. However, the asymmetric 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 to 10+ percent) seem inconsistent with random error in response. To bound the potential role of inattention more formally, we calculated the share of discrepancies among respondents who passed the strict attention check embedded in the survey. As reported in Table 7, this restriction only modestly reduced 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 potential explanation for the erroneous self-reports not implicating confusion is that employees may have deliberately exaggerated their contribution rate, perhaps motivated by social desirability. Once again, the distribution of discrepant reports—peaking in the lower half of the ordered menu of options—seems inconsistent with such an account. To test the potential role of exaggeration, we recalculated the rate of discrepancy after explicitly excluding employees whose response to other questions on the survey were consistent with a pattern of exaggerated response. Specifically, we identified all survey items administered to the full sample where one could reasonably infer the social desirability of the response (e.g., a higher salary is more socially desirable), tagged any employee answering with the highest available response category as an exaggerator, and then recalculated the share of discrepant reports after excluding anyone tagged as an exaggerator using each, or any, of the screens.[28] As Table 7 reports, using the most expansive characterization—exaggeration on any screen—the adjustments

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

[28] We identified five opportunities involving survey questions pertaining to salary, contribution rate, accumulated savings, education, and retirement confidence and a sixth entailing a comparison of self-reported salary and administrative records.

reduced the share of potential confusion from 0.37 to 0.21 for participation and from 0.24 to 0.14 for full match take-up. Adjusting for both exaggeration and inattention—by excluding anyone tagged as a potential exaggerator and then conditioning on passing the attention check—did not further reduce the share of discrepancies. The analysis suggests that a substantial share of employees was likely confused about their actual plan contribution rate, including roughly one-fifth to one-third of 401(k) non-participants who mistakenly believed themselves enrolled, often at a non-trivial rate of contribution.

5.4. Enrollment Complexity - Candidate Friction #3

Baseline Incidence. The third friction we consider is enrollment complexity. In theory, employees may delay saving if the expected costs of administrative enrollment, due to its perceived complexity, are sufficiently high. Table 3 reveals that 23 percent of employees likely overestimated the time required to enroll/adjust but only 11 percent perceived enrollment as sufficiently time-consuming (more than a few hours) to conceivably lead to delayed enrollment (particularly if enrollment/adjustment was associated with hassle costs extending beyond wage-based time-costs). The perception of the time required to enroll as (potentially) prohibitive moderately predicted plan participation but not full take-up of the match. And while a small share of respondents hypothesized that complexity could help to explain the efficacy of automatic enrollment, such lay beliefs did not predict plan engagement.

Experimental Test of Enrollment Complexity. For experimental evidence on perceived complexity as a barrier to saving, we compare the increase in contribution among those assigned to the generic recommendation (Moderate Arm) to the increase during the pre-study comparison period. Table 3 indicates that assignment to generic guidance did not lead to a discernable increase in saving. Moreover, Table 4 affirms, albeit with some imprecision, that exposure to the online instrument actually shifted beliefs, reducing the share of employees who perceived enrollment/adjustment as highly time-consuming.

Differential Response by Baseline Incidence. Table 5 indicates that employees who perceived enrollment as complex, by any of the three survey measures, were no more responsive to generic guidance than their counterparts. Overall, the low baseline perception of prohibitive complexity, the lack of a meaningful increase in saving in response to simplifying guidance (which successfully reduced perceptions of complexity), and the absence of such response among employees with high baseline perceptions does not support complexity as an impediment to saving. The estimates have sufficient precision to rule out complexity as a barrier to saving for any more than a nominal share of employees.

5.5. Present Focus - Candidate Friction #4

Baseline Incidence. The fourth and final friction we consider is present focus. Present focus could impede saving if employees disproportionately attended to its near-term costs relative to its delayed benefits. The first of our two measures infers present focus from preference reversals in a hypothetical

effort allocation task across time and identifies 10 percent of respondents as present-focused (Table 2). We view this measure as a likely lower bound on prevalence given the limits of the elicitation (it is non-diagnostic for the 78 percent of respondents who consistently chose the sooner-shorter task or the longer-later task). The second measure—which tagged respondents as present-focused if they attributed the efficacy of automatic enrollment to employee procrastination—suggests a prevalence of 60 percent. These (imperfect) indicators suggest a non-trivial but widely varying share of present focus that is roughly consistent with estimates from the literature, such as the 57 percent incidence among US adults documented by Xiao and Porto (2019). Contrary to the literature, we do not find a strong negative correlation between present focus and plan engagement.

Experimental Test of Present Focus. We turn to the field experiment for direct evidence as to the causal importance of present focus. Our central test involves examining the saving response of employees to the provision of the $10 reward. For employees in the Low Arm, we can also compare response to the small reward with response to clarification of the much larger, but delayed, plan match. While the reward entails the immediate receipt of $10, the clarification informs employees of a potential median (maximum) annual increase in the present value of savings equivalent to $2,000 ($3,800) for a single calendar year, or $77 ($146) per pay period. Table 3 indicates that 8 to 16 percent of employees increased their contribution following exposure to the small reward across implementations (all, $p < 0.01$). Overall, among employees offered a small reward, 11.8 percent increased their contribution. Among those who had not yet exhausted the plan match, one third to half of the increased contributions resulted in full match take-up. The large share of multiple percentage point increases in the contribution rate and the persistence of such changes until the pay-cycle following the survey (when we measure experimental response from administrative records) persuade us that response did not reflect a strategic intent of employees to temporarily increase contributions so as to claim the reward. Over the four months after the study for which we have data, we observe no systematic reversal in contribution increases. We can additionally contrast the response of employees to the microincentive with their modest response to the clarification of the match. Appealing again to Figure 5, employees were substantially more responsive to the small reward than the match across match values ranging from approximately $500 to $3500.

Differential Response by Baseline Incidence. The differential response of employees to the small reward across baseline measures of present focus offers additional evidence as to the importance of present focus. While imprecise, Table 5 suggests that employees indicated as present-focused by the effort-allocation measure were 3.5 times more responsive to the reward than counterparts ($p = 0.17$) and twice as responsive to the reward by the introspection measure ($p < 0.10$). Unreported in the table, there were no significant differences in responsiveness to match clarification across the same groups.

5.6. Synthesis of Evidence across Candidate Frictions

We interpret the evidence from the survey and field experiment, summarized in Table 5, as offering five new insights into the potential barriers to employee saving in 401(k) plans. An initial insight is that our analysis does not substantiate *low retirement literacy* as a cause of undersaving. As in the literature, we find widespread deficits in retirement literacy, whether indicated by under-estimation of required saving or assessments of financial literacy and find that at least some of these measures cross-sectionally predict plan engagement. However, precise experimental estimates indicate personalized guidance does not meaningfully increase saving, even among those with low baseline literacy. While one cannot always interpret experimental non-response as diagnostic, unlike most disclosure paradigms, we observe non-response in a setting with high compliance (e.g., few employees dropped out of the webflow, the recommendation was repeated on multiple pages of which one included a time-delay to deter reflexive click through) and confirmation that the recommendation substantially improved belief accuracy.

Why might improving the accuracy of retirement-relevant beliefs not lead employees to save more? In theory, a utility-maximizing employee with well-calibrated beliefs might rationally delay enrollment, despite a generous plan match, due to the excessive costs of financial illiquidity. We are skeptical, however, that non-response in this setting can be attributed to liquidity constraints for two reasons: the return to a marginal dollar of contribution for most employees equaled or exceeded 100 percent (implying the need for exceedingly high cost of capital to justify delayed enrollment, particularly given the availability of plan loans and hardship provisions) and we find no difference in response to the recommendation across employees across survey measures of financial illiquidity.

Figure 4 offers a potential explanation for why low retirement literacy may not contribute to undersaving. In addition to comparing average employee estimates of required saving against the saving benchmark, the figure compares these estimates to the average (perceived) actual saving rate. The comparison shows that while many employees, particularly those beginning to save later in working life, underestimate how much they should save, such underestimation does little to explain the gap between (perceived) actual and benchmark saving. A decomposition of mean differences indicates that replacing the benchmark rate with an employee's direct beliefs about how much to save does not meaningfully reduce the 9.7 percentage point saving gap while variation in beliefs about how much to save does little to explain variation in undersaving.[29] Even among the eldest quartile, where direct underestimation is most severe, underestimation explains less than one-quarter of the average saving gap. Ultimately, despite widespread underestimation of how much to save, 88 percent of employees (including most plan

[29] A bivariate regression of benchmark and perceived actual saving yields an adjusted R-squared of -0.007. Including employee beliefs as to how much to save (either direct, indirect, or both) does not increase the explanatory power of the linear model.

participants) recognized they are undersaving, often by a substantial amount. Among those in the Low Arm who did not increase saving in the study, only 5.6 percent perceived themselves as adequately preparing for retirement. A closer inspection of indirect beliefs suggests another potential explanation for why large biases in specific beliefs may overstate the overall import of retirement literacy—two biases (over-optimism about life and working-life longevity) have offsetting implications for saving.

A second insight is that we find no evidence that *confusion* about 401(k) plan details causes undersaving. While we provide novel evidence as to the non-trivial share of employees who underestimate the generosity of the match and find that such underestimation strongly predicts lower plan engagement in the cross-section, experimentally clarifying the value of the match does not result in increased saving on average or differentially across employees varying in baseline match underestimation (we also find no effect of match clarification among those not constrained by financial illiquidity). Our results are precise enough to rule out plan confusion serving as anything more than a modest barrier to saving. These findings imply that the puzzling insensitivity of employee saving to variation in the plan match, typically inferred in the literature from cross-plan analyses (see Madrian 2013), cannot be solely attributed to widespread employee confusion about the match, despite the presence of such confusion.

A third insight highlights a potentially important determinant of low plan engagement largely absent from the academic literature—a striking degree of employee confusion regarding enrollment status. Specifically, we find that 37 percent of non-participants mistakenly reported themselves as plan participants, often at contribution rates that would imply full match take-up (an error in perceived annual savings equivalent to 8 percent of salary). After attempting to rule out alternative explanations involving inattention or deliberate exaggeration, we conclude that most discrepant reports reflect genuine confusion. Two additional patterns support this interpretation. First, the modal reported contribution rate among discrepant reports was 4 percent—the widely marketed default contribution rate for new hires. The popularity of this rate suggests that employees may have been confused as to whether they had previously rejected automatic enrollment or had been enrolled as the result of an automatic enrollment sweep of existing employees, now popular among large 401(k) plans. Second, as reported in Table 5, employees overestimating their contribution and randomly assigned to the reward condition were more than three times as likely to increase their contribution, consistent with the possibility genuinely confused employees increased their contribution upon discovering their actual contribution rate.[30]

To explore the plausibility of widespread confusion outside of our partner firm, we surveyed 500 US adults (25 to 55 years of age, partially- or fully- employed at a firm with a 401(k) or 403(b) and

[30] The nearest analogue in the literature to this finding is perhaps the work of Dushi and Honig (2015) who found discrepancies between self-reported and administrative records of savings among elderly respondents of the Health and Retirement Study.

automatic enrollment) in August 2022 (Amazon Mechanical Turk). The survey revealed that 23 percent of respondents lacked certainty about their enrollment status (on a 1 to 10 scale) and, among self-reported enrollees, 41 percent were not certain of their contribution rate. Given the financial stakes of enrollment in a plan with a sizable match, a non-trivial degree of employee confusion may seem incredible. Consider, however, that new hires at our partner firm were asked to make enrollment decisions for up to twelve benefit programs with varying rules governing eligibility and default enrollment—retirement savings, life insurance, commuting benefits, short and long-term disability insurance, personal accident insurance, medical and prescription health plans, dental insurance, vision care coverage, health savings account, and a wellness program. In the context of the broader complexity of the benefit program landscape at most firms, confusion regarding specific program enrollment seems more plausible.

A fourth insight is to reject administrative complexity of enrollment as a major impediment to saving. While we estimate that about one-quarter of employees in our sample overestimated the time-costs of administrative enrollment, only a small share of employees perceived enrollment as time-consuming enough to conceivably affect the decision to save. We find that while the baseline webflow reduced perceptions of time-indexed complexity, it did not increase contributions, even among those originally perceiving enrollment as particularly time-consuming (or among those free of illiquidity). Even assuming psychological, or hassle, costs of enrollment extending beyond wage-based time-costs, it is difficult to reconcile our precise estimates of a non-effect with the possibility that complexity meaningfully deters saving at this firm. This finding is perhaps less surprising given the widespread adoption of digital enrollment interfaces by 401(k) plans, such as our partner firm, in recent years.

Centrally, the survey and field study provide perhaps the most direct causal evidence of present focus on 401(k) saving. While the survey suggests non-trivial prevalence of present focus, the experiment reveals the responsiveness of 8 to 16 percent of employees to the immediate small reward but not clarification of the substantially larger, but delayed, match. Those indicated as present-focused by baseline measures were 2 to 3.5 times more likely to respond to the small reward. Even employees previously underestimating the match, for whom clarification should have provided novel information, exhibited this pattern. Given many employees increased their contributions by more than one percentage point and increases persisted months after the study diminishes the likelihood of strategic gaming. The willingness of many low-saving employees to increase contributions in response to a small reward contrasts with their documented insensitivity to other widely-discussed interventions such as increases in the match (Madrian 2013) or the provision of saving recommendations studied here.

Beyond the differential response to experimental treatments, our administrative and survey data provide evidence implicating widespread present focus via another pattern—the baseline savings of

employees. Specifically, while low savings in the context of a generous match has been previously documented, we document such saving patterns among a sample of employees with a stated preference to save more within the subsequent year (67 percent), no underestimation of the plan match (80 percent of the sample), and the absence of emergency liquidity constraints (61 percent of the sample). This implies a substantial share of employees delayed saving despite a preference to save and a recognition that such delay entailed the permanent loss of a substantial plan match.

6 INVESTIGATING MECHANISMS UNDERLYING PRESENT FOCUS

In this section, we investigate potential explanations for the present-focused behavior of employees as indicated by the experiment and the baseline enrollment delay of employees with confirmed intentions to save and confirmed knowledge of the match. We initially consider a model of present bias, the predominant approach for explaining present focus within economics, and then briefly discussing the plausibility of other theoretical frameworks from the literature. We conclude by advancing a novel account of present focus—and provide suggestive evidence in support of this account—that offers a potential explanation for the findings in this setting and perhaps empirical savings puzzles more broadly.

6.1. Present Bias – Baseline Enrollment Delay

We begin by assessing whether present bias can account for the observed delay in baseline enrollment via a series of calibrations. Specifically, we calibrate the previously introduced beta-delta model of enrollment under varying assumptions about enrollment costs. We restrict our consideration to the modelled scenario in which a non-participating employee must decide whether or not to delay enrollment at a contribution rate of 4 percent, the plan's match limit. We further treat each period as a business day, assume 250 business days in a calendar year, stipulate an employee can make only one enrollment decision each period, and assume matching benefits accrue every period (later, we consider the more realistic scenario where plan changes are processed at the end of the pay-cycle). Without loss of generality, we consider the case of a 35-year-old employee earning $50,000 annually ($200/ day) subject to the same effective marginal tax rate now and in retirement, $\tau_0 = \tau_R = 0.25$. We assume a relatively aggressive annual discount factor of $\delta^{250} = 0.93$, implying a daily discount factor of δ = 0.9997.

<u>Standard Model</u>. We first consider the reference case of an exponential discounter. Recall that an employee governed by exponential discounting decides whether to enroll now, or never, by comparing the present value of expected future plan benefits (derived from the match), *b*, against enrollment costs, k: $k \leq \frac{\delta b}{1-\delta}$. The decision rule dictates that our representative employee, for whom *b* equals 6 dollars each day (i.e., [0.04 * 200 * (1-0.25)]), should enroll so long as the value of enrollment disutility does not exceed $19,994, roughly 40 percent of pre-tax income. If *k* simply reflects the opportunity time-cost of

administrative enrollment, then the employee's hourly wage (roughly $25/hour) and our finding that most employees perceived enrollment as requiring a few minutes to a few hours implies that an exponential discounter would immediately enroll. If instead the employee 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) who estimates the disutility associated with itemizing deductions on federal tax filings, another presumably aversive financial task, as equivalent to roughly four times the wage-based time-cost of itemization. Assuming enrollment requires 30 minutes, the hassle factor implies wage-based enrollment disutility of $k = 50$ (i.e., 0.5 hours x $25/hour x 4 hassle factor), while assuming enrollment/deliberation of 2 hours implies $k = 200$. For enrollment disutility of this magnitude, the decision rule would continue to predict immediate enrollment.

Present Bias with Sophistication. We now consider the enrollment decision of an otherwise identical employee with present-biased preferences ($\beta < 1$). Recall that for a present-biased employee with sophistication ($\hat{\beta} = \beta$), the maximum enrollment delay, T^*, is given by: $T^* = k\frac{1-\beta}{\beta b}$. Assuming the disutility of enrollment is limited to 30 minutes to 2 hours of wage-based time-costs (i.e., $k \in [12.5, 50]$), the expression implies that for the model to rationalize an enrollment delay of a single two-week pay-cycle (i.e., ten business days), 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 implies a degree of present bias further removed from the typical range, $\beta \in [0.09, 0.29]$. Reintroducing hassle costs of the previous form, (i.e., $k \in [50, 200]$), implies $\beta \in [0.45, 0.77]$ for a delay of a single pay-cycle and $\beta \in [0.29, 0.63]$ for a delay of two pay-cycles.

Figure 6 plots the values of beta required to rationalize enrollment delays for a sophisticated employee of varying durations from a single business day to a full year assuming enrollment costs, *k*, equal to either $12.5 (solid line), $50 (long-dashed line), or $200 (short-dashed line). For reference, the red line demarcates the enrollment delay associated with $\beta = 0.7$, a substantial but arguably plausible degree of present bias. The figure suggests that this degree of present bias could rationalize an enrollment delay of roughly 1 to 3 business days assuming no hassle costs (i.e., $k \in [12.5, 50]$) and 3 to 14 days otherwise (i.e., $k \in [50, 200]$). A beta of 0.9, and hassle costs, implies a delay of no more than four days. Given most baseline non-participants neglected to enroll for months prior to the study despite confirmed knowledge of the match, the figure highlights the challenge of explaining delayed enrollment with a model of sophisticated present bias, even allowing for psychologically aversive enrollment.

Naïveté and Employee Beliefs. In theory, present bias might result in a lengthy enrollment delay even in the context of a sizable 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 reconcile lengthy 401(k) enrollment delays within the beta-delta framework (e.g., DellaVigna 2018). Our field study permits us to directly test the assumption of naiveté by inspecting employee beliefs about the timing of future saving. Figure 6 displays the cumulative distribution of beliefs about future 401(k) enrollment for plan non-participants. The figure reports the earliest time-horizon by which non-participants indicate being either moderately or very likely to enroll. The plot shows the large majority of non-participants intended to enroll within a year, 91 percent of such employees anticipated a delay of at least one month and 60 percent anticipated a delay of at least six months. Overall, the self-reported beliefs of employees are not consistent with explaining observed delays in baseline enrollment through beta-delta preferences even with naiveté.

Discrete Enrollment Choice. As a practical matter, it is worth noting that this plan, like most plans, administratively processes plan changes no earlier than the beginning of the subsequent (in this case, two week) pay-cycle. Consequently, at some point during the pay-cycle, a delay of even a single period, or one business day, would effectively result in 10 additional periods of foregone matching incentives. At these terminal periods in each pay-cycle, our model implies that a sophisticated present-biased employee with $\beta = 0.9$ would enroll immediately for any level of disutility within our considered range, $k \in [12.5, 200]$, while an employee with $\beta = 0.7$ would delay one pay-cycle only if $k > 140$.[31]

6.2. Present Bias – Experimental Response to Microincentive

The response of a non-trivial share of employees to the microincentive offers a more direct test of present bias that does not rely on data on employee beliefs. Assuming the benefits of the match accrue in every period, the beta-delta framework implies that for a present-biased employee to enroll immediately in the presence of a $10 reward, but not otherwise, despite confirmed knowledge of the plan match, the employee must associate enrollment with disutility falling within a modest, but narrow, range of $10 and (naively) believe that they would enroll in the very near future. For example, the calibrations suggest that an employee with $\beta = 0.7$ who enrolls in response to the reward, but not otherwise, associates enrollment with disutility $k \in [14, 24]$, and would delay enrollment in the absence of a reward by no more than 1.7 days. Reward-induced enrollment for an employee with $\beta = 0.9$ implies enrollment disutility, $k \in [54, 64]$, and a delay of enrollment, in the absence of the reward, of no more than a single day. Finally, in the case where enrollment/adjustments are processed at the end of the pay-cycle, the beta-delta model implies

[31] The model predicts that the maximum enrollment delay should be inversely related to an employee's annual salary, all else equal. This implies that many employees with salaries exceeding $50,000 should have been unwilling to delay even with $\beta = 0.7$.

that an employee enrolling in the terminal period in response to the reward, but not otherwise, must perceive enrollment disutility as both high and within a range of arguably implausible specificity ($k \in$ [140, 150] for β = 0.7 and $k \in$ [540, 550] for β = 0.9).

6.3. Alternative Theories of Present Focus

Are there alternative models of present focus that could more accurately account for the documented behavior and stated beliefs of employees? Researchers across several disciplines have advanced models of intertemporal decision-making in which individuals disproportionately privilege immediate over delayed outcomes. We briefly comment on the potential of these models for explaining the present findings. To orient the discussion, we note that a practical difficulty for any explanation is that it must jointly explain the propensity of many employees to significantly delay enrollment, despite confirmed knowledge of a lucrative match, the stated intent to enroll in the intermediate (months), but not immediate (days to weeks), future, as well as the willingness to enroll in response to a small reward.

Economists have advanced several alternatives to the standard beta-delta framework to explain differential impatience in the near-term (see Frederick, Loewenstein, and O'Donoghue 2002 or Ericson and Laibson 2019 for reviews). As with present bias, many of these models interpret present focus as arising from non-standard preferences. These preferences reflect context-specific discount rates based on affect (e.g., Vallacher 1993; Loewenstein 1996) or income (Banerjee and Mullainathan 2010) or emerge from the strategic interaction of distinct decision-making systems (e.g., Shefrin and Thaler 1988; Fudenberg and Levine 2006). Other models adapt the beta-delta framework by introducing some fixed initial decision-cost (Benhabib et al. 2010). While these models, under arguably reasonable assumptions, could predict modest delays in enrollment or response to a microincentive, it is not obvious how preference-based approaches could explain sustained delays in enrollment and/or the stated intent of employees to save in the intermediate, but not immediate, future without substantive additional structure (e.g., stochastic enrollment costs and systematic optimism about the evolution of such costs).[32]

Researchers have also proposed mechanisms to explain present focus without involving preferences (Urminsky and Zauberman 2015). Such mechanisms include emotion (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 the present and future self (e.g., Parfit 1984; Bartels and Urminsky

[32] For instance, employees who discount retirement dollars more severely than other dollars due to affective associations might be less sensitive to matching incentives than the standard model predicts. However, a high retirement-specific discount rate, in an otherwise standard framework, cannot readily explain baseline delays in enrollment. For example, an annual (daily) retirement discount factor of δ=0.50 (δ=0.9972), implies immediate enrollment in our calibration for k < \$2,137. As another example, models of present bias with high initial decision-costs could explain modest delays but not response to the small reward.

2015), systematic expectations of greater future resource flexibility (Zauberman and Lynch 2005), or planning failures (Lynch et al. 2010). While these approaches offer compelling accounts for specific findings in the present research (insensitivity to the large, but delayed, match), it is unclear how each framework can explain the broader pattern of results without additional assumptions.

6.4. Hedonic Account of Present Focus – The Serenity Model

Motivating Evidence. Drawing on several strands of existing research, we advance an alternative model of present focus that offers a potentially unifying explanation for the present findings. The model builds on a promising empirical correspondence between employee saving and an exploratory measure from the survey involving financial well-being. The survey revealed the prevalence of high financial anxiety among employees in the sample coupled with substantial optimism about their hedonic future. Critically, this optimism was exhibited over the intermediate (i.e., weeks to months) rather than immediate (i.e., days to weeks) horizon. Specifically, 93 percent of the 575 respondents assigned to the exploratory module reported at least a little anxiety about their finances (2+ on a 4-point scale), while 56 percent reported either a fair amount or a lot of anxiety (3+). When asked to forecast whether they would feel more, less, or the same amount of financial anxiety in randomly assigned horizons of either three or six months, the survey indicated pessimism in the near-term but increasing optimism over the longer horizon. Of note, among those reporting high anxiety in the present, 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. The combination of high present anxiety and an anticipated reduction in future anxiety, but only after some delay, parallels the dynamic of present and intended future employee saving.

We sought to corroborate the pattern of present anxiety and deferred optimism through a larger, national, survey of US employees with more granular time-horizons, within-subject elicitations, and a different time-period. We administered this supplementary online survey to 905 US full- and part-time employees via Amazon Mechanical Turk in November 2019.[33] 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 ranging from one month to one year.[34] Figure 7 describes the survey results. The first panel summarizes the incidence of present financial anxiety while the second panel describes the average forecasted change in future anxiety (on a scale of -1 (decrease), 0 (no

[33] The sample was restricted to US employees aged 25 to 55 years. The sample reflected greater gender and geographic balance than the field sample but was otherwise similar in age and imputed income. Summary statistics: (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).

[34] All subjects were asked to forecast the relative change in their anxiety in one month and one year. Randomly selected subjects were asked to provide additional forecasts for three and/or six months. Because respondents were asked to generate forecasts over a random subset of future horizons, comparisons across some horizons reflect compositional differences across samples.

change), or +1 (increase)) for the entire sample and separately for subgroups varying in present anxiety. The survey revealed a high share of anxiety in the present—42 percent of respondents reported one of the two highest categories of anxiety from a five-point scale—and considerable optimism regarding hedonic prospects in the intermediate (between 3 months and one year) but not immediate (within 3 months) future. Nearly half of respondents anticipated reduced anxiety in one year, despite only 15 percent anticipating relief in one month. Said differently, (high anxiety) respondents were 3.8 (7.4) times more likely to believe their anxiety would decline rather than increase in one year as compared to one month.

Overall, the field study and supplemental survey convey a systematic pattern of high present anxiety and deferred optimism regarding future anxiety across a diverse sample of working adults at different points in time. A significant share of those with severe present financial anxiety seem to expect their situations to worsen before eventually improving. While the prevalence of anxiety has been documented in national surveys of financial well-being, and prior research has asserted a cognitive bias towards optimism (e.g., Sharot 2011), to our knowledge, these findings offer the first evidence asserting the phenomenon of systematically deferred optimism about future anxiety (we do not distinguish between optimism and over-optimism, though the persistence of patterns across samples/time suggests the latter).

Model Overview. 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 deferred 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 anxious employees have noisy but well-defined beliefs as to when they will transition from high to low anxiety (here, we model the transition as 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 the trajectory of future anxiety. If presently anxious employees are sufficiently optimistic about the future, they may rationally decide to delay enrollment until they expect it to be less hedonically costly.

The general phenomenon of anxiety (or stress)—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

might influence behavior, such as 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 (e.g., Hartley and Phelps 2012). According to an animal study asserting a direct neural pathway between 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). While the relationship between general anxiety and personal financial anxiety has been less scrutinized, some have argued the latter should be treated as a distinct and measurable construct also associated with avoidance (Shapiro and Burchell 2012). As an empirical example of anxiety-avoidance in a financial context, Choi and Robertson (2020) found that 37 percent of US adults not participating in the stock market cited "don't like to think about my finances" as very/extremely important for explaining non-participation. Our own analysis of data from the National Financial Capability Study (NFCS) indicates only a modest correlation between the constructs of financial anxiety and financial illiquidity or financial literacy.[35]

Model Setup. We now introduce the proposed hedonic model of present-focused saving more formally. To facilitate comparison with the beta-delta framework, we adopt the same simplifying assumptions, stylized decision structure, and parameter definitions. That is, we consider the decision of an employee to delay enrollment at a four percent contribution rate in a 401(k) plan with an annual pre-tax, dollar-for-dollar, match up to four percent of salary (as earlier, b denotes the post-tax per-period utility associated with the match). We once again assume $\delta = 1/(1+r)$ and normalize the constant marginal utility of consumption, now and in retirement, to 1. The innovation in the model is the inclusion, in the employee's otherwise standard utility function, of a parameter, θ_t, representing 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 all employees are initially in a state of high anxiety and that a stochastic process governs whether an 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, so that $f(\theta^L) < f(\theta^H)$. Intuitively, one can think of $f(\theta)$ as replacing the earlier cost parameter, k.

If the transition from a high to low anxiety state follows a geometric hazard function, 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 for this transition, where λ

[35] Financial anxiety does 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), based on analysis of the NFCS state data extract, retrieved July 2020.

denotes the per-period transition rate conditional on having not previously transitioned. For example, if the likelihood of transition due to a favorable shock to 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. In light of the uncertainty introduced by the stochastic transition process, we also 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. The construction allows for the non-linear influence of anxiety on behavior, uncertainty about 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 stylized, we speculate that it may 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. For an employee governed by the model, we can characterize the decision to enroll now (*s=1*) or delay enrollment (s=0) as emerging from a comparison of the present-discounted expected costs and benefits of delay. The first of these objects refers to the discounted value of the expected foregone plan match while the second refers to the discounted expected cost-savings associated with less anxious enrollment. After normalizing the utility of never saving to 0, a risk-neutral employee would therefore enroll now under the following condition:

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

An employee choosing to delay enrollment would expect to enroll in $\hat{t}_s$ days (or potentially never in the unlikely event that one did not expect relief from anxiety until sometime close to, or after, retirement). For additional tractability, we can assume δ=1 and normalize the discounted cost of enrolling later, in a state of low anxiety, to zero so that $f(\theta^H)$ reflects the *difference* in the expected cost of enrollment across states. The simplified decision rule stipulates that our employee should enroll now if the expected value of the foregone match exceeds the expected savings from delayed enrollment, $f(\theta^H) < \hat{t}_s b$.

Figure 8 provides graphical intuition for this decision rule. The first panel shows that a risk-neutral employee with well-calibrated beliefs would delay enrollment if they expected relief from anxiety prior to t^*, the point at which the expected accumulated foregone benefits of enrollment, bt, began to exceed the expected cost 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 the ease with which one could amend the model to accommodate the presence of other frictions, such as low retirement literacy or plan confusion, leading to benefit underestimation, $\hat{b} < b$. All else equal, such bias would flatten the expected cost of delay curve, y',

leading to a higher likelihood of delay and longer expected delays. And while the baseline version of the model does not presume an explicit error in hedonic forecasts, one could incorporate an optimism bias by assuming $\hat{t}_s < t_s$, resulting in a higher share of delayed enrollment. If employees were persistently over-optimistic, and naïve to this bias, the model could help explain sustained periods of non-participation.

Microincentives and Enrollment. One implication of the model is that a participatory incentive could influence behavior far beyond that predicted by its monetary value based on its structure or framing (e.g., if it were to affect $f(\theta^H)$ rather than b). For greater clarity into the nature of such incentives, we appeal to research on the neuroanatomy of motivated decision-making. A feature common to many theoretical models emerging from evidence on functional neuroanatomy is the supposition of distinct neural systems to engage cognitive and emotion/motivational processes, the latter routinely associated with both stress and rewards (routinely defined as appetitive stimuli, such as food, drugs, sex, or monetary incentives, that promote approach behavior). For example, a study on the neural bases of choice involving either immediate or delayed incentives found that the former—paid out with Amazon gift cards, as in the present research—activated regions of the limbic system typically associated with regulating emotion and anxiety, whereas delayed incentives engaged the lateral prefrontal cortex and posterior parietal cortex, regions associated with deliberation and cognitive control (McClure et al. 2004). The shared neural circuitry, even extending to shared populations of neurons, implicated by acute stress and reward has been widely posited by animal and human studies—as such, research has found that rewards offset the physiological and behavioral response to acute stress (Ulrich-Lai et al. 2010) while others have found acute stress increases reward sensitivity (Ironside et al. 2018). Based on this research, we speculate that microincentives—which we define as modestly-valued, immediate, and unexpected financial incentives (i.e., likely to engage the dopaminergic pathways of the brain)—could be leveraged to engage those who would otherwise avoid financial decisions due to stress by either defusing (or reducing the costs of) stress or by compelling action because of stress-induced increases in reward sensitivity.[36]

We sought to confirm our hypotheses regarding the influence of rewards—i.e., their presence would elicit a discrete behavioral response and such response would be particularly pronounced for those afflicted with high anxiety—through a scenario-based experiment involving hypothetical enrollment. Specifically, we recruited a sample of 568 employees from Amazon Mechanical Turk (2022), self-identifying as "not on track" for retirement. We asked them to make a hypothetical enrollment decision as if they were a new employee (with a $50,000 annual salary) eligible for a 401(k) plan with a 4 percent

[36] Our definition implies microincentives are too small to meaningfully relieve financial illiquidity or produce an income effect. One might also specify that microincentives should be acontextual in the sense of not being tied to a specific program context (e.g., a ten-dollar reduction in one's insurance premium for enrolling in a wellness program would not qualify by this definition).

match. To make economic costs explicit, we specified that employees could only enroll once a year, on the anniversary of their hiring, such that delay would result in a minimum foregone match of $2,000.[37] We then randomized participants so they were presented with either no enrollment incentive (baseline) or a hypothetical Amazon gift card of $10, $25, or $50 to encourage immediate enrollment. The study corroborated the pattern of incomplete plan participation despite match generosity (0.77 baseline enrollment) and the positive effect of the $10 gift card on enrollment (+0.09 relative to baseline, equivalent to 38 percent of baseline non-participants, $p = 0.05$). Consistent with our hypothesis, the study revealed no significant difference in response across reward size, and more critically, that reward response was entirely driven by the 64 percent of employees reporting (moderate/high) financial anxiety (response was nearly equal across self-reported illiquidity).[38] Among anxious employees, the $10 reward increased enrollment share, relative to baseline, by 0.14 ($p = 0.01$), equivalent to an estimated 56 percent of baseline non-enrollees. Those without anxiety were unaffected by the $10 reward ($b = -0.01$, $p = 0.87$).

Model Predictions. The model generates two empirical predictions testable with field data. First, the model predicts a negative correlation between present financial anxiety and saving (or equivalently, plan engagement).[39] Second, the model predicts that among presently anxious employees, beliefs about the timing of future anxiety should correspond to expectations regarding the timing of future saving.

6.5. Evidence for The Serenity Model

Model Calibration. We evaluate the proposed model by first examining whether it can plausibly describe the decisions and beliefs of employees in the field via a series of calibrations. To facilitate comparison with the beta-delta model, we consider the same representative employee earning $50,000 facing the decision to enroll in the 401(k) plan at a four percent contribution rate (i.e., full match take-up). We adopt the previously specified assumptions regarding marginal tax rates, constant marginal utility, the equivalence of long-term discounting and the interest rate, and normalization of enrollment costs under low anxiety to zero. The second panel of Figure 8 displays the results of the calibration and compares it with those of the beta-delta model. The panel plots the enrollment disutility, measured in dollars, (y-axis) required to rationalize delayed enrollment, indexed in business days, of up to a year (x-axis) in the Serenity Model (solid line) and the beta-delta model assuming a beta of 0.7 (long-dashed line) and 0.9

[37] Our confidence in the usefulness of the paradigm draws from contemporaneous research showing a strong correspondence between the hypothetical enrollment decisions of experimental subjects and the actual enrollment decisions of employees across several hundred 401(k) plans (Bhargava et al. 2021). In the present study, employees were given the option to enroll now, delay enrollment and probably enroll in one year, or delay enrollment and probably not enroll in one year.

[38] While we hypothesized participant response would not be highly sensitive to reward size, one could interpret moderation by reward size as consistent with research on the behavioral effect of rewards. However, the absence of such moderation poses a challenge to models that interchangeably treats rewards and other financial incentives.

[39] While the model allows for only two states of anxiety and presumes that everyone begins in a state of high anxiety, one could amend the model to accommodate varying levels of initial anxiety by adopting a continuous anxiety measure.

(short-dashed line). Overall, the figure conveys that the Serenity Model can rationalize enrollment delays of the length typically forecasted by employees with significantly lower enrollment disutility than beta-delta preferences. For example, an intended delay of three to six months (63 to 125 business days) in the beta-delta model, with a beta of 0.9, implies enrollment disutility of $3,402 to $6,750, compared to the $378 to $750 implied by the Serenity Model. Incorporating even modest match underestimation, or over-optimism about future anxiety, would further reduce these implied costs under the proposed model.

Evidence on Model Predictions. Next, we test the two empirical predictions of the model using data from the field. Figure 9 documents the correlation between self-reported measures of employee financial anxiety and two measures of 401(k) plan engagement—plan participation (left axis) and full match take-up (right axis) (Panel A). Consistent with model predictions, the panel indicates a positive correlation between present anxiety and engagement. Specifically, 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 describes the positive correspondence between the timing of forecasted reductions in anxiety and saving intentions. The figure separately plots the share of employees intending to increase their saving at each of several future time-horizons, ranging from one month to one year, for employees who anticipated anxiety relief within 3 to 6 months and those that did not. The figure shows that employees expecting relief from anxiety in three to six months were only nominally more likely to express an intent to increase saving in one month or one year, compared to less optimistic employees, but were 44 percent more likely to express an intent to increase saving in six months ($p < 0.01$). Regression analyses confirm the graphical intuition conveyed by the figure—present anxiety negatively predicts current plan engagement while the expected timing of future relief from anxiety predicts the expected timing of future saving.[40]

Empirical Saving Puzzles. Beyond providing a reasonable explanation for baseline enrollment delay in the presence of a substantial match and delayed future intentions to save, we speculate that the Serenity Model could help to explain other empirical puzzles from the literature, including those motivating this research. As one policy-relevant example, the model offers an explanation for the widely documented insensitivity of employees to increases in the generosity of the match. Consider, for example, a plan contemplating an increase in their match limit from 4 to 5 percent of salary. While standard theory would predict that increasing matching incentives by 25 percent should produce a non-trivial increase in

[40] To assess model predictions, we estimated *Pr*(Increased Saving) = $\alpha + \gamma_1 \text{LessAnx}_i + \gamma_2 \text{MoreAnx}_i + \mathbf{X}\theta + \lambda_i + \pi_i + \varepsilon_i$. The dependent variable indicates a moderate or greater intent to increase saving, **X** is a vector of demographic controls (age, gender, marital status, education, and income category), λ_i denotes fixed effects for present contribution rate, and π_i denotes fixed effects for present anxiety. The estimate, $\hat{\gamma_1} = 0.22$ ($p < 0.01$), indicates that expecting hedonic relief predicts a 61 percent increase in the intent to increase future saving. An analogous model implies that high, relative to low, present anxiety predicts a -0.14 shift in current participation ($p < 0.10$) and a -0.19 shift in current match take-up ($p < 0.05$).

enrollment, under the Serenity Model (assuming enrollment up to the match limit and enrollment disutility, $f(\theta^H)$, of $200), such an increase would only predict a change in enrollment for employees expecting hedonic relief within the narrow range of 27 and 33 business days. As another example, the model offers a plausible explanation for the otherwise puzzling success of AE in raising participation, since AE can also be seen as a mechanism to bypass the psychological costs of enrollment. As a third example, if one assumes the hedonic optimism of employees reflects a forecasting error, the model could explain the puzzling persistence of gaps between intended and actual saving. Finally, we believe that the model offers a more reasonable account for the success of automat-escalation programs such as Save More Tomorrow than present bias or loss aversion.

7 POLICY IMPLICATIONS AND STAKEHOLDER SURVEY

We see our findings as offering several practical lessons for policymakers, employers, and record-keepers seeking to improve the retirement security of US employees. Such lessons may have meaningful welfare consequences given recent research suggesting the risk of retirement insecurity, even among 401(k) *enrollees*, is substantially higher than commonly believed (Bhargava et al. 2021). In the near-term, our findings imply that popular engagement strategies such as the use of personalized guidance or financial education at the time of enrollment, efforts to further simplify enrollment, or campaigns aimed at clarifying the plan match—or even increasing the match—may have limited success in increasing contributions among financially at-risk employees. This conclusion stands in contrast to the emphasis of such strategies in the academic literature, policy discourse, and industry. As an example of prevailing industry sentiments on engagement, a prominent annual benchmark survey of defined-contribution plan practices found 74 percent of plans offered financial education to their employees and 95 percent of plans perceived such offerings as useful (see footnote 9). While our results are not inconsistent with broader benefits of education, our findings offer perhaps the most direct evidence that inaccurate understanding of how much one needs to save does not itself lead to undersaving. Our evidence also points to the potential efficacy of two strategies receiving less stakeholder attention—the use of participatory microincentives and, suggestively, reforms that increase awareness of plan status.

To systematically investigate the views of leading stakeholders, we collaborated with the Georgetown Center for Retirement Initiatives to survey the 81 participants of a forum on US retirement policy in November 2021. The participants included current and former leadership from federal and state governments, large financial service firms, retirement advocacy and public policy groups and academics

active in policy discourse.[41] The survey asked respondents to forecast the efficacy of interventions for raising 401(k)-saving among presently low/non-saving employees: (1) simplification of enrollment, (2) clarification of plan eligibility and match generosity, (3) reminders of employee enrollment status, (4) personalized guidance (recommendations, decision aids and financial education), (5) increases to the plan match, (6) microincentives, and (7) improvements to the design of digital enrollment interfaces.

The survey, completed by about half of the invitees, yielded three insights into stakeholder sentiments. First, consistent with our understanding, most stakeholders perceived enrollment simplification and personalized guidance as effective strategies for increasing engagement among at-risk employees. Notably, stakeholders ranked enrollment simplification as the single-most effective of the enumerated strategies for increasing saving (86 percent saw it as at least moderately effective; 5 percent rated it as ineffective). One possible explanation for the discrepancy between our findings and the emphasis on complexity in the survey may be the recent, but widespread, adoption of digital plan administration by providers, as such interfaces often reduce enrollment/plan adjustment to a few simple steps. Second, the survey suggests openness among stakeholders as to the possibility of employee confusion as an impediment to saving (i.e., 49 percent perceived communications intended to clarify enrollment status as a promising strategy for increasing participation). While the academic literature has not addressed widespread confusion of this sort, the survey echoes sentiments of industry contacts with whom we reviewed these results. Finally, while 51 percent of stakeholders thought small rewards could be leveraged to increase plan engagement, only 19 percent explicitly ranked them above increasing the plan match in terms of likely efficacy. We note that while the current regulatory language of ERISA does not explicitly condone the use of financial incentives to encourage retirement savings, as of the July 2022, Congress was debating legislation that would, among other more prominent provisions, explicitly permit *de minimis* incentives (i.e., small immediate rewards such as gift cards) to encourage plan participation. Given recent evidence on the positive effects of small incentives on vaccine take-up (e.g., Campos-Mercade et al. 2021), our findings suggest the potentially substantial promise of such reform, particularly for at-risk employees not presently responsive to increases in the plan match or personalized guidance.

In the longer-run, our hedonic account of present-focused savings hints at a direction for more fundamental reform. Specifically, the possibility that the dynamic of present anxiety and deferred optimism may impede saving offers a rationale for recent dual-account proposals that aim to supplement

[41] Attendees for the 2021 Annual Policy Innovation Forum included an Acting Assistant Secretary from the US Department of Labor, a former Deputy Assistant Secretary from the US Department of the Treasury; leadership from five state governments including a state Treasurer; multiple principals/partners/managing directors of large financial service firms including Blackrock, BNY Mellon, and JP Morgan; and representatives from AARP and the Brookings Institution. While the event engaged several topics pertaining to US retirement savings policy, the theme of the event was lifetime income solutions.

the illiquidity of a traditional 401(k) with a more-liquid account designed to address near-term financial concerns. In theory, dual-account plans could direct employee contributions into a highly-liquid account providing emergency liquidity before automatically transferring accumulated funds, above a certain threshold, into a less-liquid, long-term account. While dual-account models have recently been advocated to address economic factors such as emergency illiquidity, leakage, and student debt (Beshears et al. 2015; 2020; Gruber 2016; John 2015; Mitchell and Lynne 2017), the present research offers an additional, psychological, rationale for these proposals in that, for many, addressing near-term financial anxiety may be a precursor for long-term saving. Our findings lead us to speculate that the psychological design of dual accounts may be crucial for determining their success (e.g., the strategic marketing of plans as "Serenity Accounts" rather than an emergency savings accounts, the use of small rewards to encourage participation, and the inclusion of additional provisions aimed at alleviating near-term financial concerns).

8 CONCLUSION

We describe findings from a field study, and supplementary surveys, to assess the role of four behavioral explanations for long-standing empirical puzzles associated with how US employees save. The field experiment, which targeted undersaving employees at a US firm with a representative 401(k) plan and generous match, was embedded within a detailed survey of employee beliefs and decision-making. The research design allowed us to document the baseline incidence of each friction (and correlation with plan engagement), estimate the causal effect of reducing each friction on saving through information- and incentive-based treatments, and assess whether baseline frictional incidence predicted (differential) responses to experimental treatments. The high rate of compliance to the treatments and in-sample tests of how treatments influenced beliefs strengthened our ability to make causal claims.

We report four novel insights with respect to the existing empirical literature. First, we corroborate extant evidence on the prevalence of low *retirement literacy* and the correlation between some measures of literacy and baseline saving but find that improving the accuracy of beliefs through personalized guidance produced only a precisely-measured nominal effect on saving, even among those with documented baseline deficits. We reconcile our finding with the emphasis on literacy among academic, industry and policy stakeholders by noting that despite widespread deficits in literacy across various measures, most undersaving employees recognize they are undersaving (often substantially) and intend to save soon. Second, in an unplanned analysis of *plan confusion*, we find substantial discrepancies between self-reported contribution rates and administrative records, including a striking share of non-participants believing themselves enrolled. An analysis of alternative explanations, such as survey inattention and willful exaggeration, and the fact that discrepant non-participating employees, assigned to the small reward, were far more likely to enroll than counterparts leads us to conclude that a non-trivial

share of non-participants genuinely believe themselves to be enrolled. In a supplementary national survey of 401(k)-eligible employees, we documented similar magnitudes of uncertainty about enrollment status and contribution rate. Next, despite its perceived importance by stakeholders, we find no evidence that *enrollment complexity* impedes savings in this setting. Two recent trends in benefit administration—the adoption of digital plan engagement and the proliferation of, often non-standardized, benefit programs available to employees—could perhaps help to explain how employees might be unfazed by administrative enrollment while simultaneously confused about their 401(k)-enrollment status.

Finally, we present novel evidence directly implicating *present focus* as a cause of low plan engagement by documenting the willingness of a non-trivial share of employees (and a substantial share of employees indicating as present-focused in baseline measures) to increase saving in response to an immediate small reward but not to clarification of the much larger, but delayed, plan match. We replicate the influence, and magnitude, of small rewards via a series of hypothetical enrollment studies administered to a national sample of employees. Calibrations highlight the difficulty of explaining baseline enrollment delay (despite confirmed knowledge of the match), the stated intent of employees to save in the intermediate, but not immediate, future, and the response to the experiment via beta-delta preferences, even allowing for substantial enrollment disutility. Motivated by a promising empirical correspondence between saving and self-reported financial-anxiety, we propose an alternative hedonic account of present-focused saving. The model stipulates that if enrollment is costly due to anxiety and employees expect relief from such anxiety in the intermediate, but not immediate, future, they may rationally delay enrollment despite a generous match. We describe how the model could plausibly account for the present findings and multiple other empirical puzzles in the literature.

We highlight three potentially important limits to the present research. First, our field experiment is restricted to undersaving employees at a large but single US firm. As such, one might regard the findings, particularly pertaining to complexity and confusion, as firm-specific. While we cannot rule out this possibility, there are reasons the findings may generalize, at a minimum, to the roughly estimated 35 million enrollees of large 401(k) plans with AE—e.g., our partner firm resembles other large plans in structure and administration; among the universe of non-participants and random sample of otherwise undersaving employees we invited to the study, there was limited observable selection and unusually high intervention compliance (in contrast to paradigms involving letters, texts, etc.); and we sought to validate findings regarding confusion, hedonic forecasts, and microincentives with distinct national employee samples. Second, our findings could be seen as reflecting the effects of idiosyncratic interventions. While ultimately a question for future research, we intended for the study to be interpretable beyond our choice of interventions. For example, while there are many interventional strategies for improving literacy, we

operationalized retirement literacy as the accuracy of beliefs as to the minimal level of saving required to secure retirement security and then tested how simple recommendations affected beliefs and behavior. In this sense, our conclusions regarding the limits to literacy interventions or financial education may not apply to financial education acting through alternative channels such as persuasion, identity, social pressure, etc., nor does it rule out the many potential benefits of financial education outside of plan engagement (e.g., Kaiser et al. 2022). Finally, our visibility into saving extends only to the four months following the field study and does not include assets outside the plan. While we suspect private savings is low for our sample based on our survey and external data, we cannot observe if employees offset in-study increases to contribution with reduced saving, or increased debt, elsewhere.

Despite these limits, we see the paper as offering prescriptions for the near-term administration of 401(k) plans and long-term reform of retirement savings policy. In the near-term, our findings should prompt stakeholders to challenge prevailing sentiments regarding the efficacy of proximal financial education and plan match increases as strategies for increasing 401(k) plan engagement. Instead, our findings point to the potential value of reducing employee confusion about plan status (e.g., through broader efforts to consolidate/simply benefit program offerings or targeted messaging) and, if legally sanctioned, encouraging engagement through microincentives, a class of behavioral interventions for which we believe there is considerable promise based on neuroscientific evidence. In the longer-term, we see this research as offering a roadmap for more fundamental reform informed by decision-making micro-foundations. Specifically, if financial anxiety and (overly) optimistic hedonic forecasts deter savings, then there may be a rationale for reforming the basic structure of savings plans through dual-accounts models.

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.

Bartels, Daniel M., and Oleg Urminsky. 2015. "To Know and to Care: How Awareness and Valuation of the Future Jointly Shape Consumer Spending." *Journal of Consumer Research* 41 (6): 1469–85. https://doi.org/10.1086/680670.

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.

Benzarti, Youssef. 2015. "How Taxing Is Tax Filing? Leaving Money on the Table Because of Hassle Costs." https://doi.org/10.2139/ssrn.2412703.

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.

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

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."

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.

Campos-Mercade, Pol, et al. 2021, "Monetary incentives increase COVID-19 vaccinations." *Science* 374 (6569): 879–92. https://doi.org/10.1126/science.abm0475.

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, 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, and Brigitte C. Madrian. 2011. “$100 Bills on the Sidewalk: Suboptimal Investment in 401(k) Plans.” *The Review of Economics and Statistics* 93 (3): 748–63. https://doi.org/10.1162/REST_a_00100.

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.

Choi, James J., and Adriana Z. Robertson. 2020. “What Matters to Individual Investors? Evidence from the Horse’s Mouth.” *The Journal of Finance* 75 (4): 1965–2020. https://doi.org/10.1111/jofi.12895.

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.

Dushi, Irena, and Marjorie Honig. 2015. “How Much Do Respondents in the Health and Retirement Study Know about Their Contributions to Tax-Deferred Contribution Plans? A Cross-Cohort Comparison*.” *Journal of Pension Economics & Finance* 14 (3): 203–39. https://doi.org/10.1017/S1474747214000237.

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.

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.

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.

Ironside, Maria, Poornima Kumar, Min-Su Kang, and Diego A. Pizzagalli, 2018. “Brain Mechanisms Mediating Effects of Stress on Reward Sensitivity.” *Current Opinion in Behavioral Sciences*, 22: 106-113.

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.

Kaiser, Tim, Annamaria Lusardi, Lukas Menkhoff, and Carly Urban. 2022. “Financial Education Affects Financial Knowledge and Downstream Behaviors.” *Journal of Financial Economics* 145 (2, Part A): 255–72. https://doi.org/10.1016/j.jfineco.2021.09.022.

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.

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, 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.

———. 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.

McClure, Samuel M., David I. Laibson, George Loewenstein, and Jonathan D. Cohen. 2004. “Separate Neural Systems Value Immediate and Delayed Monetary Rewards.” *Science* 306 (5695): 503–7. https://doi.org/10.1126/science.1100907.

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.

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.

Phelps, E. S., and R. A. Pollak. 1968. “On Second-Best National Saving and Game-Equilibrium Growth1.” *The Review of Economic Studies* 35 (2): 185–99. https://doi.org/10.2307/2296547.

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.

Sharot, Tali. 2011. “The Optimism Bias.” *Current Biology* 21 (23): R941–45. https://doi.org/10.1016/j.cub.2011.10.030.

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.

Ulrich-Lai, Yvonne M., Anne M. Christiansen, Michelle M. Ostrander, Amanda A. Jones, Kenneth R. Jones, Dennis C. Choi, Eric G. Krause, et al. 2010. “Pleasurable Behaviors Reduce Stress via Brain Reward Pathways.” *Proceedings of the National Academy of Sciences of the United States of America* 107 (47): 20529–34. https://doi.org/10.1073/pnas.1007740107.

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.

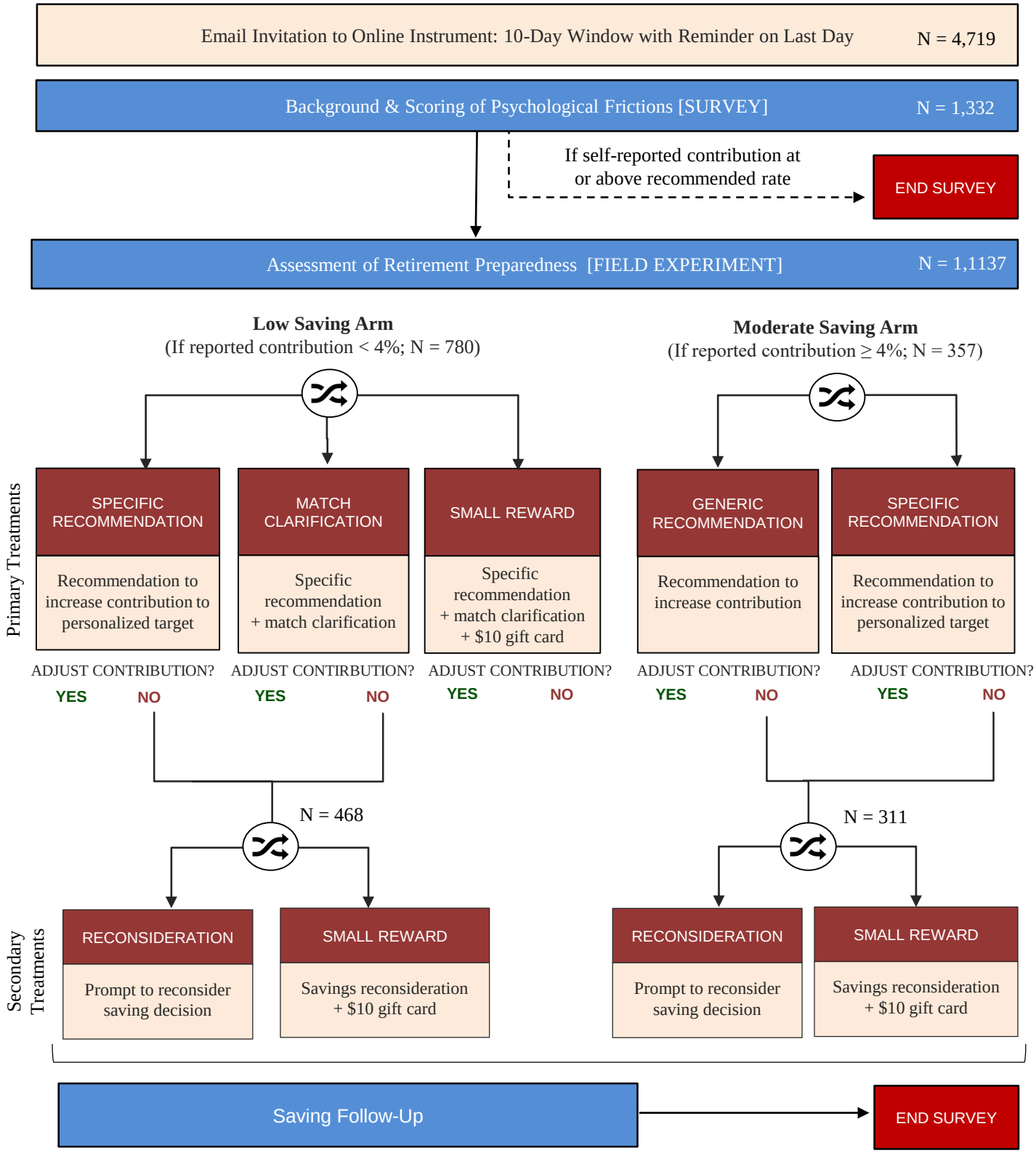
Vallacher, Robin R. 1993. “Mental Calibration: Forging a Working Relationship between Mind and Action.” In *Handbook of Mental Control*, 443–72. Century Psychology Series. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

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

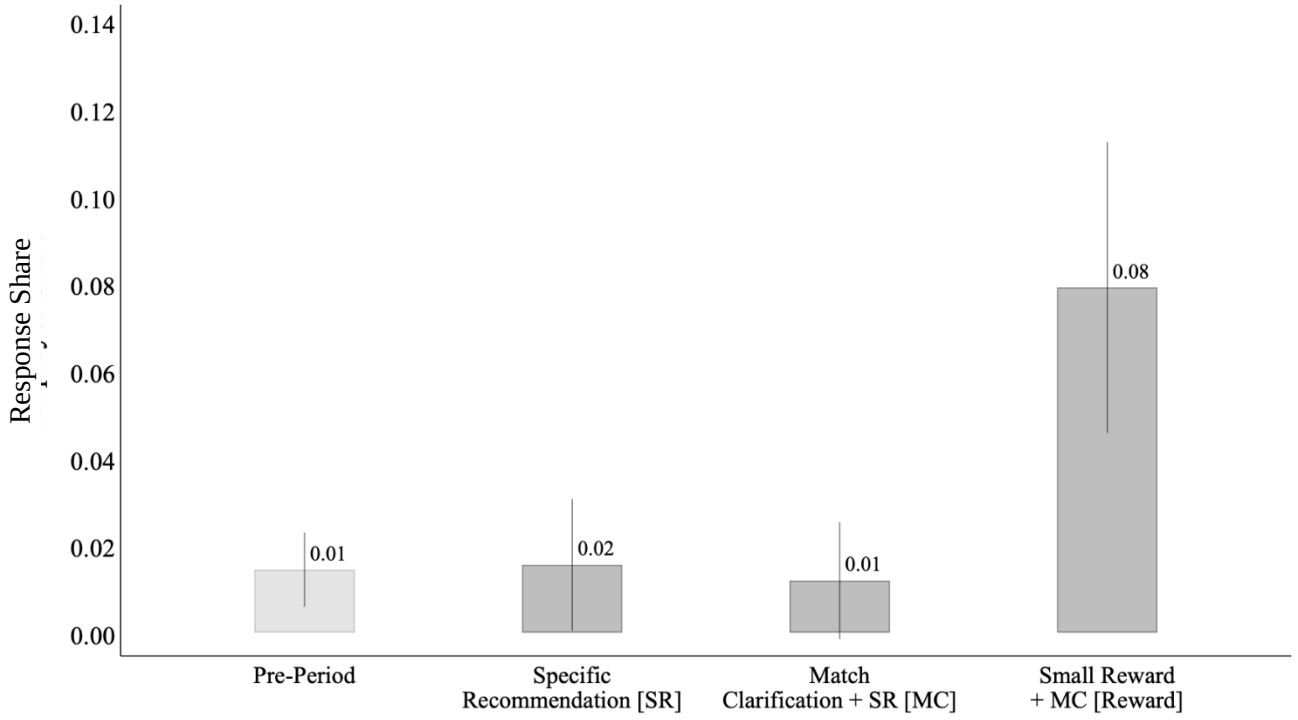


Note: This figure schematically depicts the research design and general procedure for the survey and field study. The figure charts the progression of qualified employees from an email invitation to participate in the survey to an initial module designed to collect background information and score each 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.

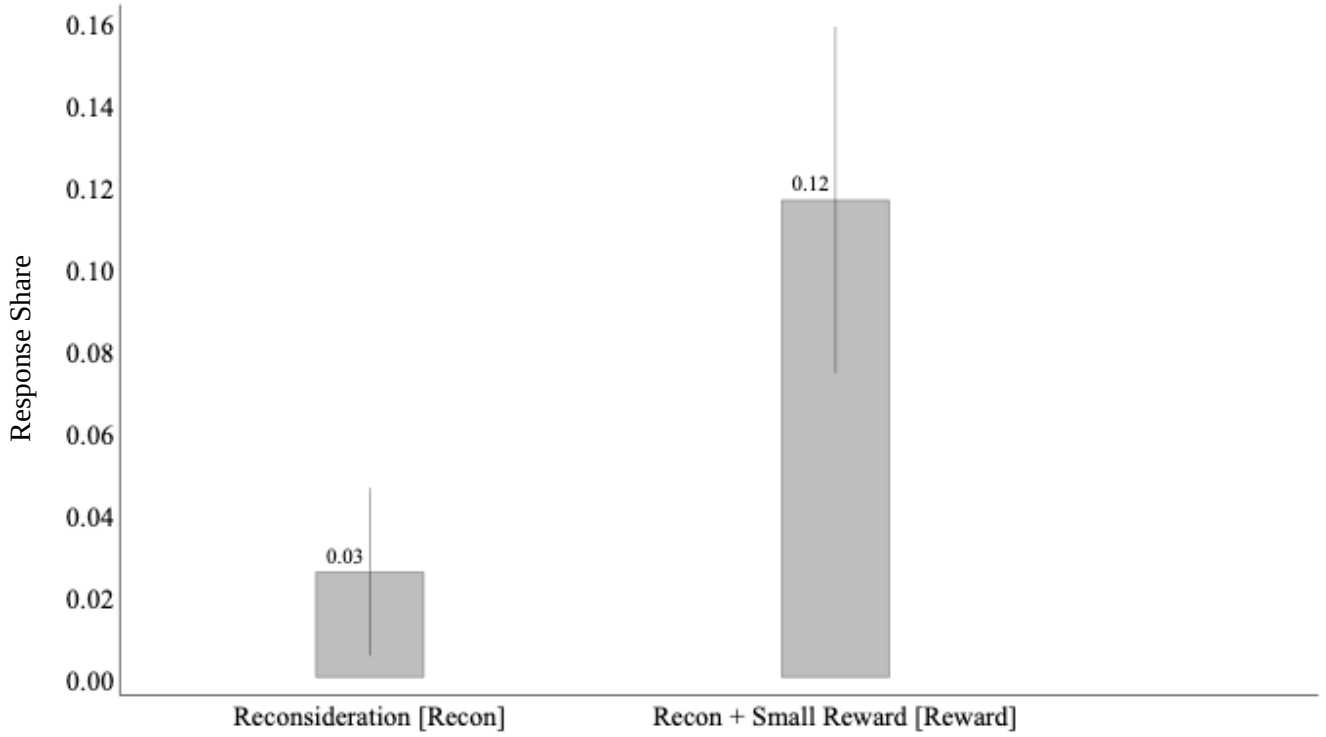
Figure 2.

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

Panel A. Primary Experimental Treatments



Panel B . Secondary Experimental Treatments

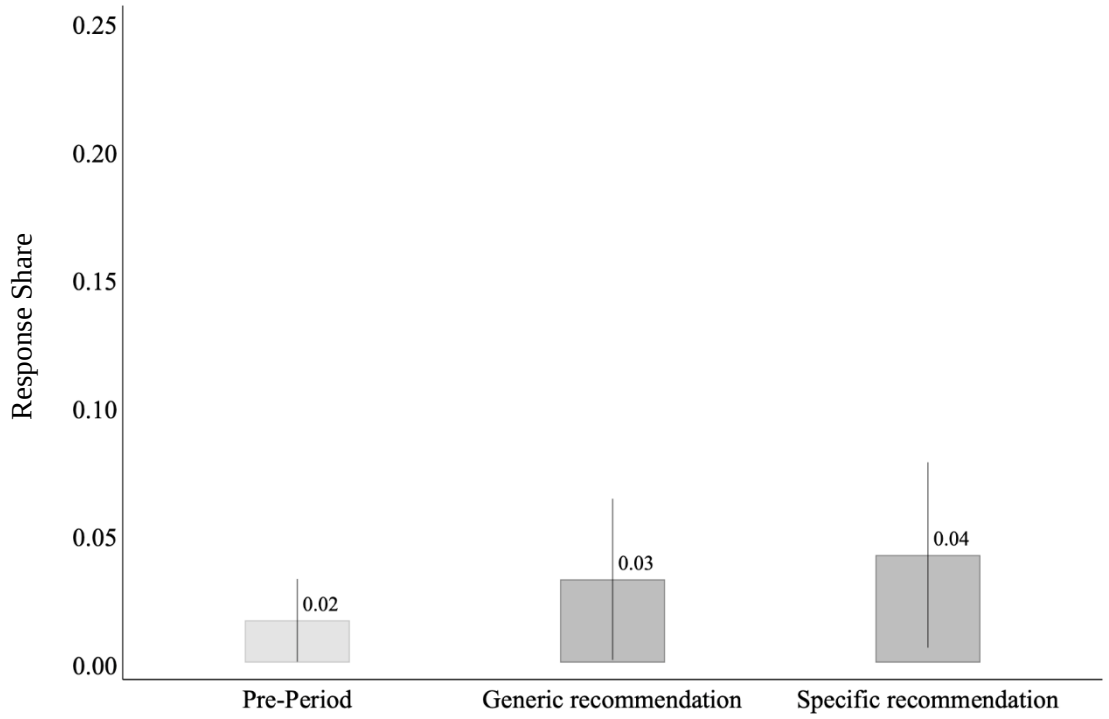


Note: This figure depicts the share of increased 401(k) plan contributions among employees assigned to each primary (Panel A) and secondary (Panel B) treatment in the Low Arm. Panel A additionally reports the average share of increased contributions by in-sample employees during a specified period prior 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.

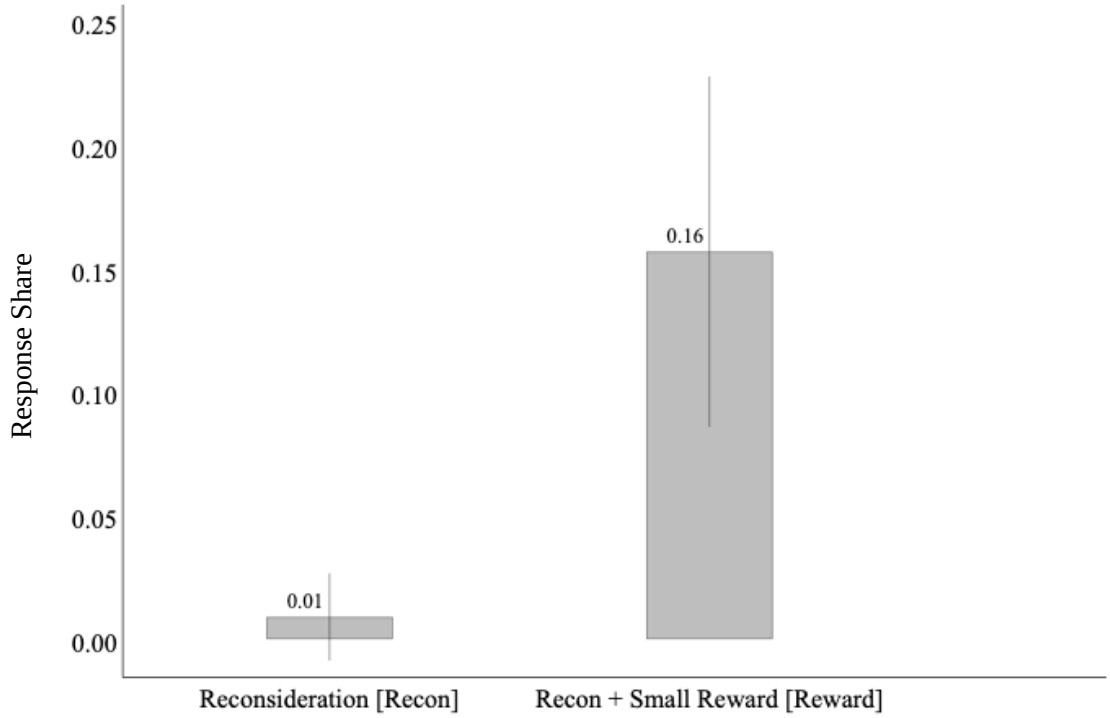
Figure 3.

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

Panel A. Primary Experimental Treatments



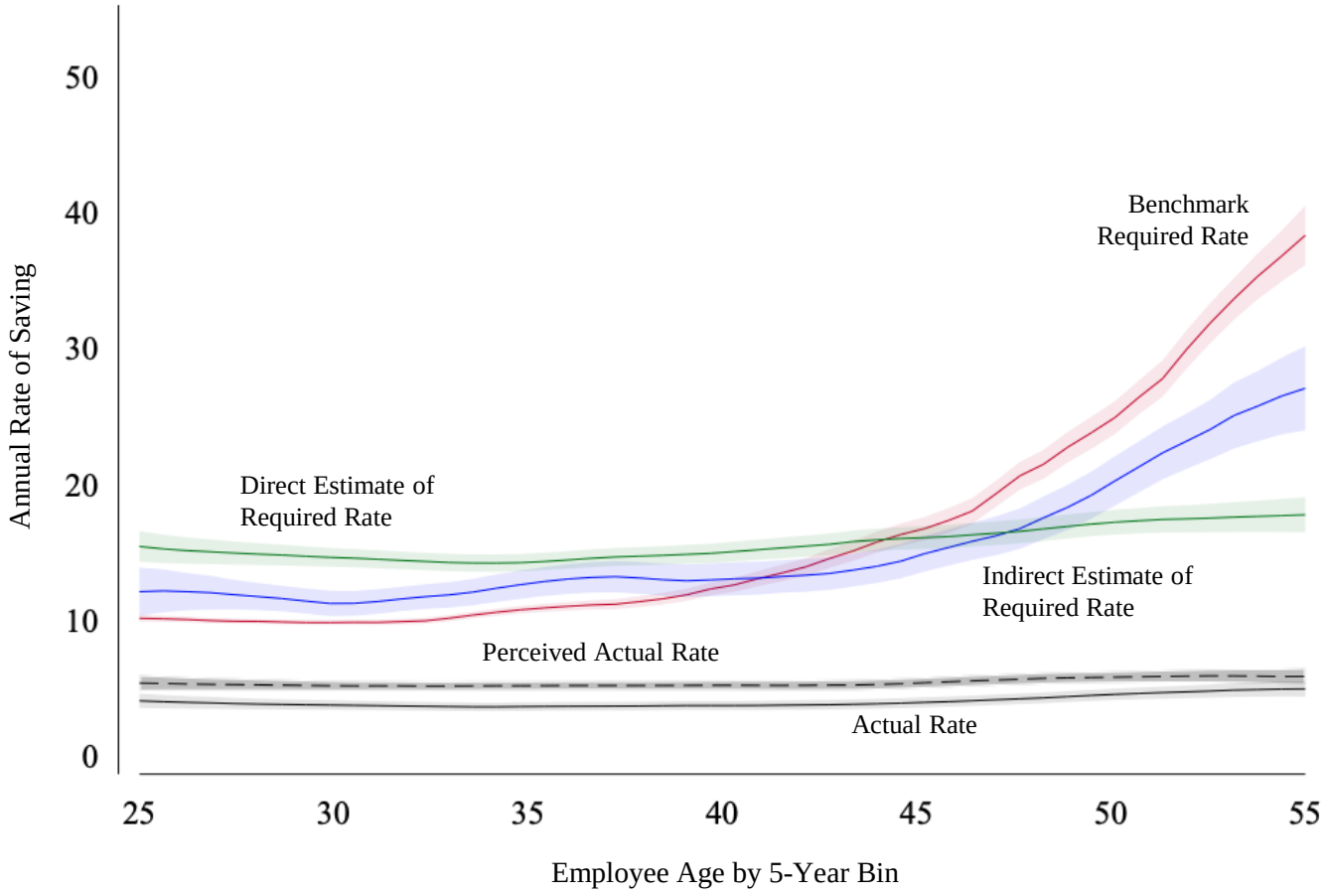
Panel B. Secondary Experimental Treatments



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.

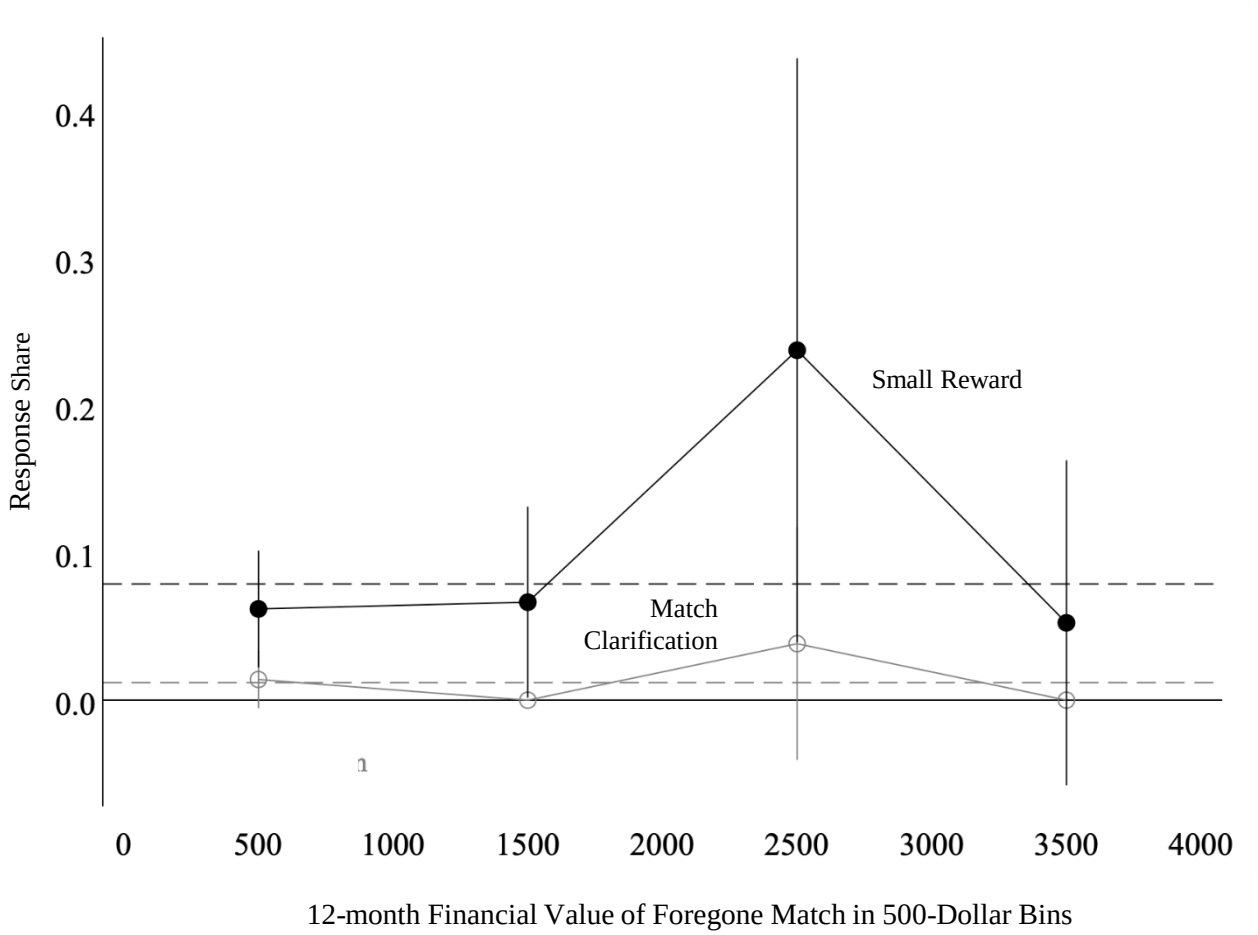
Recommended, Actual and Perceived Annual Rate of 401(k) Plan Saving by Employee Age



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.

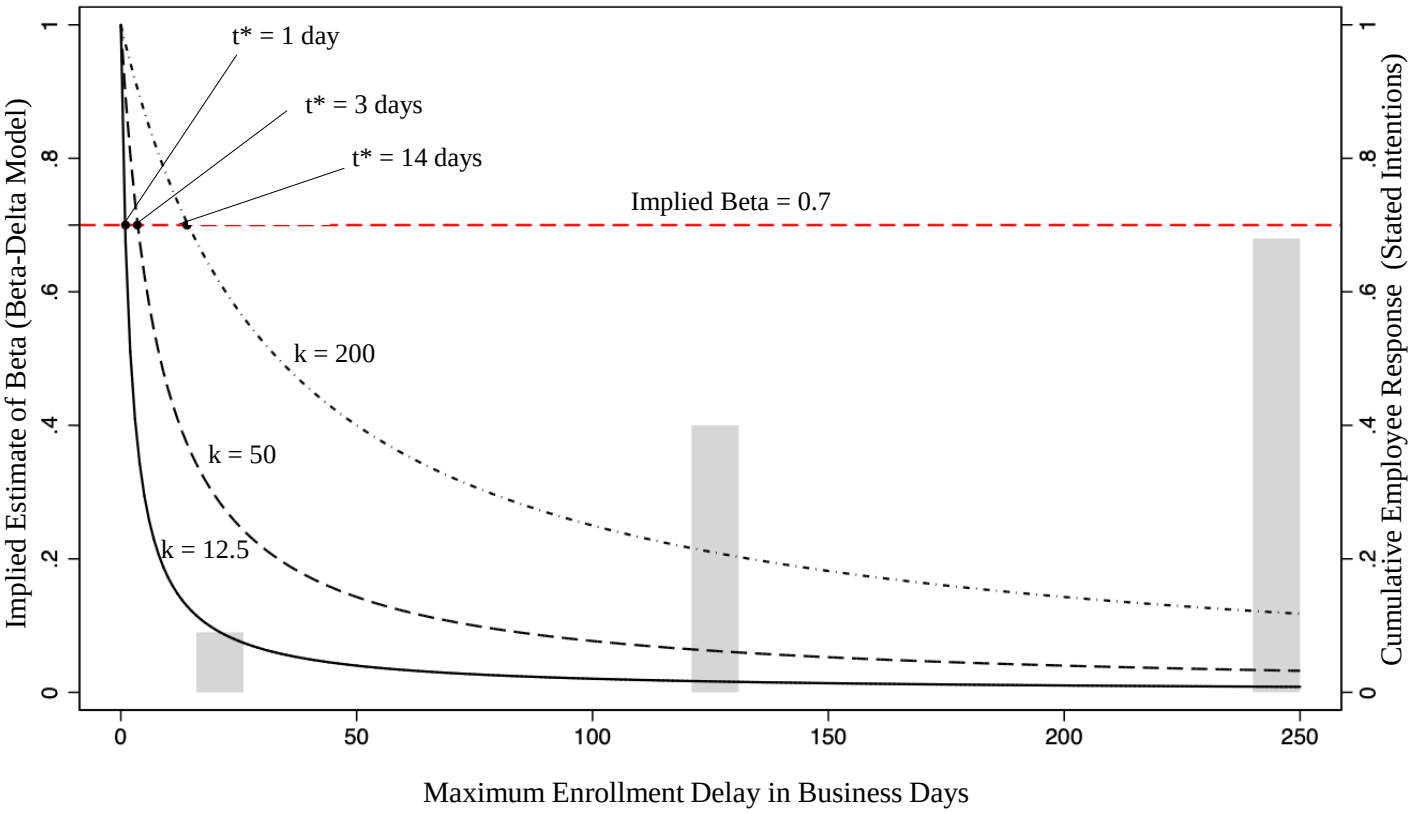
Share of Increased 401(k) Plan Contributions in Response to Match Clarification and Small Reward by 12-month Value of Foregone Match - Low Saving Arm



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.

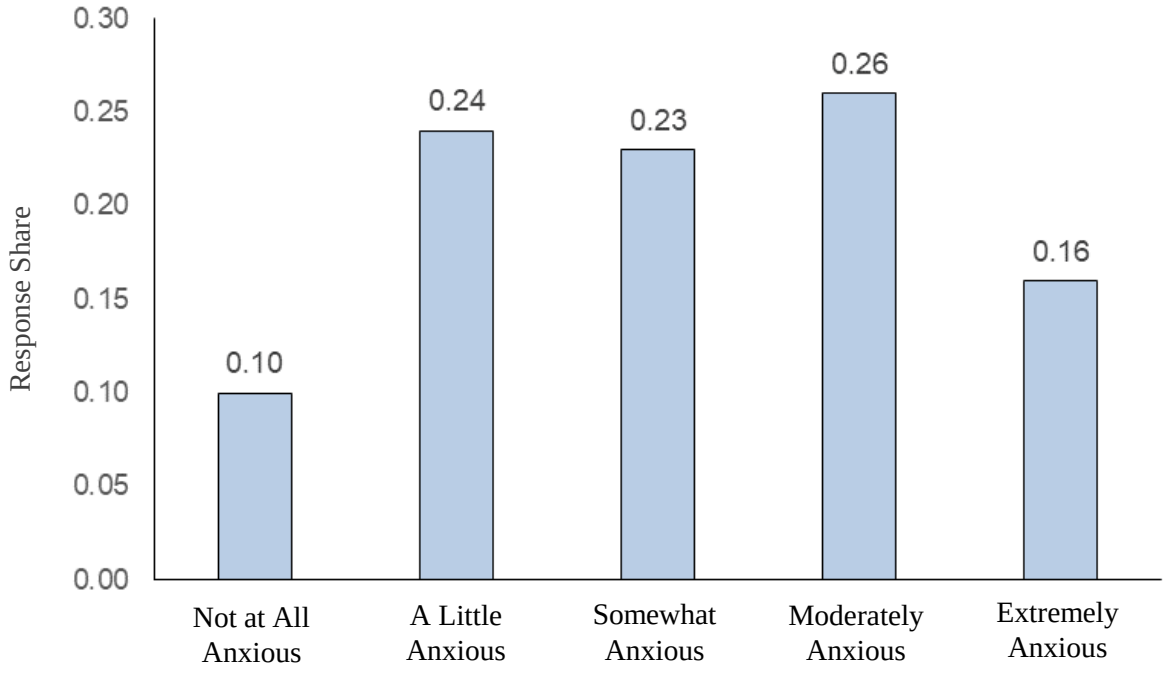
Delay in 401(k) Plan Enrollment Implied by Beta-Delta Model and Stated Intentions of Employees



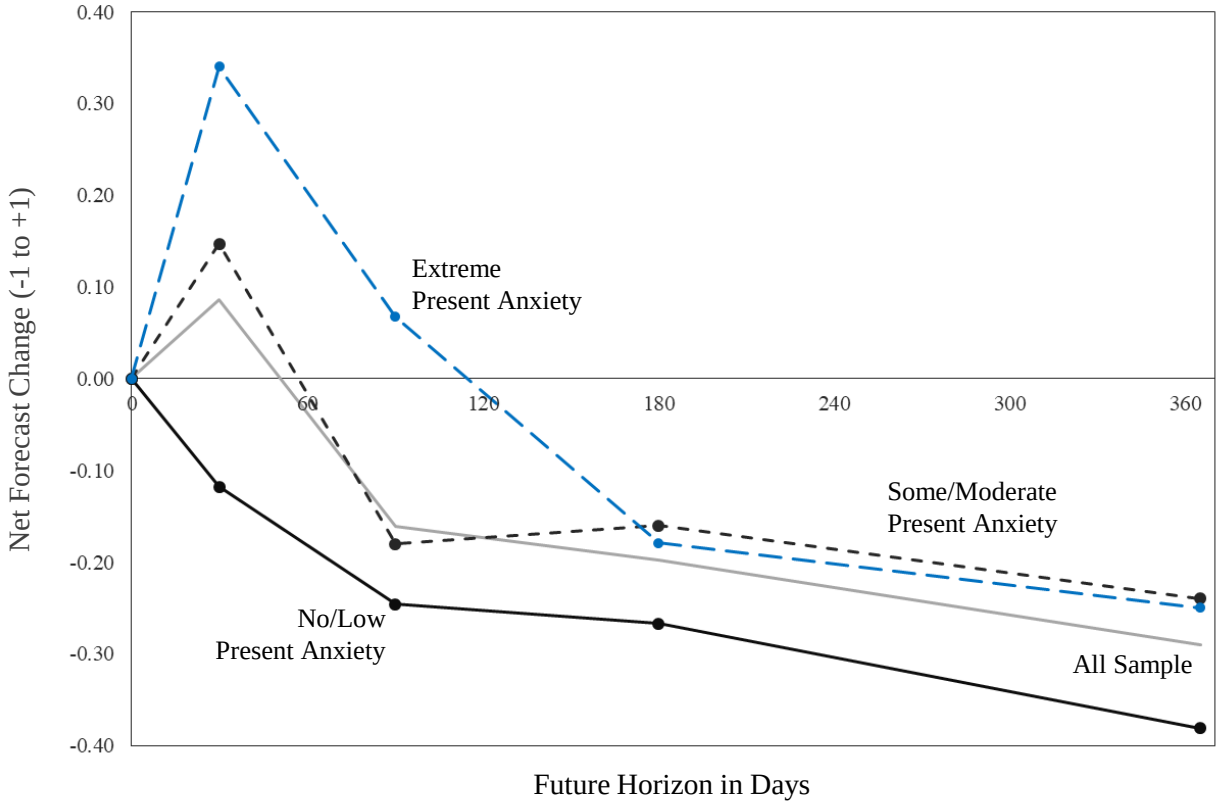
Note: This figure reports the value of beta required to rationalize varying durations of delay in 401(k) plan enrollment as implied by the beta-delta model (assuming sophistication). The plot separately displays estimates of beta assuming enrollment costs of k = 12.5, 50, and 200 and annotates the delay 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

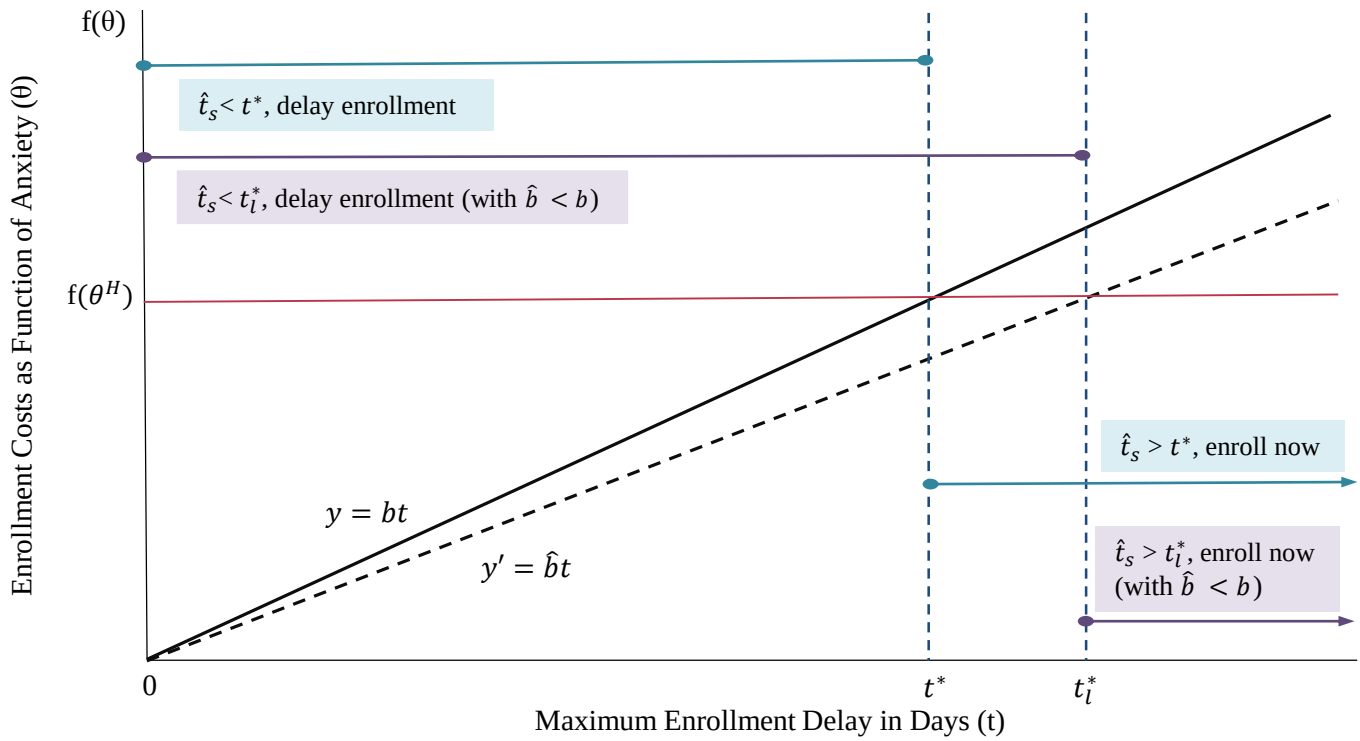


Note: This figure describes present and forecasted change in financial anxiety among a supplementary survey sample of US employees. Panel A depicts the distribution of self-reported present financial anxiety on a scale ranging from not at all to extremely anxious. Panel B reports the net forecast change 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.

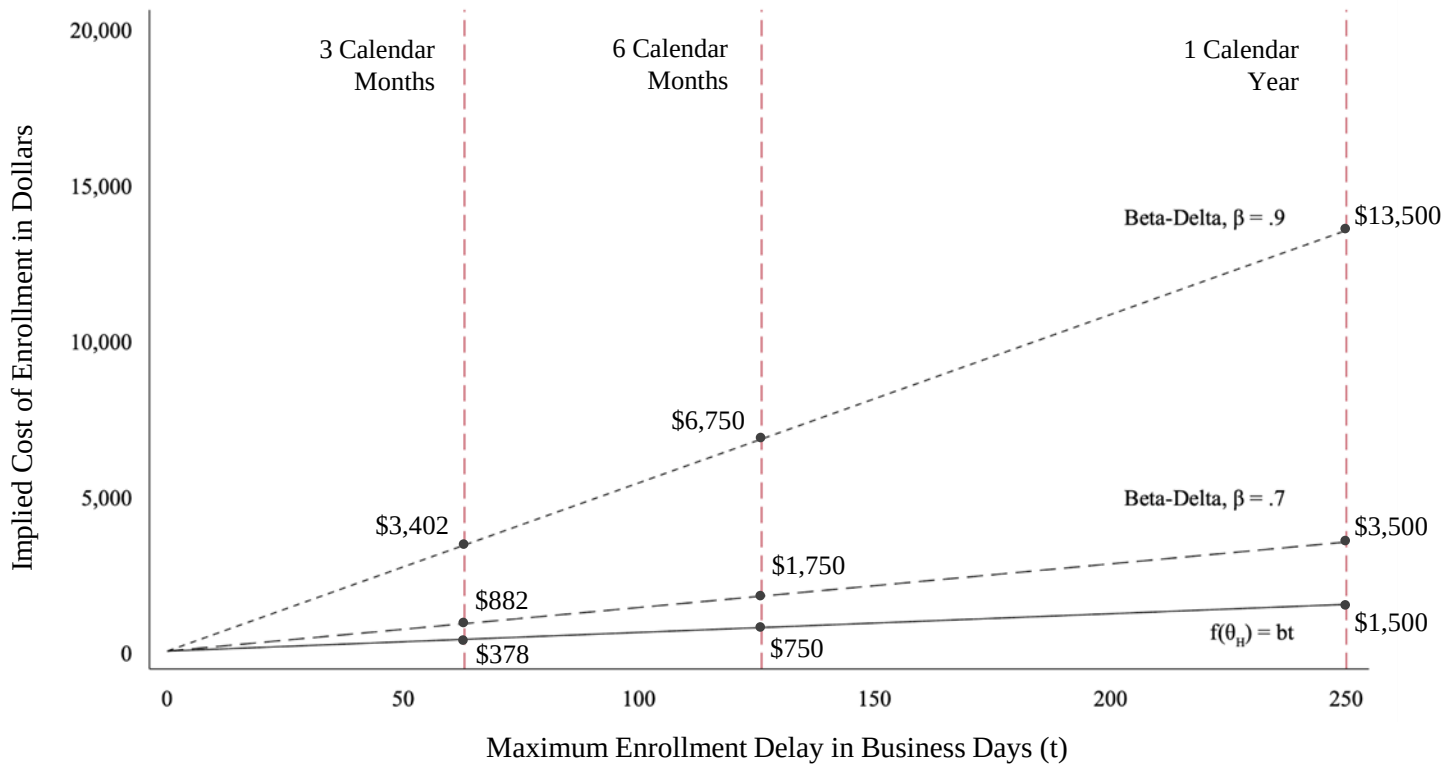
Figure 8.

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

Panel A. Stylized Costs and Benefits of Enrollment Delay



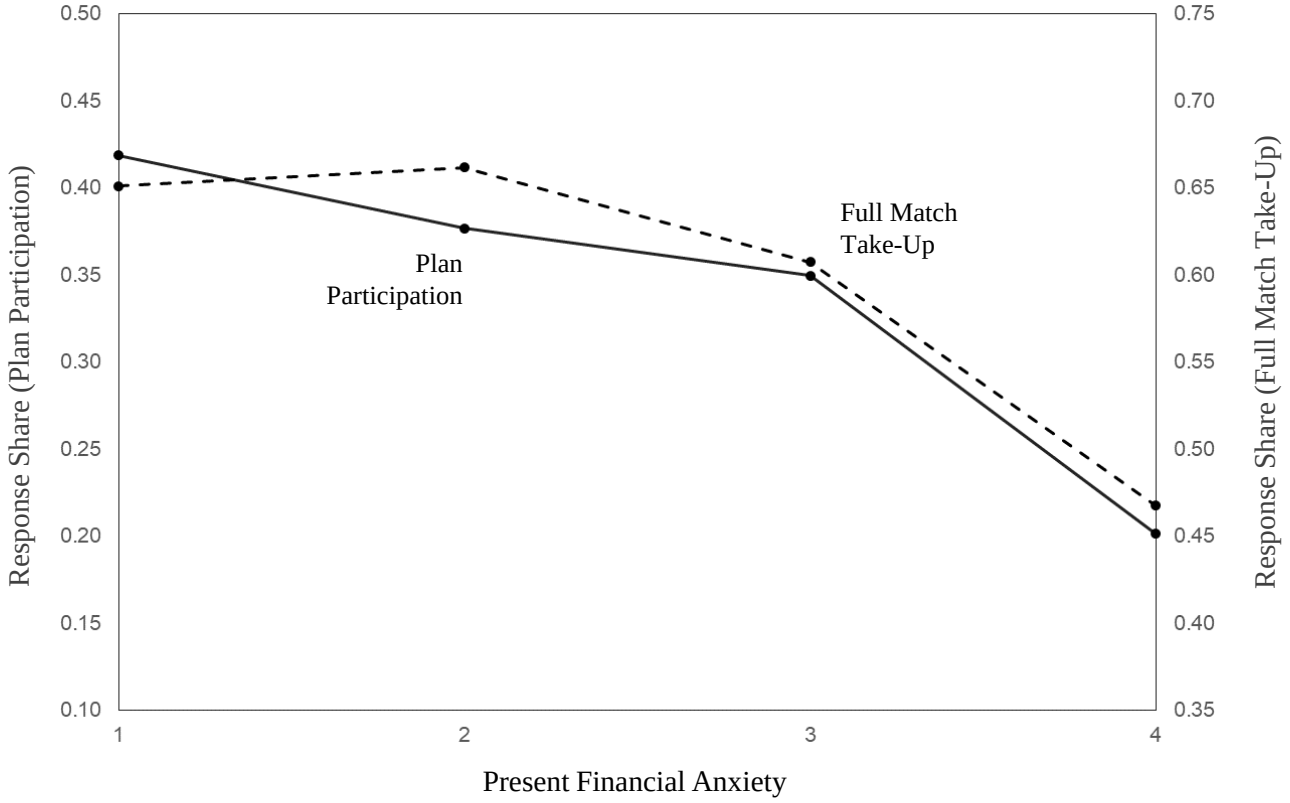
Panel B. Implied Enrollment Costs by Duration of Delay in Beta-Delta and Serenity Models



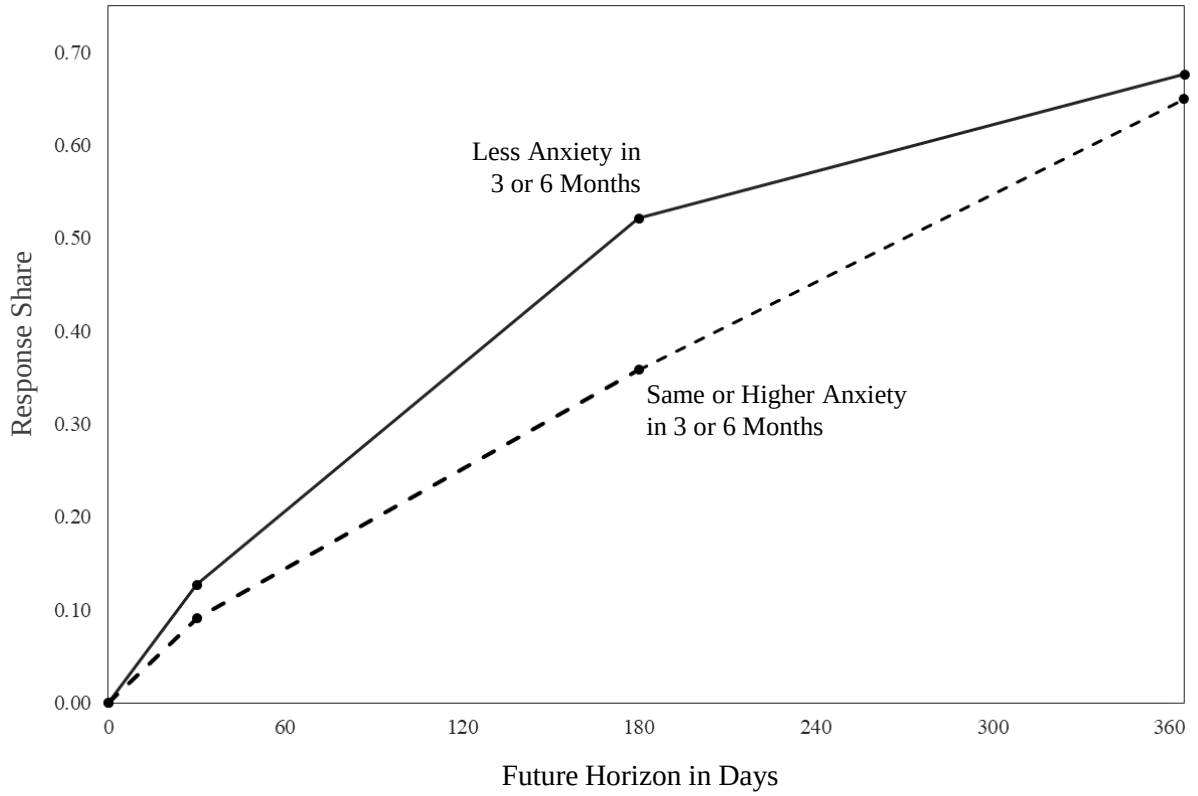
Note: This figure describes the delay in 401(k) plan enrollment implied by the Serenity Model. Panel A depicts the marginal cost (due to the foregone plan match) and benefits (due to potential reductions in anxiety costs) of enrollment delay for the model. The graph separately plots the cost of delay 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	0.37	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 + Reconsideration [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. Reconsideration	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			Experimental Response [I(Increased Contribution Rate)]			
Friction Indicator	Baseline Incidence	E(ΔParticipation)	E(ΔMatch Claim)	Treatment [Low Arm if unspecified]	All	Friction Not Indicated	Friction Indicated	Difference Test (p-value)
1. Low Retirement Literacy								
Direct Underestimation of Required Savings	0.47	0.04	-0.03	Specific Recommendation	0.02	0.02	0.01	0.48
Indirect Underestimation of Required Savings	0.43	-0.03	-0.11***	Specific Recommendation	0.02	0.01	0.02	0.95
Financial Literacy - Zero Score on 2-Item Assessment	0.20	-0.13*	-0.14**	Specific Recommendation	0.02	0.02	0.00	0.72
2. Plan Confusion								
Underestimation of Plan Match	0.20	-0.16***	-0.14***	Match Clarification	0.01	0.02	0.00	0.55
Overestimation of Plan Contribution Rate	0.24	-0.29***	-0.24***	Small Reward	0.08	0.06	0.21	0.00
Overestimation of Plan Enrollment | Non-Participant	0.38	-	-	Small Reward	0.08	0.06	0.20	0.00
3. Enrollment Complexity				[Moderate Arm]				
Overestimation of Adjustment (> few minutes)	0.23	-0.07	0.02	Generic Recommendation	0.03	0.02	0.00	0.73
Prohibitive Estimation of Adjustment (> few hours)	0.11	-0.13**	-0.02	Generic Recommendation	0.03	0.02	0.00	0.81
Theory of Automatic Enrollment - Complexity	0.10	-0.02	-0.02	Generic Recommendation	0.03	0.02	0.00	0.81
4. Present Focus								
Present Focus Implied by Effort Allocation Choice	0.10	0.01	-0.04	Small Reward	0.08	0.04	0.14	0.17
Theory of Automatic Enrollment - Present Focus	0.60	0.20***	0.15***	Small Reward	0.08	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 overall share of employees increasing their contribution rate in response to the specified treatment and the differential experimental response across employees for whom the friction was and was not indicated (estimated from a single pooled regression). 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 No	Plan Participation Yes	Difference Tests (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	0.04	--	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.

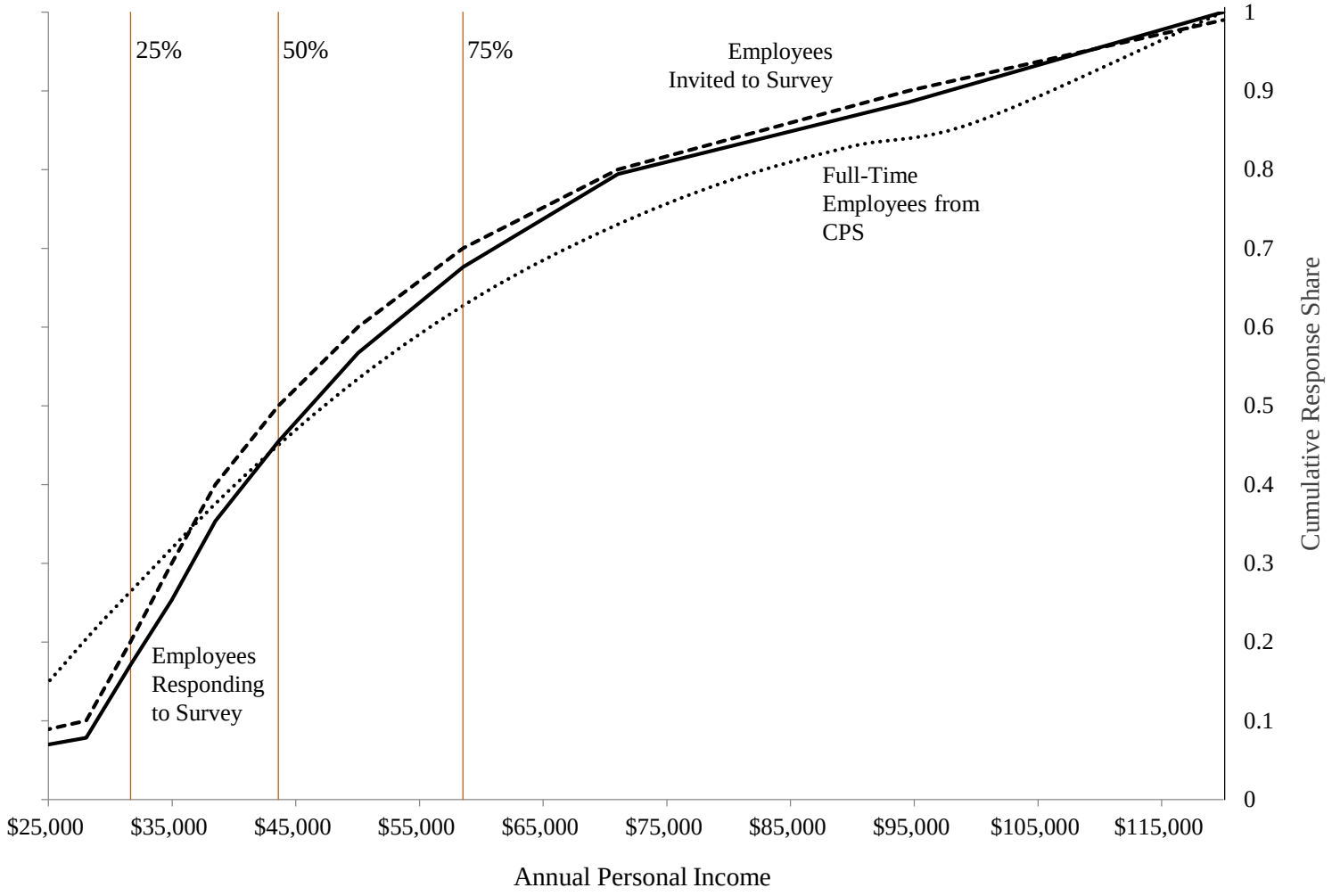
Table 7.
Discrepant Employee Reports of 401(k) Plan Engagement Adjusted for Inattention and Exaggeration

	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.

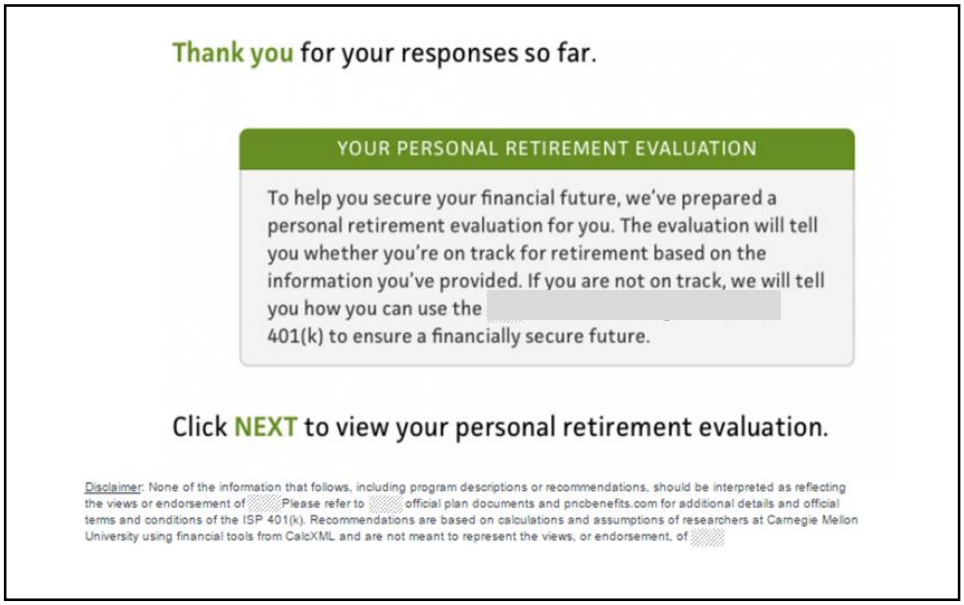
Comparison of Income Distribution from Field Study and Employees in 2015 Current Population Survey



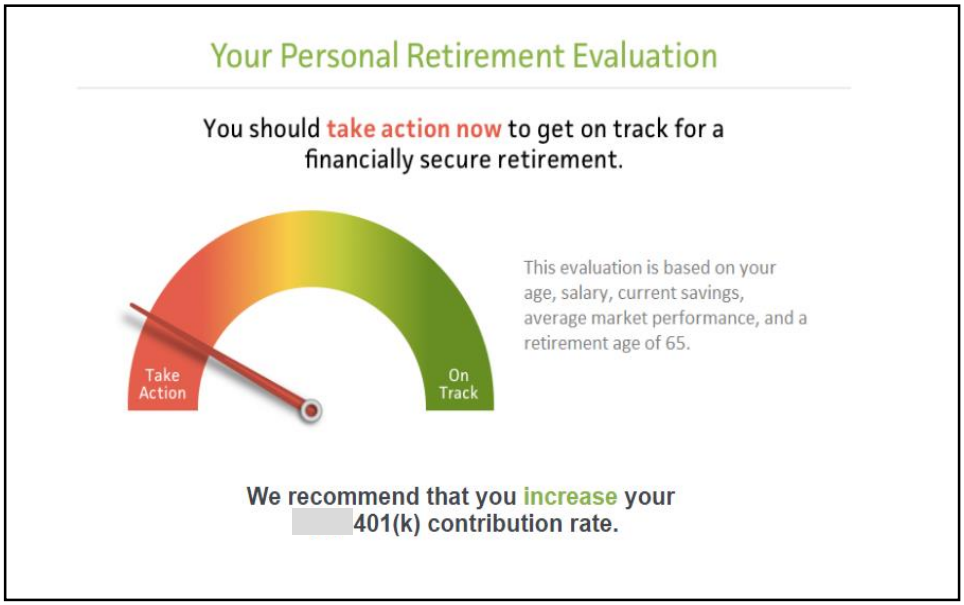
Note: This figure compares the distribution of annual salary of employees from the field study with annual salary for a national sample of employees from the Current Population Survey (CPS). Specifically, the plot depicts the cumulative distribution of annual salary for employees responding to the field 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.

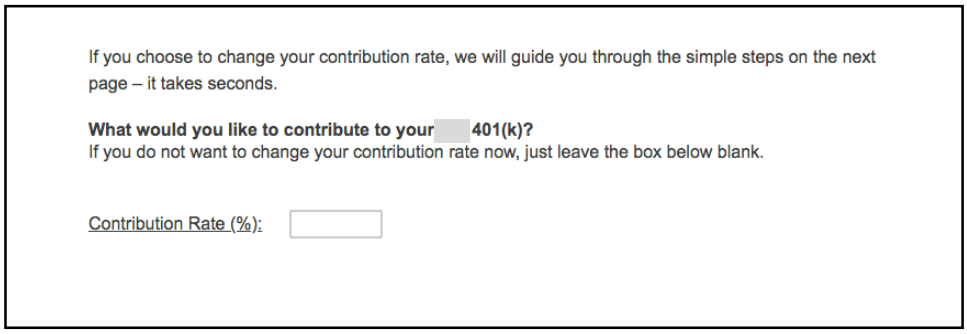
Screenshots of Baseline Retirement Assessment Web-Flow from Field Study
(Generic Recommendation)



Introductory Screen



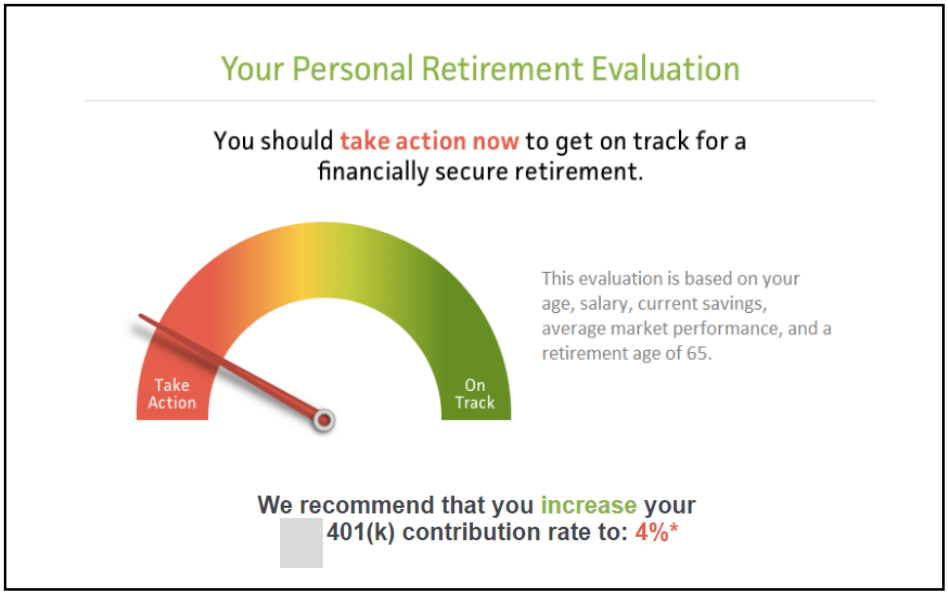
Retirement Assessment
(Generic Recommendation)



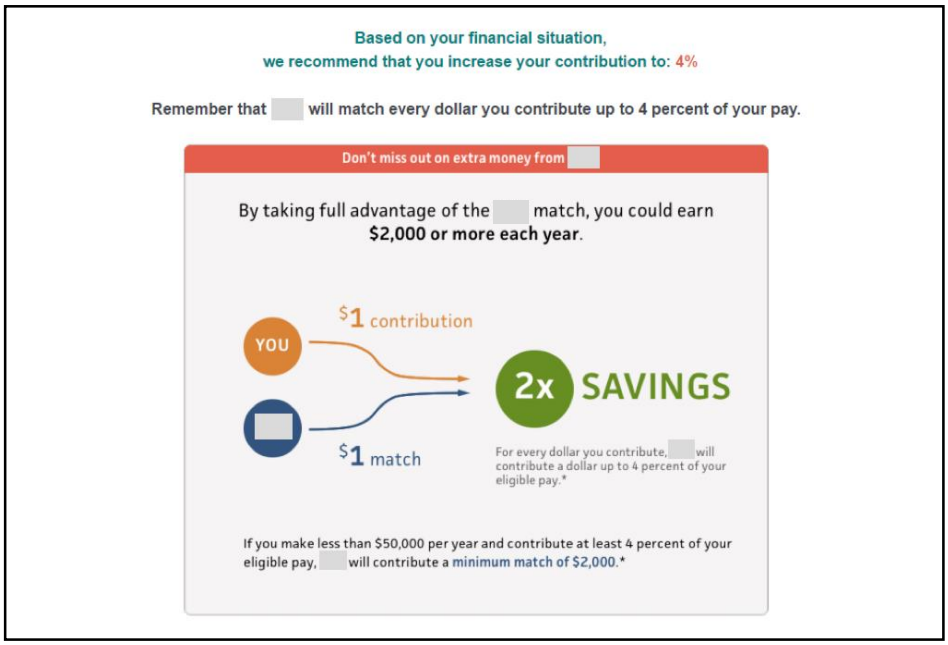
Saving Prompt
(Prior to Benefit Portal Link)

Appendix Figure A3.

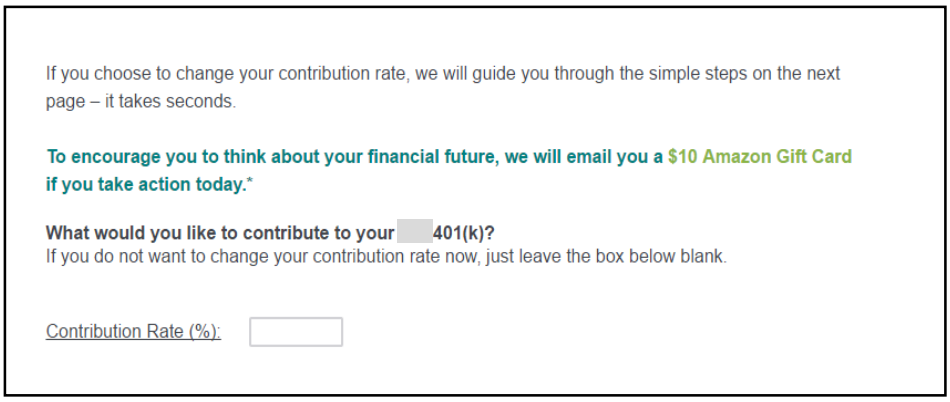
Screenshots of Experimental Variation in Retirement Assessment Web-Flow from Field Study



Specific Recommendation

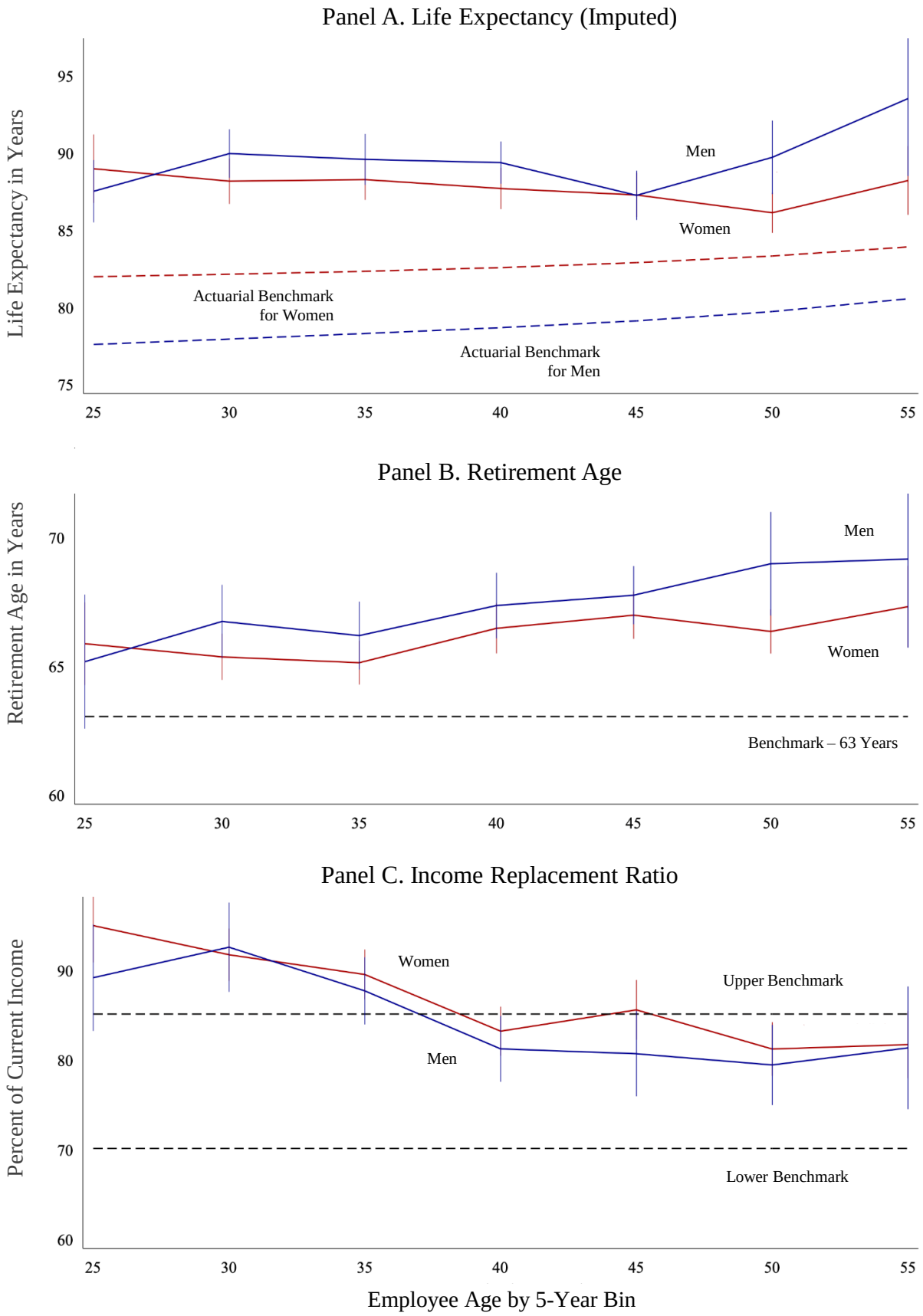


Match Clarification



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.
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 select survey modules.

Appendix Table A2.
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.