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 field experiment randomizing undersaving employees to information- and incentive-based treatments linked to a survey assessing each friction's baseline incidence. We describe four main findings: (1) We corroborate prior work showing pervasive deficits in *retirement literacy* and their correlation with saving but reject any meaningful increase in saving from personalized recommendations that demonstrably improve literacy. (2) In an (unplanned) analysis of *plan confusion*, we estimate that 20 to 37 percent of non-participants mistakenly believed themselves to be enrolled—these employees enrolled at high rates when prompted to review their enrollment status. (3) We find no evidence that *enrollment complexity* impedes saving—few employees perceived enrollment as prohibitively time-consuming and simplifying enrollment further did not increase saving. (4) We directly implicate *present focus* as a cause of undersaving by showing that a significant share of employees increased saving in response to a small but immediate microincentive ($10 gift card) but not to clarification of the dramatically larger, but delayed, plan match. A survey of leading stakeholders suggests that the prescriptions for increasing saving, implied by our findings, depart from those currently prioritized within the industry. Finally, calibrations indicate that a beta-delta model of present bias cannot account for the observed behavior and stated beliefs of employees without assuming implausibly high enrollment disutility. We propose an alternative model of anxiety-based present focus and delayed optimism that does explain our findings—and possibly other retirement savings puzzles—and offers a psychological rationale for reforms that link traditional 401(k) accounts to more liquid accounts (e.g., "Serenity Account") 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 401(k) plan structure such as the presence of automatic enrollment (Madrian and Shea 2001) or small variation in the non-economic design of a plan's digital enrollment interface (Bhargava et al. 2021).[1]

Economists have advanced a number of potential departures from the standard economic framework—or psychological frictions—to explain these empirical anomalies. Four of these frictions have come to occupy a central role in the literature. The first, which we refer to as *retirement literacy*, encompasses both low financial literacy (the absence of working knowledge of financial concepts or the propensity to misapply such concepts) and biases in other retirement-relevant beliefs that might lead an employee to underestimate their saving needs. An extensive literature has documented widespread deficits in various measures of retirement literacy and found correlations between at least some of these measures and retirement planning or saving outcomes (e.g., Hastings, Madrian, and Skimmyhorn 2013; Lusardi and Mitchell, 2014). The second, *plan confusion*, refers to the possibility that confusion about plan details, such as underestimation of eligibility or the plan match, might deter saving. While direct evidence on confusion in the context of 401(k) plans is limited, studies have cited confusion as a barrier to take-up across other a range of private and social benefit programs.[2] The third friction, *enrollment complexity*, describes the possibility that the economic and psychological costs of complicated administrative enrollment could lead employees to delay saving.[3] Finally, a fourth friction, *present focus*, implies that undersaving may reflect the tendency of employees 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).[4] 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 automatic

[1] Researchers have also documented the sensitivity of retirement saving to non-standard factors such as complexity (Beshears et al. 2013), auto-escalation (Thaler and Benartzi 2004), and the framing of incentives (Choi et al. 2017; Duflo et al. 2006).
[2] For example, see Domurat, Menashe, and Yin (2019), Bhargava and Manoli (2015), and Chetty, Friedman, and Saez (2013).
[3] For example, see Choi, Laibson, and Madrian (2009), Beshears et al. (2013), Bertrand, Mullainathan, and Shafir (2004).
[4] 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 that disproportionately favors the present.

enrollment in increasing participation (e.g., Laibson 1997; 1998; O'Donoghue and Rabin 1999a; Diamond and Köszegi 2003). While measures of present bias have been shown to predict saving (Goda et al. 2019; Brown and Previtero 2018) and response to experimentally varying plan defaults (Blumenstock, Callen, and Ghani 2018), arguably the most direct field evidence implicating present bias in saving is the demand for commitment routinely 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.[5] We attempt to provide such evidence through an online field experiment through which we administered incentive- and information-based treatments to 1,137 low-saving, 401(k) plan-eligible, employees at a large US firm with a generous plan match. We embedded the treatments within a broader survey intended to assess the employee-specific incidence of the four frictions along with an additional exploratory friction, *financial anxiety*, increasingly cited by practitioners, policymakers, and psychologists as an important determinant of financial decisions.[6] After summarizing evidence from the survey-linked field study, we consider whether the findings can be explained by existing economic models through a series of calibrations. We conclude by advancing a new hedonic model of saving that offers a unifying framework from which to potentially understand both the decisions and beliefs of employees in the present setting and empirical savings puzzles more broadly.

Several features of our research design contribute to its distinctive potential for clarifying how psychological frictions affect employee 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 employees varying in baseline incidence of that friction. Taking the case of retirement literacy, for example, while the survey documents the baseline prevalence of literacy and its naïve correlation with saving, the field experiment reveals how improving literacy, through the provision of personalized guidance, affects average saving. And jointly, the survey and experiment reveal heterogeneous treatment effects across employees varying in their baseline deficits. Second, our field study targets undersaving employees with access to a 401(k) plan with a generous match—that is, the employer matched each dollar of contribution up to four percent of annual salary with a guaranteed minimum of $2,000 for anyone contributing at least four percent over a calendar year. Consequently, for the many employees contributing below the match limit, the rate of return to an additional dollar of contribution ranged from 100 to 367 percent—a marginal return not easily explained

[5] 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."

[6] For example, several national household financial surveys now explicitly measure financial anxiety (e.g., the National Financial Capability Survey administered by FINRA). 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).

through traditional economic channels. Third, because we simultaneously test several candidate frictions in the same setting, we can directly compare their relative importance. Finally, we implemented the study using an online instrument where we could monitor attrition, attentiveness and, in some cases, changes in beliefs. This strategy was intended to avoid the inferential challenges often encountered in email, text, or letter paradigms where the rate of respondent engagement may be low, non-representative, or unobserved. In the literature on 401(k) savings, we believe this is the first to simultaneously test the role of multiple psychological frictions, to integrate experimental reductions of frictions in the field with survey measures of baseline incidence, and to use microincentives to assess present focus.

We administered the field study by inviting a few thousand employees situated below pre-specified saving and income thresholds to participate in an online survey marketed as an opportunity to provide confidential workplace feedback. Beyond capturing demographic and financial background, an initial module of the survey included questions intended to diagnose 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 experimental treatments, the assessment truthfully conveyed that the employee was not "on track" for retirement security, advised the employee to increase their contribution rate, provided simple instructions to any employee seeking to adjust their contribution, and, finally, asked the employee about their future intentions to save. 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, microincentive ($10 Amazon gift card) to encourage employees to visit the enrollment portal and to 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—employees underestimated how much they should save to ensure retirement security and 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 (that verifiably improves the accuracy of beliefs) had a precisely-estimated null effect on contribution, even among employees with deficits in literacy. The data offer insights to help reconcile this finding with existing research—for example, while most employees appear to underestimate how much they should save annually for a secure retirement, most also recognize the (often substantial) insufficiency of their present saving.

Second, we offer novel evidence that employee confusion may explain a significant amount 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 employees had accurate beliefs about eligibility, a

significant share of employees underestimated the generosity of the match. Despite a strong correlation between match underestimation and baseline saving, we find that experimentally clarifying match incentives did not lead employees to increase saving on average, nor did it lead to a (differential) increase among underestimating employees (for whom such clarification could be interpreted as new information). Additionally, in an unplanned analysis, we find that a significant share of non-participants reported themselves as being enrolled. After attempting to adjust for potential survey inattention or willful exaggeration, we conclude that 20 to 37 of non-participants were genuinely confused about their enrollment status. Consistent with this interpretation, discrepant employees assigned to the small reward (and thus more likely to visit the enrollment portal and observe their actual contribution rate), were three times more likely to increase their contribution. While widespread confusion about plan status may seem incredible, we speculate that it arises from the broader complexity of benefit program offerings at large US firms—e.g., new hires at our firm were asked to make enrollment decisions for up to twelve benefit programs, each with their own set of eligibility and enrollment rules.

Third, we present evidence indicating that perceptions of enrollment complexity do not inhibit plan engagement. While a small share of employees appears to overestimate the time required to adjust their contribution, few perceived enrollment as sufficiently time-consuming so as to conceivably affect the decision to save, even allowing for the possibility that enrollment involves psychological hassle costs that substantially exceed its wage-based time-costs. Moreover, assignment to the baseline condition, which conveyed the simplicity of plan adjustment and promised step-by-step instructions (and verifiably reduced perceptions of enrollment time), did not increase saving relative to a pre-study comparison period, even for employees who perceived enrollment as highly time-consuming at baseline. We speculate that the apparent absence of complexity as a deterrent to saving in our setting may reflect the ease with which employees can make 401(k) plan changes through digital enrollment portals.

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 microincentive across multiple implementations of the treatment, despite not responding to clarification of the far larger, but delayed, plan match. The effect of the small reward persisted over the subsequent four months for which we observed administrative data, and at least one-half of adjustments entailed an increase of more than one percent of salary, suggesting that response was not a temporary strategy intended to collect the reward. Moreover, employees tagged as present-focused in the survey were 2 to 3.5 times more responsive to the reward than counterparts. For those who hadn't yet exhausted the match, the response to the $10 reward, assuming no subsequent adjustments, implied an average (maximum) gain from the match of $677 ($1,583) in the remaining five months of the year and $2,632 ($5,383) in the next calendar year. Our survey and administrative data provide additional evidence

consistent with present focus outside of the experiment—at baseline, many of the employees in our sample undersave and fail to take up a generous match, despite a stated preference to save in the near future, confirmed knowledge of the plan match, and the self-reported absence of emergency illiquidity.

To explore 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 for the model to rationalize delay in enrollment exceeding a few days would require an implausible degree of present bias or enrollment disutility. While an approach adopted by the literature to explain lengthier delays is to assume employee naïveté (O'Donoghue and Rabin 1999b; DellaVigna 2018), our survey data on the saving intent of employees soundly rejects this possibility—most employees self-reportedly intend to save more in the future, but only after a delay on the order of weeks to months rather than days. The calibrations also suggest the improbability of explaining employee response to the small reward through beta-delta preferences alone, this time without invoking data on employee beliefs.

After describing similar challenges confronting other approaches for modeling present focus, we conclude by proposing a novel account informed by an intriguing empirical correspondence between employee saving and financial anxiety, the exploratory friction assessed in the survey. Specifically, most employees reported substantial anxiety about their current financial situation yet expressed optimism about achieving relief from such anxiety in the intermediate (weeks to months) but not immediate (days) future. This pattern of high present anxiety and delayed optimism parallels the dynamic of low present saving and delayed intent to increase future saving. Prompted by this correspondence, and a large literature on the avoidant effects of anxiety on decision-making (e.g., Hartley and Phelps 2012), we specify a hedonic model of present-focused savings. The model stipulates that the high financial anxiety afflicting low-saving employees creates a hedonic cost to engaging stressful financial decisions, such as 401(k) enrollment. Crucially, employees believe their anxiety is temporary and have well-defined, and possibly overly-optimistic, beliefs as to when they will transition to a state of low anxiety. The model predicts that a well-informed, utility-maximizing, but financially anxious employee might delay enrollment if the expected benefit of delay (cost-savings with less anxious enrollment) exceeds its cost (foregone match). In this framework, rewards motivate employees not through their financial value but by reframing enrollment from an anxiety-laden decision about one's future to an exercise in immediate reward-seeking, an interpretation for which there is neuroscientific support (McClure et al. 2004).

Calibrations indicate that the model can explain both lengthy enrollment delays and the stated intent of employees to increase saving in the intermediate future without assuming implausibly high costs

of enrollment disutility. And consistent with model predictions, we observe a negative correlation between present anxiety and plan engagement and a positive correlation between the timing of forecasted reductions in anxiety and future intentions to save. Given that the descriptive accuracy of the model hinges on the distinctive phenomenon of high anxiety in the present coupled with an expectation of delayed hedonic relief, we surveyed a national sample of employees outside the firm using a richer set of elicitations. The supplementary survey corroborated the hedonic patterns from the field—indeed, the most anxious respondents expected their hedonic situation to *worsen* before eventually improving.[7] Beyond offering a coherent account for the present findings, we describe how this framework offers a potential explanation for other empirical puzzles such as the documented insensitivity of employees to increases in the plan match, the efficacy of automatic-enrollment, and persistent gaps in actual and intended saving.

We see this research as offering lessons for policymakers and 401(k) plans seeking to improve the financial well-being of employees. In the near-term, our findings challenge the presumption that improving employee literacy at the time of enrollment (e.g., through personalized guidance, financial education), further simplifying enrollment, or clarifying the generosity of the match will alone lead to substantial increases to engagement. Instead, our findings spotlight reforms receiving less attention in the literature, such as the use of small participatory rewards, and, suggestively, interventions aimed at raising non-participant awareness of their enrollment status. To clarify whether these prescriptions challenge prevailing beliefs among industry and policy stakeholders, we surveyed attendees of a recent invite-only forum on US retirement policy—high-ranking officials from federal and state governments, large financial service firms, and national policy organizations. When asked to assess a menu of potential interventions, attendees rated reductions in enrollment complexity, increases in the plan match, and personalized guidance as the most effective strategies for increasing saving.

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

[7] While consistent with prior research on a more general cognitive bias toward optimism (Sharot 2011), we believe this is the first evidence asserting the phenomenon of systematically delayed optimism regarding future financial anxiety.

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, apart from Social Security, through which US employees at for-profit establishments save for retirement. These plans, named after the sub-section of the legislation that enabled them, The Revenue Act of 1978, permit qualified employees to contribute a capped share of pre-tax salary by automatic deduction into a portable, tax-deferred, 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.[8] Beyond favorable tax-treatment and portability, often-generous plan matching incentives contribute to the economic attractiveness of 401(k) plans. One prominent industry survey of 2,097 defined contribution plans found that, as of 2020, 73 percent of plans offered an employer match, including 81 percent of larger plans with over $200m in assets.[9] While matches varied in their generosity and structure, the modal match (36 percent) entailed a 100 percent employer match up to a 3 percent contribution rate limit while the second most frequent match (26 percent) entailed a 50 percent employer match up to a 6 percent contribution rate limit. A majority of plans had adopted automatic enrollment and, when offered, 76 percent of default investments were target-date funds.

Plan Engagement. Three metrics help to characterize 401(k) plan engagement among 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, as of 2020, was 80 percent with an average participant contribution rate of 7.4 percent. Presumably due, at least in part, to the higher adoption of automatic enrollment (and auto-escalation), larger plans have both higher average participation rates and higher average participant contribution rates. A significant share of 401(k) eligible employees, however, fail to fully claim available matching incentives. One paper documented that across the universe of several thousand small-to-midsize plans 401(k) administered by a large US plan provider in 2016, 73 percent of eligible employees failed to fully take-up available matching incentives (Bhargava et al. 2021). Although one might expect plan engagement to rise with the generosity of the match, several studies have documented a modest relationship between the presence and generosity of plan matching incentives and engagement (e.g., Papke and Poterba 1995; Choi et al. 2002; Duflo et al. 2006; Kusko, Poterba, and Wilcox 1994; see Madrian 2013 for a review).

[8] Table A1(a) of the Private Pension Plan Bulletin, 2019 Abstract Form 5500 Annual Reports, EBSA (2021), retrieved 12/2021.
[9] Based on statistics from a prominent annual industry benchmarking survey for defined-contribution plans administered by PLANSPONSOR magazine in 2020. The survey summarized plan statistics for 2,097 defined contribution plans, of which 89 percent were 401(k) plans.

Retirement Preparedness. While researchers and policy analysts concerned about retirement preparedness have prioritized challenges pertaining to expanding 401(k) plan access and increasing plan participation, recent industry surveys and academic studies assert that a significant share of 401(k) *enrollees* may be insufficiently prepared for retirement. For example, one study sought to estimate the share of 401(k) enrollees at risk of retirement insecurity—i.e., a level of savings at retirement (inclusive of Social Security) insufficient to sustain a modest standard of living without return to the workforce or means-tested benefits—through a series of simulations using administrative records for 186k enrollees across 840 automatic-enrollment plans (Bhargava et al. 2021). While the precise share of risk depends on preferred parameter assumptions, midrange assumptions regarding future equity returns implied an estimated 44 percent of enrollees had a non-trivial risk—arbitrarily defined as a risk in excess of 25 percent—of insecurity. Given that the exercise relied on conservative assumptions for retirement age and contribution inertia and ignored savings leakage due to loans, early withdrawal, or job transitions, the figure likely underestimates the actual share of retirement risk among current 401(k) plan enrollees.

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 401(k) plans more broadly. The firm instituted automatic enrollment for new hires beginning in 2015 at a default contribution rate of 4 percent and a target-date fund as the default investment). In June 2015, the firm conducted an "enrollment sweep" whereby they informed tenured employees who were benefit-eligible prior to 2015 and were presently contributing less than 4 percent that they would be automatically enrolled in the plan at a 4 percent contribution rate the next month unless they decided to opt-out.[10] As of July 2016, approximately 10 to 15 percent of new hires eligible for automatic enrollment or tenured employees subject to the enrollment sweep had opted out. Employees could adjust their contribution online by proceeding through a simple webflow from their online benefits portal. The plan processed enrollment adjustments within one to a few days after which the adjustment was implemented for the subsequent two-week pay-cycle.

The firm offered a plan match somewhat 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 earning less than $50k each year and contributing below the threshold, the minimum match implied a marginal return to the next contributed dollar ranging from 100 to 367 percent

[10] Conversations with industry suggest the increasingly popularity of enrollment sweeps that target tenured employees.

in the subsequent 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 potentially high costs of enrollment. While stylized, the model captures several relevant features of the enrollment decision including the central tradeoff between the immediate costs and delayed benefits of enrollment. After describing the decision environment, we consider the case of a fully-informed, utility-maximizing, employee subject to exponential discounting and then consider departures from this baseline informed by each psychological friction of interest.

3.1. The Saving Decision

We define the savings decision for a non-participating benefit-eligible employee as a choice between enrolling in a 401(k) plan now or delaying enrollment to a future period, indexed in business days. For simplicity, we restrict our attention to the decision to enroll at a 4 percent contribution rate in a plan that offers a dollar-for-dollar match up to a 4 percent threshold. We incorporate present focus into the framework by allowing employees to exhibit present bias 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 to reflect the inertia that typifies 401(k) contributions, 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 initially denote the costs of enrollment by k and interpret such costs to include the opportunity time-costs associated with administrative enrollment (including any time required

to select a contribution rate).[11] 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 driven by the financial value of the match and any tax-related benefits of delayed consumption. We proceed to consider the enrollment decision for a baseline employee whose behavior is governed by standard model assumptions.

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

A utility-maximizing employee with time-consistent (delta) preferences will enroll immediately, or never, if the present value of expected benefits from enrollment exceeds the perceived disutility of enrollment. We can describe the enrollment decision with the following inequality:

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

Noting the Taylor series expansion for $\frac{\delta}{1-\delta}$, we can rewrite the enrollment decision rule as: $k \leq \frac{\delta b}{1-\delta}$.

Prediction: The probability of enrollment for an exponential discounter increases in *b* and decreases in k.

3.3. Psychological Frictions

Friction 1: Present Bias ($\beta \in (0,1)$). 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 such as enrolling in a savings plan with a plan match, 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. O'Donoghue and Rabin 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 initially note that a sophisticated employee with present bias prefers to enroll today, rather than delay T days, if:

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

[11] 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.

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 to the sophisticate, a fully naïve present-biased employee expects to behave as an exponential discounter in the future. Therefore, a naïve present-biased employee will enroll (today) if: $k \lesssim \frac{\beta b}{1-\beta}$. For the remainder of this section, we assume sophistication for present-biased employees and revisit the possibility of naiveté later in the paper.

Prediction. For a present-biased employee with sophistication, the maximum enrollment delay rises in *k* and falls in β and b.

Friction #2: Retirement Literacy ($\hat{b} < b$). The next friction we consider captures the possibility that an employee underestimates the minimum level of required saving to ensure retirement saving due to deficits in retirement literacy. These deficits could involve biases in retirement-relevant beliefs (e.g., the length of one's working life, growth of future income, the investment returns to saving) or financial illiteracy (e.g., a lack of numeracy, misunderstanding of inflation, etc.). To avoid complicating the framework, we model an employee's underestimation of how much to save as equivalent to underestimation of the benefits of saving, $\hat{b} < b$.[12] This implies that an exponential 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.

Prediction: 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 $\hat{b}$.

[12] 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 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.

Friction #3: Plan Confusion ($\hat{\mu} < \mu$). The third friction we consider captures the possibility that employees underestimate the plan match for which they are eligible. This could be due to an underestimation of the match, a lack of awareness of the existence of the match, or an underestimation of eligibility. We model this friction as $\hat{\mu} < \mu$, or equivalently, $\hat{b} < b$. Due to this equivalence, the decision rule and maximum delay for an employee subject to plan confusion are identical to those that govern employees with deficits in retirement literacy.

Prediction: The likelihood of enrollment for an exponential employee with confusion increases in $\hat{b}$ (equivalently, decreases in match underestimation). The maximum delay under confusion decreases in $\hat{b}$.

Friction #4: Enrollment Complexity ($\tilde{k} > k$). A final friction captures the possibility that employees view the disutility of enrollment, $\tilde{k}$, as exceeding the economic time-costs of administrative enrollment due to its perceived complexity, such that $\tilde{k} > k$. Perceived complexity could heighten the expected costs of enrollment by causing an employee to overestimate the time/effort required to enroll or by causing the employee to view enrollment as psychologically costly. The notion that small administrative burdens, or hassle costs, could lead to outsized disutility has precedence in the prior literature (e.g., Bertrand, Mullainathan, and Shafir 2004). The expressions governing the enrollment decision and maximum delay for an employee who perceives enrollment as highly complex resembles the above but for the replacement of k with $\tilde{k}$.

Prediction: The likelihood of enrollment for an exponential employee who perceives enrollment as complex 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 low- and non-saving employees at a large US financial services firm in July 2016.[13] 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.

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

The second module promised employees to assess their retirement preparedness, based on their prior responses, and if necessary, provide them with guidance to improve their preparedness. It was within this second module that we implemented the field experiment by randomizing employees to one of several information- and/or incentive-based treatments. While the survey provides evidence as to the baseline prevalence of each friction and the field experiment offers evidence as to the average effect of reducing/engaging each friction on saving (evidence for one friction, enrollment complexity, relied on a pre-period comparison), jointly, the survey and field experiment clarify the heterogeneous importance of frictions across employees differing in baseline incidence. In this section, we describe the sample, research design, procedure, and contents of the survey and experimental treatments in greater detail (see Figure 1 for a schematic overview of the study).

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 provided in the invitation email within the ten-day survey period. To encourage a high response rate, we informed employees that completing the survey would enter them into a raffle for an Apple iPad and we sent a reminder to complete the survey via a second email prior to the deadline.

We constructed the invitation sample with two considerations in mind—an intent to target undersaving employees of low-to-moderate income and the firm's request to limit invitations to 5,000 employees. Because we sought to differentiate interventions based on whether an employee had claimed the plan match, we ultimately invited two non-overlapping samples to participate in the survey. The primary sample (henceforth, the Low-Saving Arm, or "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 (henceforth, the Moderate-Saving Arm or "Moderate Arm") comprised a random draw of all 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 ultimately participated in the survey during the study period, a fairly high response rate for an email solicitation. We attribute the response rate to several factors including the email reminder, lottery-based incentive, and sponsorship/promotion by the employer. After excluding employees who exited the survey prior to the final module or who self-

reported a disqualifying contribution 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).[14]

Table 1 describes the demographic, financial, and savings background for the invited and respondent samples. The table offers at least two insights into the representativeness of the samples and potential generalizability of the research. First, the table conveys substantial sample diversity across demographic categories (notably, the sample is disproportionately female, like the broader firm). With particular respect to income, Appendix Figure A1 compares the income distribution of the samples to a contemporaneous, national, sample of full-time US employees drawn from the 2015 CPS. The figure indicates the approximate representativeness of the samples to the national cross-section but for a modest over-representation of those of low-to-moderate income. Second, the table (and figure) additionally convey the demographic similarity between the respondent and invited samples, suggesting limited selection based on demographic observables. 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 online instrument was a survey intended to collect background detail and to assess the employee-specific incidence of the candidate frictions. The survey was identical for all respondents excepting questions that were customized to reflect either personalized detail (e.g., an employee's contribution rate) or prior response or were restricted to a random subset of respondents in an attempt to manage survey length.[15] 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. We used this background data to calculate a personalized contribution recommendation for each employee (presented to select employees in the retirement assessment), carry out robustness tests involving financial illiquidity, and to otherwise inform subsequent analyses. Of particular note, to assess the degree to which employees were constrained by financial illiquidity, we adapted questions on liquidity from a prominent national household survey

[14] 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.

[15] 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.

administered by the Federal Reserve Board.[16] 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).[17] Specifically, to generate a first, direct, measure of employee underestimation, we asked 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).[18] Recognizing the widespread use of third-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 translated these inputs (again, accounting for social security benefits and the plan match) into an annual contribution rate using the same retirement savings calculator and compared this rate against the benchmark. We interpret the two resulting indicators of saving underestimation as lower-bounds given the conservative benchmark inputs and because the exercise ignores the potentially substantial diminution of employee savings due to leakage due to loans, early withdrawal, or job transitions. Finally, prompted by the literature asserting that deficits in financial literacy are a cause of low saving (e.g., Hastings, Madrian, and Skimmyhorn 2013; Lusardi and Mitchell, 2014), our third measure of retirement literacy was an indicator of low financial literacy. We assessed financial literacy using two widely-used questions about inflation and compound interest popularized by Lusardi and Mitchell (2007).

[16] Specifically, 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 2015 Survey of Household Economics and Decision-making, a national household survey administered by the Federal Reserve Board.

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

[18] 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 percent (current income less than $25k), 100 percent (current income between $25 and $55k), or 80 percent (current income above $55k) 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 assumed no accumulated savings for employees under 50 and $50k in savings for those above 50 and conservatively assumed a 5 percent real rate of investment return (see Bhargava et al. 2021 for discussion of these assumptions). Finally, we constrained recommendations so that they were between 4 (full match take-up) and 25 percent.

We measured the incidence of a second candidate friction, *plan confusion*, through a series of 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, our intent was 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 potential lack of awareness that a match exists). To help differentiate confusion from survey inattention, we included an "attention check"—a generic question on work-life balance that instructed anyone reading the question carefully to proceed to the next page without selecting a response.

We assessed the incidence of a third candidate friction, *enrollment complexity*, with two measures. First, we asked respondents to estimate the time required to adjust their contribution rate, or to newly enroll, via the enrollment portal, including any time required to select an appropriate rate. Given the simplicity of the enrollment/plan change webflow—we surmise that, excluding deliberation, one could adjust their plan contribution in less than a minute—we used these estimates to construct an indicator of likely overestimation of the time required to enroll (i.e., more than several minutes) and an indicator for the potential perception of enrollment as prohibitively time-consuming (i.e., more than a few hours). As an alternative strategy for measuring whether an employee perceived enrollment complexity as an impediment to save, 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 could reflect insight into personally-relevant mechanisms.[19]

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 measure followed the literature in asking 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 module, employees progressed to a second module that evaluated each employee's retirement preparedness based on earlier survey response and administrative data and promised to facilitate any desired change in plan contribution. In practice, this module also implemented the field experiment by varying the webflow encountered by employees. As depicted in Figure 1, an

[19] The strategy of inferring the presence of a friction from introspection as to causes of an empirical puzzle was borrowed from Bhargava and Manoli (2015) who used this strategy to better understand psychological frictions in EITC take-up.

employee's webflow was determined by non-random assignment to a study arm (i.e., based on their self-reported contribution rate) and random assignment to a primary, and for many, a secondary, experimental treatment within a study arm. The design permitted us to differentiate experimental tests based on whether an employee had exhausted the match and, in some cases, to increase statistical power by sequentially randomizing employees to multiple treatments.

More concretely, we assigned employees reporting a contribution of 0, 1, 2, or 3 percent of salary to the Low Arm and assigned remaining employees to the Moderate Arm. Within each arm, we initially randomized employees to one of three (Low Arm) or two (Moderate Arm) primary experimental treatments after which employees were afforded an opportunity to increase their contribution. We then re-randomized employees who had declined to increase their contribution, and had not been offered a small reward via the primary treatment, to one of two versions of a prompt asking them to reconsider their contribution decision. Employees who had not increased their contribution initially but had been offered a small reward were all assigned to a baseline version of the reconsideration 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 (i.e., the retirement preparedness module), we first describe a baseline webflow. The baseline webflow served as one of the experimental conditions of the Moderate Arm (generic recommendation) and also constitutes the 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.[20] To encourage follow-through,

[20] 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."

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 respondents assigned to 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.

- 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 to not 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 who initially declined to increase their contribution to one of two versions of the saving reconsideration prompt—the baseline version or an amended version offering the small reward (because no one in this arm was offered the reward as a primary treatment, we did not further restrict assignment to the secondary treatment as we did in the Low Arm).

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.[21] 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-savings 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. We begin by summarizing the overall response to the survey and the experimental treatments as they pertain to candidate frictions. To facilitate analysis and exposition, we

[21] 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.

constructed several dichotomous measures to capture employee-specific incidence for each friction. Table 2 organizes these measures by 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 (note that differences in sample size in column 1 reflect the strategy of randomizing employees across some subsets of questions). The final two columns of the table describe how these measures correlate with engagement, reporting p-values for tests of mean differences across plan participation and full match take-up. We present data on an extended set of survey measures in Appendix Table A2.

Overall, the table reveals a diverse pattern of incidence across the frictions. The most pervasive friction is that of low retirement literacy, with nearly one-half of employees either directly or indirectly underestimating how much they should save relative to a conservative benchmark. The table indicates a more moderate degree of plan confusion—while most employees were aware that they were eligible for their 401(k) plan, 20 percent underestimated the generosity of the plan match (and in an unplanned analysis, an even greater share overestimated their actual plan contribution). With respect to perceptions of enrollment complexity, while about one-quarter of employees likely overestimated the time required to make a plan adjustment, few employees perceived it as sufficiently time-consuming so as to conceivably affect the decision to enroll due to time-costs alone. Finally, the table is less diagnostic as to the prevalence of present focus. While 10 percent of employees explicitly exhibited present focus as indicated by a preference reversal in the intertemporal effort allocation task, for the large majority of employees, we could not rule out present focus based on their survey response. When asked for their lay-theory as to why auto-enrollment systematically increases plan enrollment, a far larger employee share of 60 percent cited an explanation involving present focus. Several of the 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. In particular, 68 percent of employees reported insufficient savings to cover emergency expenses, while 39 percent reported insufficient access to liquidity via savings, borrowing, or the sale of assets (Table 1). The prevalence of illiquidity in our sample parallels the findings of contemporaneous national household surveys of financial well-being, such as the National Financial Capability Survey (NFCS) administered every three years by FINRA.[22] Consistent with their possible role in undersaving, the illiquidity measures negatively correlate with plan engagement.

Experimental Response. Turning to the field experiment, a significant share of sampled employees modified their contribution during the study period. Specifically, during the two pay-cycle duration of the study, 10.5 percent of employees modified their contribution. Eighty-seven percent of

[22] For example, the 2018 NFCS survey of over 25,000 individuals found that 31 percent of respondents could certainly/probably not produce $2,000 through savings, borrowing, or selling valuables to meet an unexpected financial challenge in the next month.

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, 1.4 percent of respondents increased their contribution during the pre-study period, indicating that employees were 6.5 times more likely to increase saving during the study.

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, the first three columns of Panel A reports OLS estimates of the following model for each saving outcome, s_i: $s_i = \gamma\, SR_i + \theta\, MC_i + \beta\, Reward_i + \varepsilon_i$, 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 estimates for the relevant saving outcomes from regression models adapted to the moderate-saving 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 indicate that the significant response of employees to the experiment was predominantly driven by the response to the small reward. Providing recommendations, whether generic or specific, and clarifying the match prompted, at most, modest increases in average saving. In contrast, across the primary and secondary treatments in both study arms, 8 to 16 percent of employees increased saving in response to the $10 microincentive. For those in the Low Arm, who had previously not exhausted the match, a substantial share of contribution increases resulted in full match take-up.

Savings Follow-Up. Finally, we highlight a noteworthy result regarding employee intentions to save in the future. While the majority of employees expressed an intent to save more in the foreseeable future—67 percent of employees, including 63 percent of plan non-participants, indicated they were moderately to very likely to increase their contribution within 12 months—most 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.

[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.

5.2. Low Retirement Literacy - Candidate Friction #1

Baseline Incidence and Saving Correlation. With respect to retirement literacy, Table 2 indicates that nearly one-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 both because of the conservatism of the benchmark, ignorance of leakage, and the implicit assumption of accurate plan match knowledge (in actuality, many employees appear to underestimate the generosity of the match). A third measure of low retirement literacy—a score of zero on the two-question assessment of financial literacy—indicates a more moderate incidence of 20 percent, although we note that 66 percent of employees scored one or less on the assessment.[25]

Figure 4 compares the average direct (green) and indirect (blue) beliefs of the annual required saving rate with the benchmark rate by employee age. The figure indicates that underestimation is primarily concentrated among employees in their 40s and 50s. If many younger undersaving employees transition into older undersaving employees, the figure implies that underestimation may eventually afflict an even greater share of employees than we report in the table. The pattern is consistent with the possibility, suggested by the literature, that employees misunderstand the effect of compounding on the trajectory of savings (Stango and Zinman 2009). To better understand the source of bias, at least for the indirect estimates, we separately examine age-specific average beliefs for each of the three retirement inputs against actuarially-informed benchmarks. This comparison (Appendix Figure A4) points to two sources of systematic bias—beliefs about life expectancy and beliefs about working-life expectancy. The figure documents employee over-optimism about life expectancy relative to either age-specific actuarial estimates or, to a lesser extent, our benchmark assumption of 85 years. It also alludes to employee over-optimism about the duration of working life, relative to either the 63 year average median age of recent living retirees in the US or our benchmark assumption of 65 years.[26] Given the offsetting implications of these two biases for how much to save, the figure raises the prospect that indirect employee beliefs about saving may be more accurate on a whole than a focus on individual biases might naively suggest.

Table 3 also reports the correlation between measures of retirement literacy and plan engagement. The table corroborates assertions in the literature regarding the positive correlation between financial literacy and plan engagement as judged by plan participation (24 percent of non-participants vs. 16 percent of participants scored zero, $p = 0.06$) or full match take-up (23 percent of those not fully taking-

[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).

[26] Our actuarial benchmarks for life expectancy draw on projections from the SSA's 2014 Actuarial Life Table, averaged across 5-year age bins, while the retirement age benchmark was informed by data on recent retirees from the 2017 SHED. The income replacement ratio benchmark reflects a 2016 GAO report that characterizes industry advice as ranging between 70 to 85 percent.

up the match vs. 11 percent of those fully taking-up the match scored zero, $p = 0.02$). The evidence on the correlation between employee underestimation of saving and engagement is mixed—indirect underestimation predicts lower participation but without statistical significance ($p = 0.27$) and negatively predicts full match take-up ($p < 0.01$); direct underestimation does not clearly predict lower engagement.

Experimental Test of Low Retirement Literacy. While the survey documents widespread employee underestimation of how much to save, a more moderate share of low financial literacy, and a correlation between at least some of these measures and plan engagement, we explicitly test for the causal role of retirement literacy through the field experiment. If deficits in retirement literacy cause employees to underestimate how much to save, and such underestimation leads to undersaving, then presenting employees with a specific, credible, saving recommendation should increase contribution rates. A causal relationship between literacy and saving also implies that employees initially underestimating how much to save, or scoring low in financial literacy, should be particularly, or differentially, responsive to a specific recommendation than their higher literacy counterparts.

On average, we find that employees did not substantively increase contributions in response to the experimental provision of a specific recommendation (the precision of the estimates permit us to reject anything more than a modest 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 ($p_{diff} = 0.70$).

It is possible that employees did not respond more decisively to the specific recommendation because of inattention or skepticism as to the credibility of the recommendation. Table 4 explicitly tests this possibility by describing the effect of experimental assignment on employee beliefs. The first set of columns reports the marginal effect of assignment on an indicator for whether an employee's direct estimate of how much to save met or exceeded the benchmark recommendation (constant suppressed). The estimates indicate that the specific recommendation significantly increased the share of non-under-estimation 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 the average employee response to the specific recommendation offers little support for a causal pathway between retirement literacy and saving, we can additionally test whether differences in the baseline incidence of each friction predict heterogeneous response to the experimental treatment. Table 5 implements this test for each indicator (and also summarizes the 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 between employees varying in baseline retirement 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 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 surveyed employees—underestimated its generosity. This figure almost surely understates the true degree of underestimation since we did not explicitly ask employees about the $2,000 minimum match, a provision that effectively increased 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 (However, it is worth noting that this particular correlation may 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 (i.e., who had not exhausted their match) responded to the treatment clarifying the generosity of the plan match. As reported in Table 3, comparing employee response to match clarification and the specific recommendation suggests that clarifying the substantial benefit of the match did not lead to an increase in employee saving. The estimates are 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 ranked 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 single calendar year if they were to increase their contribution to 4 percent and maintain full match take-up (assuming no salary change). In practice, this value could be larger or smaller than those in the figure depending on one's assumptions about counterfactual adjustments to contribution rates. Ignoring potential compositional differences across samples, the figure implies that response to match clarification was not sensitive to the potential value of the unclaimed match– even employees who stood to gain a few thousand dollars annually did not save more when their match was clarified.

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. While our field study was designed to test for the importance of employee confusion regarding plan eligibility and match generosity, our analysis revealed an unanticipated dimension of confusion—remarkably, 28 percent of respondents reported a contribution rate inconsistent with administrative records. Most of these discrepancies—24 percent of the overall sample—involved employees who *overestimated* 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 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 more formally bound the potential role of inattention, we calculated the share of discrepancies among the 60 percent of respondents who passed the strict attention check embedded in the survey. As reported in Table 7, this restriction 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 involving employee confusion is that employees may have deliberately exaggerated their contribution rate, perhaps in an attempt to increase the social desirability of their response. Once again, the distribution of discrepant reports—peaking in the lower half of the ordered menu of options—appears inconsistent with such an account. However, to more formally test the potential role of exaggeration, we attempted to estimate the rate of discrepancy after explicitly excluding employees whose response to other questions on the survey were consistent with potential exaggeration. We implemented this strategy by identifying 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) and then classifying anyone who answered with the highest available response category as an exaggerator. The exercise identified five opportunities for exaggeration throughout the survey via questions pertaining to salary, plan contribution rate, accumulated savings, education, and confidence in retirement preparation. After including a sixth exaggeration

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

screen—a comparison between self-reported salary with our administrative record of salary decile—we recalculated the share of discrepant reports after first excluding anyone tagged as a potential exaggerator using each (or any) of the screens, reported in Table 7. Using the most expansive characterization of exaggeration (exaggeration on any screen) the adjustments 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. We conclude that a substantial share of employees were confused about their actual plan contribution rate, including roughly one-fifth to one-third of 401(k) non-participants who mistakenly thought that they were 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 summarizes the three baseline measures of perceived complexity. The table reveals that 23 percent of employees likely overestimated the time required to enroll (including the time required to select one's rate) in estimating that plan adjustment required more than a few minutes. Perhaps more relevantly, 11 percent of surveyed employees perceived enrollment as sufficiently time-consuming (more than a few hours) so as to conceivably lead an employee to delay enrollment, particularly if the disutility of adjusting one's plan included hassle costs that extended beyond wage-based time-costs. The perception of the time required to enroll as (potentially) prohibitive moderately predicted plan participation (0.14 for non-participants vs. 0.09 for participants, $p = 0.04$) but not full take-up of the match. The table also indicates that while a small share of respondents hypothesized that enrollment complexity could help to explain the efficacy of automatic enrollment, such lay-beliefs did not predict plan engagement.

Experimental Test of Enrollment Complexity. While the survey suggests that only a small share of employees perceived enrollment as sufficiently complex to plausibly impede saving, we turn to the field experiment for more direct evidence. Specifically, we compare the increase in plan contribution among those assigned to the generic recommendation in the Moderate Arm to the increase during the pre-study comparison period. Table 3, which implements the comparison, indicates that assignment to generic guidance did not lead to a discernable increase in saving. To affirm that exposure to the online instrument, which conveyed that plan adjustment could be accomplished in seconds and promised step-by-step instructions, actually led employees to modify their beliefs, we appeal to within-subject estimates of belief reported in Table 4. The table suggests, albeit with imprecision, that proceeding through any of the experimental webflows substantially reduced the share of employees who perceived enrollment as highly

time-consuming (or alternatively, increased the share of employees perceiving enrollment as requiring only a few minutes or less).

Differential Response by Baseline Incidence. As a final test of the causal influence of enrollment complexity, we report the differential response of employees to generic guidance across baseline perceptions of complexity. Table 5 indicates that employees who perceived enrollment as complex, by any of the three survey measures, were no more responsive and, in fact, were directionally less responsive, to generic guidance than their counterparts. Overall, we interpret the low baseline perception of prohibitive complexity, the lack of a meaningful increase in saving in response to simplifying guidance (which appeared to reduce perceptions of complexity), and the absence of such response among employees who viewed enrollment as highly time-consuming or complex at baseline as offering little evidence indicting complexity as an impediment to saving. Moreover, the estimates have sufficient precision to rule out complexity as influencing any more than a modest share of employees in this setting.

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 attend 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, however, Table 2 does not suggest a negative correlation between present focus and 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 (implemented as either a primary or secondary treatment in either of the two study arms). For employees in the Low Arm, we can additionally compare 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 their retirement savings equivalent to $2,000 ($3,800) for a single calendar year, equivalent to roughly $77 ($146) per pay period. While the precise value of the

foregone match depends on assumptions of counterfactual saving, an acceleration in claiming of even a few months represents significant, but delayed, financial value.

Table 3 indicates that 8 to 16 percent of employees increased their contribution following exposure to the small reward across implementations (all, $p < 0.01$). Overall, among any employee offered a small reward, 11.8 percent increased their contribution. Among those who had not yet exhausted the plan match (i.e., employees in the low-saving arm), one-third to one-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 (the point at which we inferred employee response from administrative records) persuade us that the documented response did not reflect a strategic intent of employees to temporarily increase contributions so as to claim the reward. Over the four months following the study for which we have data, we find no evidence for meaningful reversals among those who increased their contribution during the study.

One can additionally contrast the substantial response of employees to the microincentive to the, previously discussed, small, and precisely estimated, response to the clarification of the plan match ($b = 0.01$, $se = 0.01$). To better understand the potency of the immediate small reward in comparison to the significant, but delayed, value of the match, we appeal once again to Figure 5. The figure shows that across a wide-range of plan match value, from approximately $500 to $3500, employees were significantly more responsive to the $10 gift card than match clarification. This is despite many employees underestimating the match, for whom clarification could be construed as novel information.

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 causal 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 likely to respond to the reward than counterparts ($p = 0.17$) while those indicated as present-focused by the introspective measure were twice as responsive to the small reward ($p < 0.10$). 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 the analysis does not substantiate, at least in this setting, the importance of *low retirement literacy* in explaining undersaving. Consistent with assertions in the literature, we do find widespread deficits in retirement literacy, whether measured through underestimation of required saving or assessments of financial literacy, and find that at least some of these measures predict plan engagement in the cross-section. Yet our experiment suggests that improving retirement literacy through personalized guidance

changes beliefs about how much to save but does not meaningfully increase saving, either among all employees or just those with low baseline literacy.

What might explain why improving the accuracy of retirement-relevant beliefs does not lead employees to save more? In theory, a utility-maximizing employee with well-calibrated beliefs might rationally delay enrollment in a plan with a generous match if they lacked financial liquidity and faced exceedingly high costs of borrowing or adjustment to consumption. There are at least two reasons to be skeptical that the liquidity constraints afflicting employees in this setting could, on their own, explain the unwillingness to save. First, the return to a marginal dollar of contribution for many employees equaled or even exceeded 100 percent (reaching 367 percent in our sample). This implies that an employee's cost of capital must have been exceedingly high over a prolonged period to justify delayed enrollment for that reason alone, particularly given the availability of 401(k) loans and hardship provisions. Second, in comparing the behavior of employees across our two measures of emergency liquidity (Table 1), we find no difference in experimental response to the personalized recommendation ($p = 1.00$), emphasizing that even those not severely constrained by liquidity did not respond to the improvement in retirement literacy.

Figure 4 offers another 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 (dashed-black). The comparison shows that while many employees, particularly ones who begin 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. In addition, a simple regression reveals that variation in beliefs about how much to save does little to explain variation in undersaving.[28] Even among the eldest employee 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 contribute, 88 percent of employees already recognize that they are undersaving, often by a substantial amount. A closer inspection of indirect beliefs suggests that another potential explanation for why a singular focus on individual biases may overstate the overall importance of retirement literacy is that two of the biases have offsetting implications for how much to save. That is, while over-optimism about the longevity of working-life implies a reduced need to save (greater accumulation), over-optimism about life-longevity implies a greater need to save (greater decumulation).

[28] A bivariate regression of benchmark and perceived actual saving yields an adjusted R-squared of -0.007. The inclusion of employee beliefs about how much one should save does not meaningfully increase explanatory power of the linear model (0.0008 adjusted R-squared with direct estimate; 0.0008 adjusted R-squared (also) with indirect estimate).

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), should not be solely attributed to widespread employee confusion about the match, even though some confusion about plan details likely exists.

A third insight highlights a potentially important determinant of low plan engagement largely absent from the academic literature—employee confusion regarding their 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 potential alternative explanations of inattention or deliberate exaggeration, we conclude that the majority of these 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 a one-time automatic enrollment sweep of existing employees, increasingly popular among large 401(k) plans. Second, as reported in Table 5, employees who overestimated their contribution and were randomly assigned to the small reward condition were more than three times as likely to increase their contribution ($b = 0.21$) than counterparts ($b = 0.06$) ($p_{diff} < 0.01$). A possible explanation for the differential response is that many genuinely confused employees increased their contribution upon discovering their actual contribution rate.[29]

The presence of substantial employee confusion regarding one's contribution rate (or even enrollment status) may seem incredible from the perspective of traditional economic models of saving, particularly given the generosity of the plan match. However, consider that newly hired employees at our partner firm were asked to make enrollment decisions for up to twelve employee benefit programs—i.e., retirement savings, life insurance, commuting benefits, short and long-term disability insurance, personal accident insurance, medical and prescription health plans, dental insurance, visual care coverage, health

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

savings account, a wellness program—characterized by varying rules governing eligibility and default enrollment. When evaluated in the context of the broader complexity of the benefit program landscape, 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 sufficiently time-consuming so as to conceivably affect the decision to save in the absence of some other friction. We find that while proceeding through the baseline condition of the webflow reduced the perceived effort required to enroll, it did not prompt an increase in contributions, even among those originally perceiving enrollment as particularly time-consuming or among those not explicitly subject to liquidity constraints. Even if one assumes the presence of psychological, or hassle, costs of enrollment that extend beyond wage-based time-costs, it is difficult to reconcile our evidence with the claim that enrollment complexity meaningfully deterred saving in this setting. 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.

Most centrally, the survey and field study provide perhaps the most direct evidence as to the causal influence of present focus on 401(k) saving. While the survey suggests highly varying but non-trivial prevalence of present focus, the experiment reveals the responsiveness of a significant share of employees to the immediate small reward but not clarification of the substantially larger, but delayed, match. Even employees previously underestimating the match, and for whom clarification should have provided novel information, exhibited this differential response. As additional evidence, those indicated as present-focused by baseline measures were, judging from point estimates, 2 to 3.5 times more likely to respond to the small reward. Given that many respondents increased their contributions by more than one percentage point and increased contributions persisted after the study diminishes the likelihood of alternative motives involving strategy or financial illiquidity. The willingness of many low-saving employees to increase contributions, and earn matching incentives, in response to a small reward contrasts with their documented insensitivity to other widely-discussed interventions such as changes to match generosity (Madrian 2013) or the provision of saving recommendations/guidance (present research).

Beyond the differential response to experimental treatments, our administrative and survey data provide evidence implicating widespread present focus in 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), confirmed non-underestimation of the plan match (80 percent of the sample), non-belief in enrollment complexity (89 percent), and the absence of emergency liquidity constraints (61 percent of the sample). This implies that a substantial share of employees delayed either enrollment, full match take-

up, or benchmark saving despite the desire to save, a belief that enrollment was not prohibitively complex, awareness of plan eligibility, and knowledge of a significant plan match. In the remainder of the paper, we explore the potential mechanisms underlying present focus in the experiment and the baseline saving of employees and discuss implications for optimal policy design and administration.

6 INVESTIGATING MECHANISMS UNDERLYING PRESENT FOCUS

In this section, we investigate potential explanations for the present-focused behavior of employees. We initially consider whether a model of present bias, the predominant approach for explaining present focus within economics, can explain the baseline decision of employees to delay 401(k) enrollment despite the stated intent to save and confirmed knowledge of plan eligibility/match and the differential willingness to increase saving in response to the small, immediate, reward but not clarification of the larger, but delayed, match. After briefly discussing the plausibility of other 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 a model of present-biased preferences can account for the baseline decision of employees to delay enrollment through a series of calibrations. Specifically, we calibrate the previously introduced beta-delta model of enrollment, under varying assumptions about the costs of enrollment, to determine whether it can explain delayed enrollment given a plausible degree of present bias. We restrict our consideration to the previously-described 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 treat each period as a business day and assume 250 business days in a calendar year, stipulate that an employee can make only one enrollment decision once each period, and further assume that benefits from the plan match incrementally accrue every period (later, we consider the more realistic scenario in which plan changes are processed at the end of a pay-cycle). For concreteness, we consider the case of a 35-year-old employee earning $50,000 annually ($200 each business 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 $\delta = 0.9997$.

Standard Model. 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) that 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 that enrollment requires 30 minutes, the same hassle factor implies a wage-based enrollment disutility of *k = 50* (i.e., 0.5 hours x $25/hour x 4 hassle factor). Assuming enrollment and deliberation requires 2 hours implies, the hassle factor implies *k = 200*. For an exponential discounter, the decision rule would nevertheless predict immediate enrollment, even allowing for substantial hassle costs.

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 (including many

with confirmed match knowledge), the figure highlights the challenge of explaining delayed enrollment with a model of sophisticated present bias, even assuming substantial psychological costs of 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. Specifically, the figure reports the earliest time-horizon by which employees indicate being either "moderately" or "very likely" to enroll. The plot shows that while the majority of non-participants reported an intent to enroll within a year, 91 percent 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 many other employer-sponsored savings plans, administratively processes plan changes at the beginning of the subsequent two-week pay-cycle. Consequently, at some point in 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 such terminal periods in each pay-cycle, our model implies that a present-biased employee with $\beta = 0.7$ would delay only if $k > 140$ while an employee with $\beta = 0.9$ would enroll immediately for any level of disutility within our considered range, $k \in [12.5, 200]$.[30]

6.2. Present Bias – Experimental Response to Microincentive

The response of a non-trivial share of employees to the microincentive offers another, more direct, test of present bias. Assuming the benefits of the match accrue in every period, the beta-delta framework dictates that for a present-biased employee to enroll immediately in the presence of a small immediate reward but not in its absence (despite confirmed knowledge of the plan match), the employee must associate enrollment with modest disutility and (naively) believe that they would enroll in the very near future. Specifically, our calibrations suggest that an employee with $\beta = 0.7$ who enrolls in response to the reward, but not otherwise, must associate enrollment with disutility, $k \in [14, 24]$. We would expect that, in the absence of a reward, such an employee would delay enrollment by no more than 1.7 days—or a single day given our assumption of one enrollment decision each period. Similarly, immediate

[30] 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 $\beta = 0.7$.

enrollment because of the reward, given $\beta = 0.9$, implies enrollment disutility, $k \in [54, 64]$. In the absence of the reward, the model predicts that such an employee would delay enrollment only by a single day. Again, the stated beliefs of employees regarding the timing of future saving casts doubt as to the plausibility of explaining experimental response through present bias alone.

Discrete Enrollment Choice. The case of discrete enrollment, where an employee must decide at some point during the pay-cycle to enroll immediately or delay enrollment for at least 10 periods presents the most serious challenge for the framework (note that the study period stretches across pay-cycles). The beta-delta model implies that an employee in a terminal period who only enrolls in response to the reward must perceive enrollment disutility as both high and within a highly specific range. For example, an employee with $\beta = 0.7$ who enrolls during the terminal period of a pay-cycle in response to the reward, but not otherwise, must perceive enrollment disutility somewhere between \$140 and \$150. An analogous employee with $\beta = 0.9$ must perceive enrollment disutility within the perhaps implausibly specific range, $k \in [540, 550]$. The calibrations point to the difficulty of explaining experimental response with beta-delta preferences alone, even without invoking data on the future saving intentions of employees.

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 (e.g., psychology, neuroscience, decision science, and economics) 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; Ericson and Laibson 2019 for review). 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 how such costs will evolve in the future).[31]

Researchers have also proposed mechanisms to explain present focus that do not operate via preferences (see Urminsky and Zauberman 2015 for review). These mechanisms involve emotion or drive states (Loewenstein 1996; Shiv and Fedorikhin 1999; McClure et al. 2007), differential construal of proximal versus distal outcomes (Liberman and Trope 1998; Malkoc, Zauberman, and Ulu 2005; Malkoc and Zauberman 2006), psychological distinctions between the present and future self (e.g., Parfit 1984; Bartels and Urminsky 2015), systematic expectations of greater resource flexibility in the future (Zauberman and Lynch 2005), or planning failures (Lynch et al. 2010). While these approaches offer compelling accounts for specific findings in the present research, such as employee insensitivity to the large, but delayed, match, it is not clear how any particular framework, without substantive additional assumptions or structure, could explain the broader pattern of results.

6.4. Hedonic Account of Present Focus – The Serenity Model

Motivating Evidence. Drawing on existing frameworks, 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 (i.e., 2 or higher on a 4-point scale), while 56 percent reported either a fair amount of anxiety (32 percent; 3 on the 4-point scale) or a lot of anxiety (24 percent; 4 on the 4-point scale). When asked to forecast whether they would feel more, less, or the same amount of financial anxiety in either three or six months (horizons to which they were randomly assigned), the survey indicated pessimism in the near-term but increasing optimism over the longer horizon. Of note, among those reporting high financial 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

[31] For instance, employees who discount retirement dollars more severely than other dollars due to negative affective associations with retirement might be less sensitive to matching incentives than predicted by the standard model. However, a high retirement-specific discount rate, in an otherwise standard model framework, cannot readily explain even a single day of baseline delay. 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, a model of present bias with high initial decision-costs, like the model we calibrate, could help to explain modest enrollment delay but not employee response to the small reward or the timing of their future saving intentions.

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 delayed optimism with a larger, national, sample of US employees that featured more granular time-horizons and within-subject elicitations. We administered this supplementary online survey to 905 US full- and part-time employees via Amazon Mechanical Turk in November 2019. The timing of the survey further permitted us to test whether or not the delayed optimism we found was specific to the circumstances employees faced in July 2016. 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.[32] The sample reflected greater gender and geographic balance than the field sample but was otherwise similar in age and imputed income.[33] Figure 7 describes the survey results. The first panel summarizes the incidence of present financial anxiety while the second panel describes the forecasted change in future anxiety for the entire sample (grey line) and separately for subgroups varying in present anxiety. That is, for each time horizon, the latter panel reports the average net change in forecasted future anxiety on a scale of -1 (decrease), 0 (no change), or +1 (increase).[34]

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

Overall, the field study, and the supplemental survey convey a systematic pattern of high present anxiety and delayed optimism regarding future anxiety across a diverse sample of working adults across different points in time. And a significant share of those with severe present financial anxiety seem to expect their situations to worsen before eventually improving. While the prevalence of financial anxiety has been documented in several national surveys of financial well-being, and prior research has asserted a

[32] We asked all subjects to forecast the relative change in their anxiety in one month and one year and randomly assigned subjects to provide additional forecasts for three and/or six months. The survey included another task unrelated to the present study.
[33] The sample was restricted to US employees aged 25 to 55 years. Summary of demographics: (i) gender (0.53 male, 0.47 female), (ii) age (mean: 34.7 years, SD: 7.8 years), (ii) employment status (0.86 full-time, 0.14 part-time), and (iii) estimated salary imputed from categorical midpoints with bounds of $25k and $150k (mean: $53.8k, SD: $27.0k).
[34] Because respondents were asked to generate forecasts over a random subset of future horizons, comparisons across some horizons reflect compositional differences across samples.

cognitive bias towards optimism (e.g., Sharot 2011), to our knowledge, these findings offer the first evidence asserting the phenomenon of systematically delayed optimism with respect to future anxiety (we do not distinguish between well-calibrated optimism and over-optimism, though the persistence of patterns across samples/time suggests the latter).[35]

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 delayed optimism regarding future anxiety might cause an otherwise well-informed and rational employee to exhibit present focus in the context of stressful financial decisions such as enrolling in a savings plan. Two features of the model distinguish it from other theoretical accounts. First, the model assumes that many employees feel anxiety about their present financial situation and that such anxiety imposes a hedonic cost to engaging financially-relevant decisions. Second, the model presumes that financial anxiety is temporary and that 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—broadly defined as a mental state in which one's regulatory system cannot meet the demands of the immediate environment—has been widely studied as a neurophysiological and psychological construct with significant influence on judgment and choice. Researchers have suggested several specific cognitive and motivational channels through which anxiety influences behavior. For instance, anxiety has been linked to activity in brain regions implicated with emotional regulation (Park et al. 2016), attentional control (Eysenck et al. 2007), memory (Wolf 2009), and executive function (Arnsten 1998). One widely-theorized behavioral response to anxiety is that of avoidance (Hartley and Phelps 2012). According to an animal study asserting a direct neural pathway between the brain regions responsible for encoding anxiety-related information and avoidant behavior, the relationship between anxiety and avoidance may be a hard-wired feature of neural circuitry (Jimenez et al. 2018). Avoidance as an action-tendency associated with anxiety has been asserted in the context of financial behavior as well. For example, in a representative survey of US adults, Choi and Robertson (2020) found that 37 percent of respondents who did not participate in the stock market cited "don't like to think about my finances" as very or extremely important for explaining their non-participation. While

[35] For example, our finding of prevalence resembles the 53 percent of households reporting moderate to high anxiety when thinking about personal finances in the 2018 NFCS administered by FINRA.

the relationship between financial anxiety (i.e., anxiety specific to one's personal finances) and anxiety more generally construed has not been extensively examined, at least some have argued that the former should be treated as a theoretically distinct, and measurable, construct that is also associated with avoidance (Shapiro and Burchell 2012). Further, while one might intuitively presume a relationship between financial illiquidity (or financial illiteracy) and financial anxiety, our analysis of the NFCS, as well our field data, indicates only a modest correlation between these constructs.[36]

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

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

[36] 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 in July 2020 from www.usfinancialcapability.org. Income was measured with an 8-point categorical scale; math ability and financial knowledge were measured with 7-point scales. Estimates exclude small share of "don't know" or "prefer not to say" responses.

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 actually approximate how employees mentally represent hedonic expectations insofar as they are internalized as beliefs about the expected timing of anxiety relief as opposed to beliefs about daily hedonic hazard rates.

Enrollment Decision Rule. An employee adhering to the proposed model would decide whether to delay enrollment after comparing the present-discounted value of utility flows associated with delay and with immediate enrollment. After normalizing the utility of never saving to 0, we describe an employee's decision to enroll now (*s=1*) or delay (s=0) by the maximization problem below:

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

Here, *b* denotes the net gain in utility per-period associated with savings (as specified earlier, this gain reflects the post-tax value of the match), $\hat{t}_s$ denotes the expected duration in days until anxiety relief, t_R denotes the start of retirement, and $-f(.)$ indicates the utility-cost of enrollment. We can simplify the enrollment decision by recasting it as a comparison of the expected marginal cost and benefit of delay. The first of these expressions is given by the discounted present value of foregone benefits associated with the plan match, $\sum_{t=1}^{\hat{t}_s} \delta^t b$, while the second is given by the discounted difference between costly and less costly enrollment, $[f(\theta^H) - f(\theta^L)\delta^{\hat{t}_s}]$. A risk-neutral employee in a high anxiety state would therefore enroll if the expected cost of delay exceeded its expected benefit:

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

An employee choosing to delay enrollment would expect to enroll in $\hat{t}_s$ days (or potentially never in the unlikely event that they expected anxiety relief insufficiently close to, or even 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 now stipulates that our employee should enroll if the expected value of the foregone match exceeds the expected savings from less anxious enrollment, $f(\theta^H) < \hat{t}_s b$.

The first panel of Figure 8 provides graphical intuition for this decision rule. The figure shows that a risk-neutral employee with well-calibrated 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,

would begin 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 the model could be modified to accommodate the presence of other frictions, such as low retirement literacy or plan confusion (e.g., match underestimation), that effectively led an employee to underestimate enrollment benefits, $\hat{b} < b$. 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 forecasting, one could also incorporate an optimism bias by assuming $\hat{t}_s < t_s$. Excessive optimism would result in a higher share of delayed enrollment. If employees were persistently over-optimistic, and naïve to this bias, the model could help explain very lengthy delays in enrollment.

Model Predictions. The model generates testable predictions pertaining to financial anxiety and saving. First, the model predicts a negative correlation between present financial anxiety and current saving and/or plan engagement—that is, the model implies that employees facing high present financial anxiety will be more likely to have delayed enrollment or full match take-up than less anxious ones.[37] Second, the model predicts that among anxious employees, beliefs about the timing of future anxiety should correspond to forecasts regarding the timing of future saving. Given that most employees do expect relief from anxiety but only after a delay of weeks to months, model-adherent employees should expect to increase their saving after a delay of similar duration. Finally, we note that the proposed framework also predicts that the framing of an incentive should influence its behavioral response. Research on the neural correlates of choice in the context of an immediate or delayed incentive suggests that immediate rewards activate regions of the limbic system typically associated with regulating emotion and anxiety, whereas delayed rewards engage parts of the lateral prefrontal cortex and posterior parietal cortex, regions associated with deliberative processing and cognitive control (McClure et al. 2004).[38] The implication is that employee response to rewards, and microincentives more generally, arise because the reward reframes the decision from a strenuous financial task to an opportunity for reward attainment (in contrast, employees treat the prospect of a sizable, but delayed match, as a traditional financial incentive).

6.5. Evidence for The Serenity Model

To evaluate the proposed model, we examine whether it can plausibly describe the saving behavior and beliefs of employees in our field sample. We accomplish this by first calibrating the model to ascertain whether it can explain the baseline delay in enrollment with plausible assumptions of

[37] 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.

[38] As we did in the present research, in their examination of the neural correlates underlying reward choice and delay, McClure et al. 2004 used Amazon gift certificates, delivered by email (see supplementary materials).

enrollment costs, particularly in comparison to the beta-delta framework and then presenting correlational evidence to assess the first two of the empirical predictions described above.

Model Calibration. To facilitate comparison with the beta-delta model, our calibration considers 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, and the equivalence of long-term discounting and the interest rate. We also normalize the costs of enrollment 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 (short-dashed line). Vertical dashed lines approximately indicate 3, 6, and 12 calendar months. Overall, the figure conveys that the Serenity Model can rationalize enrollment delays of the length typically forecasted by employees with a degree of enrollment disutility significantly lower, and seemingly more plausible, than that implied by beta-delta preferences. For example, in the beta-delta model framework, assuming a beta of 0.9, an intended delay of three months (63 business days) implies disutility equivalent to $3,402, while an intended delay of six months (125 business days) implies disutility equivalent to $6,750. A beta of 0.7 implies disutility of $882 to $1,750 for this same range. In contrast, the Serenity Model implies enrollment disutility (technically, the difference in disutility across anxiety states) of $378 for a three-month delay and $750 for a six-month delay. Incorporating even modest underestimation of the match, or over-optimism about the timing of anxiety relief, would further reduce these implied costs.

Evidence on Model Predictions. Next, we test the first two empirical predictions of the Serenity Model using data collected from the field survey. The first panel of Figure 9 documents the correlation between self-reported measures of employee financial anxiety and two measures of 401(k) plan engagement—the share of plan participation (left axis) and the share of full match take-up (right axis). Consistent with the first prediction of the model, the panel indicates reduced plan engagement for more presently anxious employees. 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 correspondence between the timing of forecasted reductions in anxiety and intentions to save. More precisely, 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 (solid line) and those that did not (dashed-line). (Employees are characterized as intending to save if they reported being

either "moderately" or "very likely" to increase their saving by the specified time-horizon). 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 (b = 0.04, p = 0.93) or one year, in comparison to less optimistic employees, but were 44 percent more likely to express an intent to increase saving in six months (b = 0.16, p < 0.01). Consistent with the model, the plot implies a correspondence between beliefs about the onset of anxiety relief and future saving. Regression analyses confirm the graphical intuition conveyed by the figure—present financial anxiety negatively predicts current plan engagement while the expected timing of future relief from anxiety predicts the expected timing of future saving.[39]

Other Empirical Saving Puzzles. Beyond providing a reasonable explanation for baseline delays in enrollment and delayed future intentions to save, we speculate that the Serenity Model may help to explain additional empirical puzzles from the literature, including those motivating the present research. As one policy-relevant example, the model could help to explain the relative insensitivity of employees to increases in the generosity of the 401(k) plan match. Consider a plan's hypothetical decision to increase their dollar-for-dollar match limit from 4 percent of salary to 5 percent, an increase in match generosity of 25 percent. Under the Serenity Model (assuming enrollment always entails contributing up to the match limit and assuming enrollment disutility, $f(\theta^H)$, equivalent to \$200), the increase in the plan match would only lead to a change in an employee's enrollment decision if the employee expected hedonic relief within the narrow range between 27 and 33 business days. As another example, the model offers an explanation for the otherwise puzzling success of automatic enrollment in increasing long-run plan participation (i.e., one can interpret automatic enrollment as a mechanism that permits employees, who have a long-run preference for saving, to enroll without incurring its psychological costs). Further, if one assumes that the hedonic optimism of employees reflects a forecasting error, the model could explain the persistent gaps between intended and actual saving that have been documented in the literature. More generally, the model envisions enrollment as substantially more sensitive to factors affecting the immediate costs of enrollment, or forecasts of future well-being, than changes to long-run plan incentives.

7 POLICY IMPLICATIONS AND STAKEHOLDER SURVEY

We see our findings as offering several practical lessons for policymakers and for retirement plans seeking to improve the financial well-being of at-risk US employees. To organize these lessons, we

[39] To assess the relationship between forecasts of future anxiety and saving intentions, we estimate *Pr*(Increased Saving in 6 months) = $\alpha + \gamma_1 \text{LessAnx}_i + \gamma_2 \text{MoreAnx}_i + \mathbf{X}\theta + \lambda_i + \pi_i + \varepsilon_i$. The dependent variable indicates a moderate or higher intent to increase saving in six months, **X** is a vector of demographics (age, indicators of gender, marital status, education, and income category), λ_i denotes fixed effects for an employee's present contribution rate, and π_i denotes fixed effects for present financial anxiety. The coefficient of interest, $\widehat{\gamma_1}$ = 0.22 (p < 0.01), suggests that the expectation of hedonic relief predicts a 61 percent increase in the likelihood of increased saving. An analogous model estimating the relationship between anxiety and plan engagement in the present implies that high present anxiety predicts a -0.14 shift, relative to less-anxious counterparts, in the likelihood of current participation (p < 0.10) and a -0.19 shift in the likelihood of current match take-up (p < 0.05).

distinguish between prescriptions that could be applied to improving engagement in 401(k) plans as currently structured and reforms that involve structural plan changes. In contemplating the former, our findings suggest that neither personalized guidance/education at the time of enrollment, efforts to further simplify enrollment or plan adjustment, nor clarification of the plan match (and possibly even attempts to increase the match) offer prescriptions for substantially increasing engagement among at-risk employees. This conclusion stands in contrast to the focus on financial education, enrollment complexity, and the plan match in the academic literature. Our findings also point to the potential efficacy of two interventions receiving less attention in the academic literature on 401(k) saving—the use of participatory microincentives and, based on suggestive evidence, interventions intended to raise non-participant awareness of their enrollment status. The latter might be accomplished through personalized plan communication or, if confusion about enrollment stems from the broader complexity of the benefit landscape, efforts to consolidate and standardize enrollment across multiple benefit programs.

To better understand how these prescriptive insights compare to the prevailing understanding of leading stakeholders in industry and policy, we collaborated with the Georgetown Center for Retirement Initiatives to survey participants of a recent invite-only forum on US retirement policy. The forum, held over two days in November 2021, assembled 81 individuals to discuss several topics pertaining to retirement saving reform. The group included both current and former high-ranking leadership from federal and state governments, large financial service firms, retirement advocacy groups and public policy institutes and a small number of academics active with policy reform.[40] In the survey, we asked respondents to forecast the efficacy of several potential interventions for raising saving among presently low- or non-participating 401(k)-eligible employees: (1) simplification of enrollment/plan adjustment, (2) clarification of plan eligibility and match generosity, (3) reminders to non-participants of their enrollment status, (4) the provision of personalized guidance, decision aids, and financial education, (5) increases to the generosity of the plan match, (6) microincentives such as a $10 gift card, and (7) improvements to the digital design of the enrollment interface.[41] Presumably because of intimate nature of the workshop and repeated requests to complete the survey prior to, and during, the event by the organizer, 70 percent of participants began the survey and 46 percent completed the intervention assessment.

[40] Attendees for the event, 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; high-ranking leaders from five state governments, including a state Treasurer; multiple principals/partners/managing directors of large financial service firms including Blackrock, BNY Mellon, JP Morgan, and State Street Global Advisors; and representatives from AARP and the Brookings Institution. The 81 participants exclude one of the present authors and the event organizer. While the event touched upon several topics pertaining to US retirement savings policy, the theme of the event was lifetime income solutions.

[41] Specifically, we asked respondents, "How would you rate the potential efficacy of these strategies for increasing 401(k) engagement among low/non-saving employees?" on a 1 (not effective) to 4 (very effective) scale. Unrelated to the present research, the survey also asked respondents to evaluate the degree of retirement insecurity among various sub-groups, prioritize savings reform initiatives and speculate as to the causes of low adoption of lifetime saving solutions.

The stakeholder survey revealed at least three patterns of relevance for the present research. First, consistent with our reading of the academic literature and industry reports, a majority of stakeholders perceived enrollment simplification and the provision of personalized guidance, decision aids, and financial education as moderate to highly effective strategies for increasing plan engagement.[42] Notably, stakeholders perceived enrollment simplification as the single-most effective of the enumerated strategies for increasing saving (86 percent of respondents 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 enrollment complexity may be the recent, but widespread, adoption of digital plan administration by providers. With digital enrollment interfaces, enrollment or adjustments to contributions often require only a few steps (see Bhargava et al. 2021 for a discussion). Second, the survey suggests some openness among stakeholders as to the possibility that employee confusion regarding enrollment status may impede saving. Specifically, 49 percent of stakeholders perceived plan communications designed to clarify enrollment status as a potentially moderately to highly effective strategy (compared to 14 percent who did not expect it to be effective). While the academic literature has not addressed widespread confusion of this form (and we did not anticipate this possibility ourselves), the survey echoes sentiments of industry contacts with whom we reviewed these results who interpreted such employee confusion as plausible in the context of contemporary employee-benefit programs.

Finally, while 51 percent of stakeholders thought microincentives could be leveraged to increase plan engagement, only 19 percent of respondents explicitly ranked small rewards above an increase in the plan match in likely efficacy (78 percent saw increases to the plan match as an effective strategy). We note that while the current regulatory language of ERISA does not explicitly condone the use of financial incentives to encourage savings, as of November 2021, Congress was considering legislation that would explicitly permit *de minimis* incentives (i.e., small immediate rewards such as gift cards) to encourage plan participation. Our findings suggest the potentially substantial promise of such reform, particularly when directed at undersaving employees not responsive to the plan match. The passage of such reform may also encourage more extensive research as to how plans can leverage microincentives to improve 401(k) plan participation as well as participation in other employee benefit programs.

Looking beyond interventions targeting plan engagement, our hedonic account of present-focused savings suggests a direction for more fundamental reform. Specifically, the possibility that short-term

[42] The results of a prominent annual industry benchmarking survey for defined-contribution plans administered by PLANSPONSOR magazine in 2020 (also referenced above) offers one example as to the perceived importance of financial education within the industry. The survey found that 74 percent of surveyed defined contribution plans offered some form of financial education to their employees and 95 percent of plan sponsors agreed that such offerings are useful to employees. While many of the financial education programs offered by plans targeted financial behaviors outside of our definition of retirement literacy, 49 percent of plans offered programs focused on "investing basics" and 53 percent focused on "saving strategies."

financial anxiety and optimism about improved future anxiety might contribute to delayed enrollment offers a rationale for dual-account proposals that supplement the illiquidity of a traditional 401(k) with a more-liquid account designed to address near-term financial concerns. Such a plan could direct employee contributions into a highly-liquid account that provides emergency liquidity before automatically transferring accumulated funds, above a certain threshold, into a less-liquid account long-term account. The dual-account model has been advocated in recent years in various forms by academics, policymakers, and industry stakeholders to address economic factors such as emergency illiquidity, leakage, and the burden of student debt (Beshears et al. 2015; 2020; Gruber 2016; John 2015; Mitchell and Lynne 2017). We see the present research as offering an additional, psychological, rationale for at least some of these proposals in that, for many employees, addressing near-term financial anxiety may be a necessary precursor for long-term saving. Our research also suggests that the psychological design of dual accounts may be important for determining their success. For example, while present proposals refer to the more liquid of the dual accounts as an "emergency savings" or "sidecar" account, we speculate that framing such accounts in a manner that does not invoke financial concerns (e.g., "A Serenity Account"), incentivizing participation with microincentives and supplementing the plan with provisions aimed at improving financial well-being would help encourage participation and sustained plan engagement.

8 CONCLUSION

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

The study yields four insights that contribute to the existing empirical literature on retirement saving among US employees. First, we corroborate existing evidence on the prevalence of low *retirement literacy* and the correlation between some measures of this friction and baseline saving, but find that the experimental provision of personalized recommendations did not increase saving, even among employees who underestimated how much they needed to save at baseline. Because the interventions led to an improvement in the accuracy of average beliefs about how much to save, we interpret our precise

estimates as rejecting any meaningful causal influence of low retirement literacy on undersaving, at least in this setting. One can perhaps reconcile our findings with the emphasis on literacy-focused education among industry, policy, and academic stakeholders by noting that while deficits in literacy may be widespread, most undersaving employees do recognize that they are undersaving, often by a large margin.

Second, in an analysis of *plan confusion*, we find that a nontrivial share of employees underestimated the generosity of the plan match and that such underestimation negatively correlates with baseline saving. However, we find that experimentally clarifying match generosity did not lead to an increase in saving, even among employees with biased baseline beliefs. In an unplanned analysis, we do present evidence for a potentially first-order impediment to saving—confusion about one's enrollment status. Specifically, we find a remarkable number of discrepancies between self-reported and administrative enrollment status and conclude that 20 to 37 percent of 401(k) non-participants in our sample mistakenly believed themselves to be enrolled (often at substantial contribution rates). Consistent with this interpretation, non-participating employees were far more likely to enroll than their counterparts when prompted to observe their actual enrollment status via assignment to the small reward. Next, despite its perceived importance by stakeholders, we find no evidence that *enrollment complexity* impedes savings in this setting. Few employees perceived enrollment (or adjustment to contributions) as prohibitively time-consuming, and simplifying enrollment did not increase saving despite reducing perceptions of its complexity. We speculate that 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 help to explain how employees might be undaunted by the administrative steps required to enroll 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 employees to increase saving in response to an immediate small reward but not to clarification of the much larger, but delayed, plan match. Through a series of calibrations, we assessed whether the commonly invoked beta-delta model of present bias could plausibly account for the baseline reluctance of employees to enroll and take-up the match (despite confirmed knowledge of the match), their response to the experimental treatments, and their stated intentions to save in the intermediate, but not immediate, future. The exercise suggests that even allowing for extreme present bias and substantial psychological disutility of enrollment, it would be difficult to explain the observed behavior and stated beliefs of employees through present bias alone. Motivated by a promising empirical correspondence between saving and self-reported financial-anxiety, we proposed an alternative hedonic account of present-focused saving. The model stipulates that if enrollment is costly due to financial anxiety and employees expect relief from such anxiety in the intermediate future, they may rationally delay enrollment despite a generous plan match. We present additional calibrations, and

supplementary evidence, outlining how the model might plausibly account for the present findings. We also describe how the model could potentially explain other puzzles in the literature such as the efficacy of automatic enrollment, the insensitivity of saving to increases in the match, and the persistent gap observed between intended and actual saving.

We highlight important limits to the present research. One potential limit is that our experimental results are restricted to predominantly low-saving employees at a large, but single, US firm. Our findings, particularly those regarding the role of enrollment complexity and plan confusion may be firm-specific. While we cannot rule out this possibility, there are reasons to believe that the findings should generalize to other 401(k) plans. First, our sample reflects a large and diverse population of low-to-moderate income employees whose financial background, plan engagement, and financial well-being resembles broader national cross-sections. Second, the study was characterized by high adherence to the interventions (presumably everyone proceeding through the webflow observed the treatments) and limited observable selection into the study. Finally, the sampled employees were eligible for a 401(k) plan that, beyond offering a match with above-average generosity, resembles 401(k) plans more broadly in structure and administration. A second limit is that our visibility into employee saving extends only to the four months following the field study and does not include assets outside the 401(k) plan. While we believe that private savings is low for undersaving employees, we cannot observe if employees offset increased contributions with reduced saving elsewhere, an increase in debt, or long-run reductions in contribution.

In spite of these limitations, this paper offers prescriptions for the administration and optimal design of retirement savings plans. In the near-term, our findings should prompt employers and plan administrators to challenge prevailing beliefs regarding the potency of interventions aimed at improving saving by addressing deficits in retirement or financial literacy (we note that our findings do not apply to interventions that act through persuasion rather than education or to interventions aimed at financial behaviors outside of retirement saving). Our findings also point to the significant potential value of reducing employee confusion about their enrollment status through targeted communications, or broader efforts to consolidate/simplify benefit program offerings, and of encouraging plan engagement through campaigns involving microincentives. 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 retirement savings plans through, as an example, recently proposed dual-account plans (Beshears et al. 2015; 2020; Gruber 2016; Mitchell and Lynne 2017). While dual-account plans have recently gained traction as a potential strategy for addressing short-term illiquidity and long-term financial security, our findings provide a psychological rationale for the dual-account structure and suggest lessons for its optimal design.

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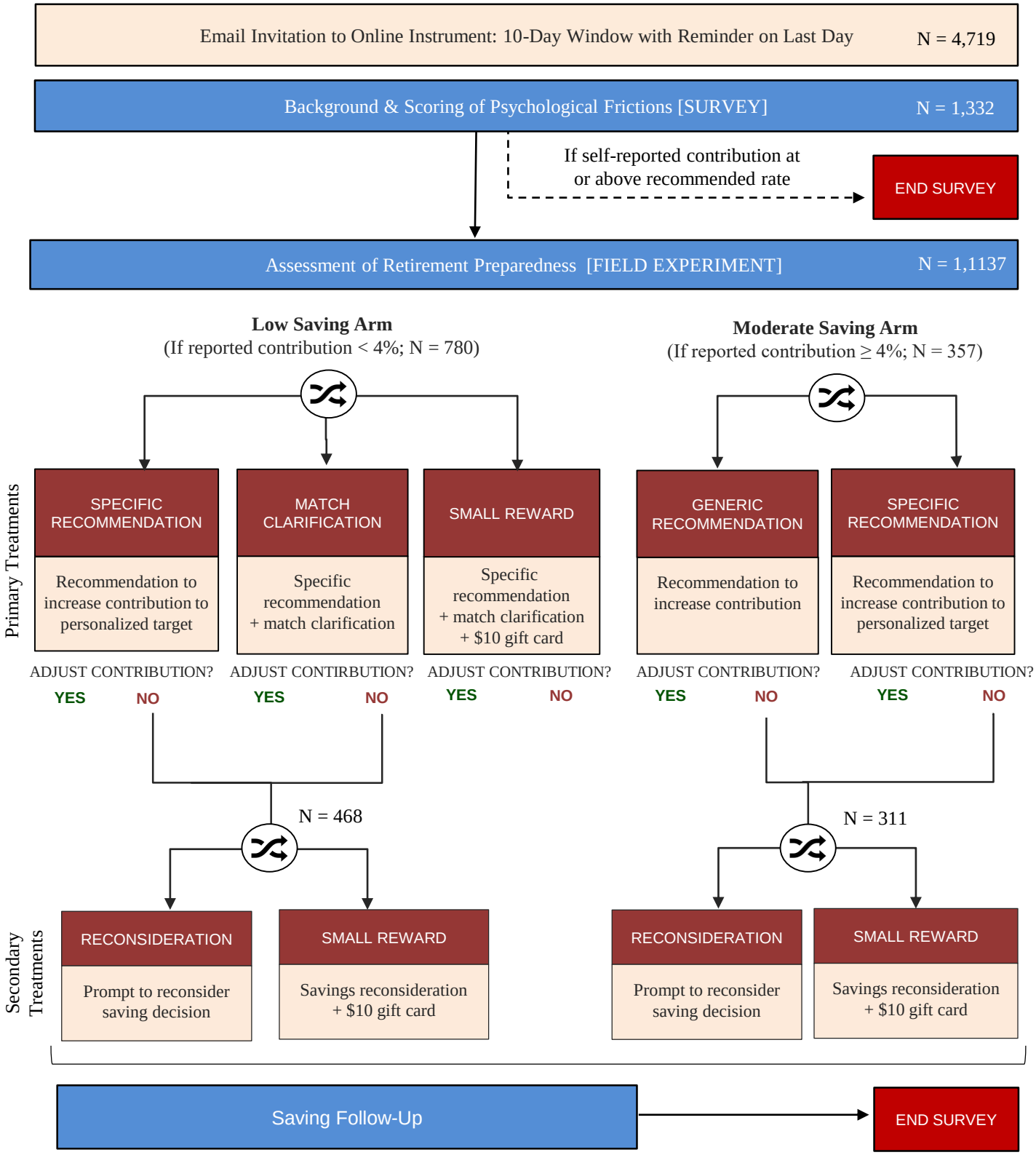
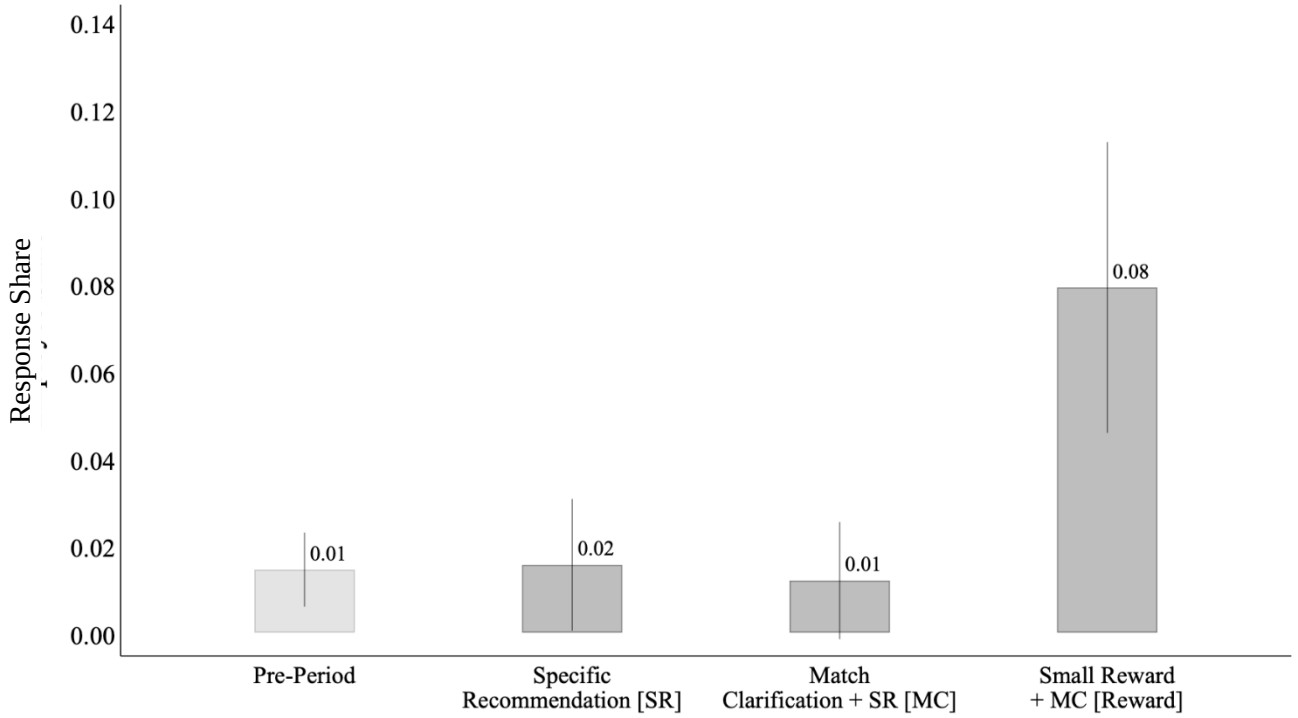
Figure 1.
Schematic Research Design for Survey and Field Study



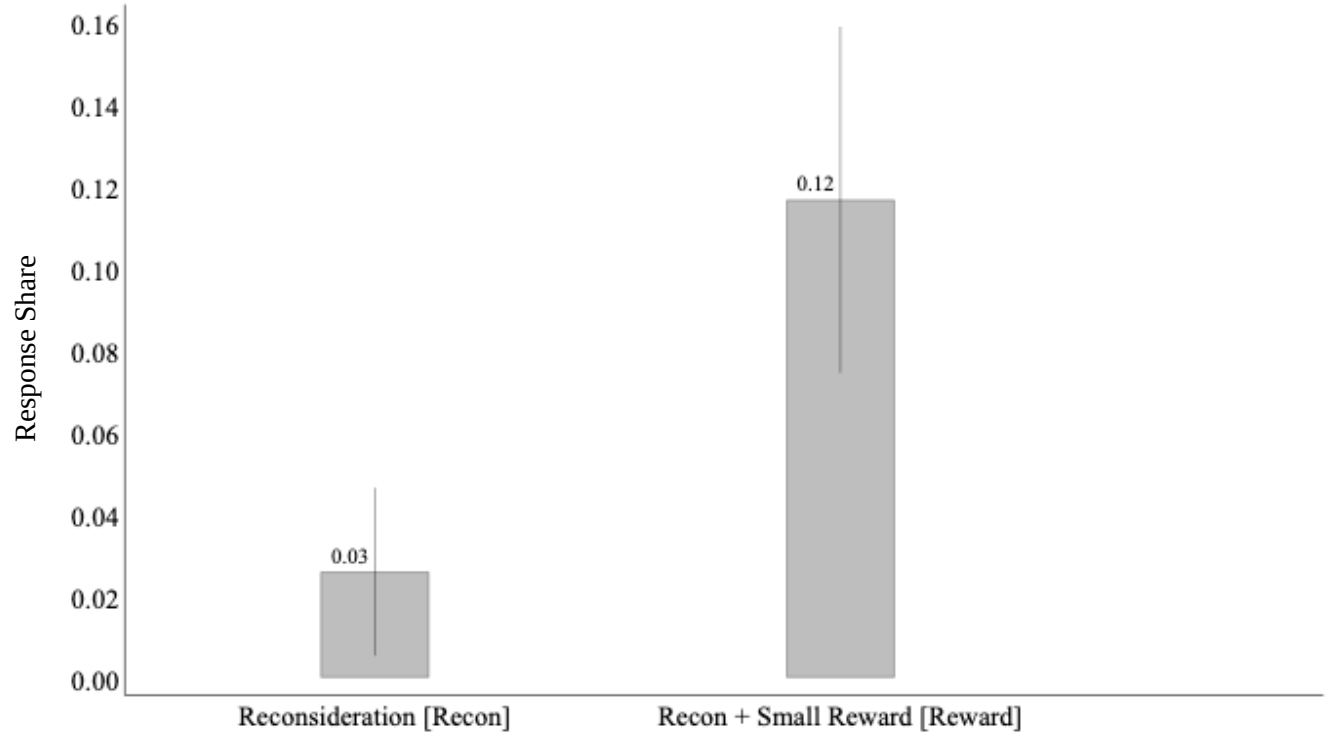
Note: This figure schematically depicts the research design and general procedure for the survey and field study. The figure charts the progression of qualified employees from an email invitation to participate in the survey to an initial module designed to collect background information and score each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



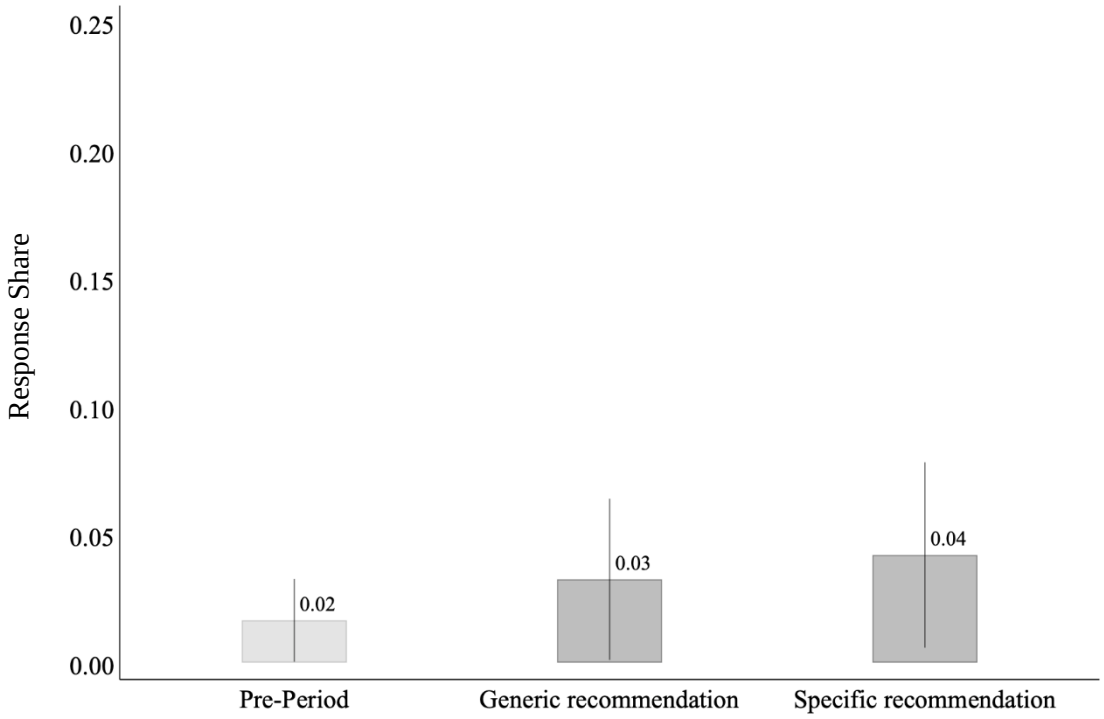
Panel B . Secondary Experimental Treatments



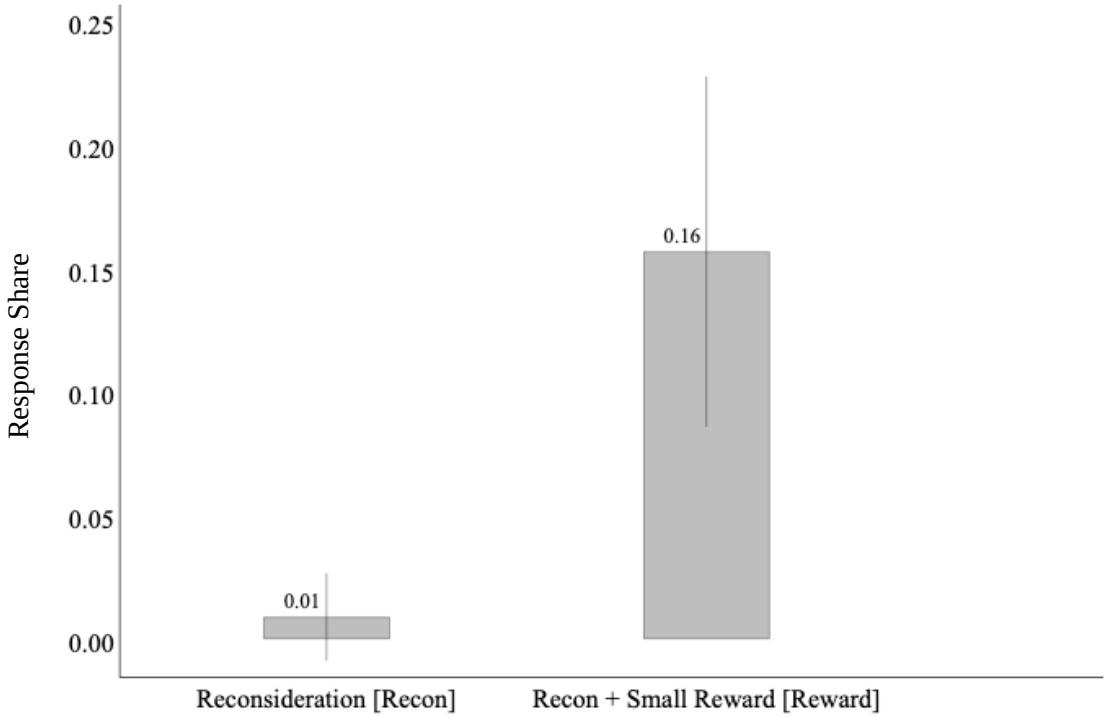
Note: This figure depicts the share of increased 401(k) plan contributions among employees assigned to each primary (Panel A) and secondary (Panel B) treatment in the Low Arm. Panel A additionally reports the average share of increased contributions by in-sample employees during a specified period prior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

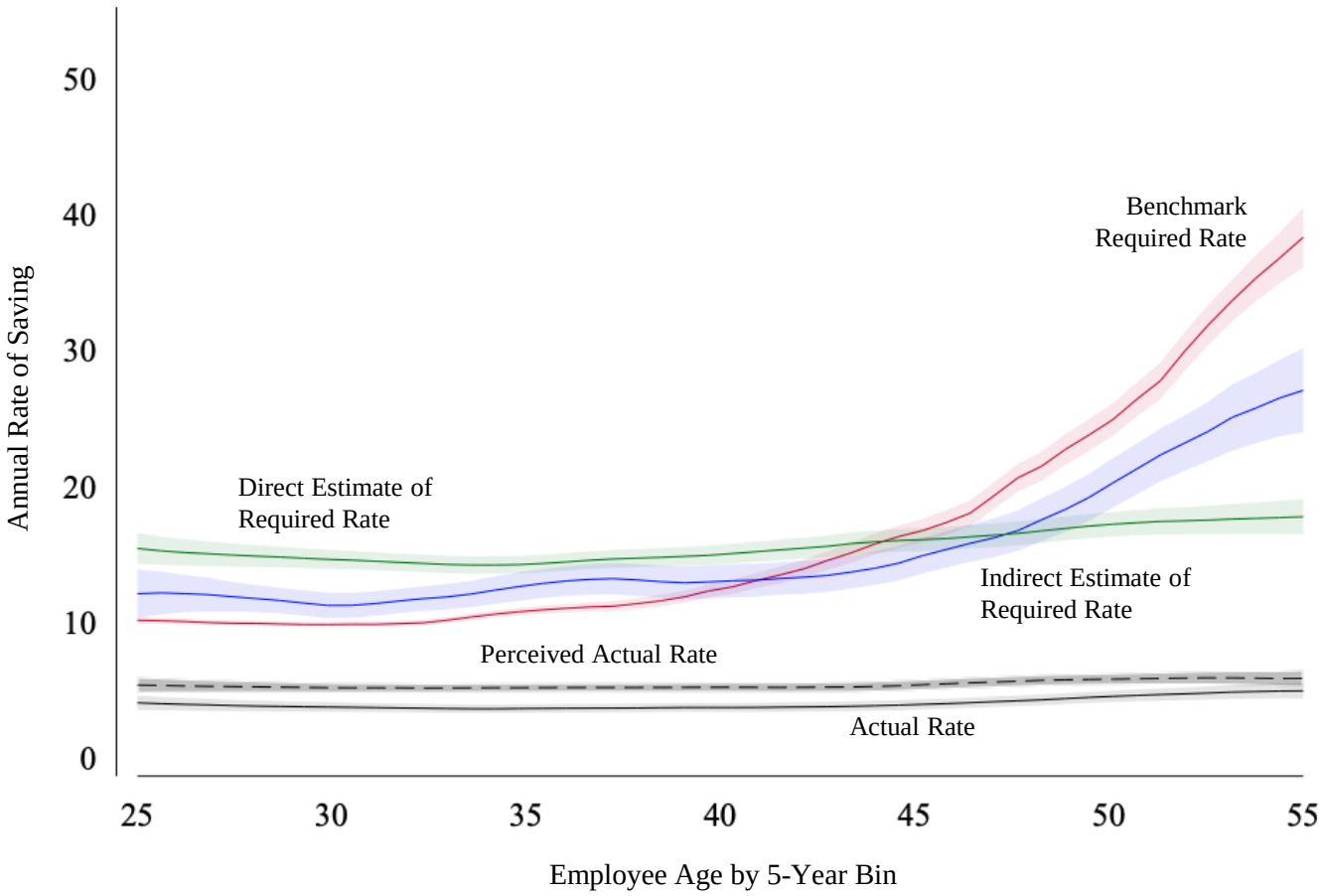


Panel B. Secondary Experimental Treatments



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.

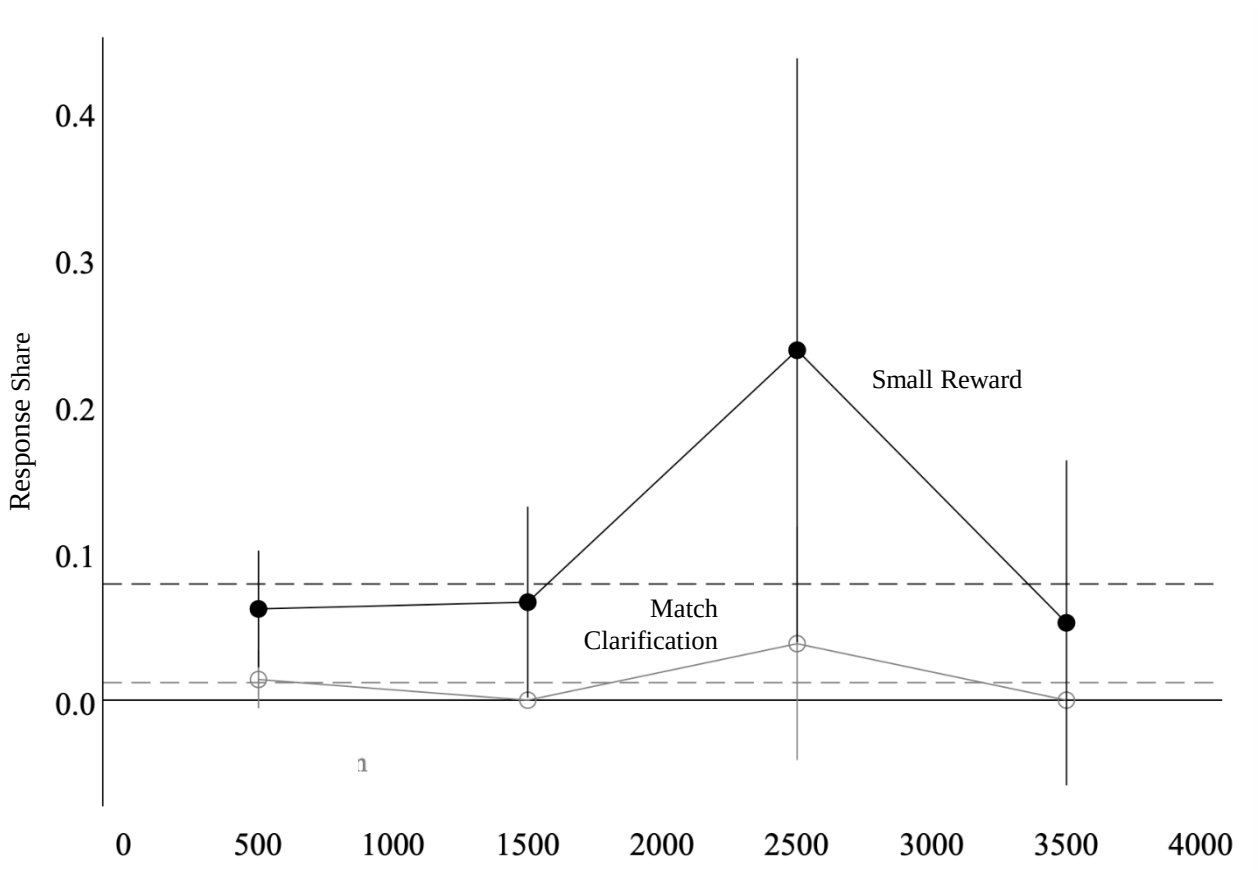
Figure 4.
Recommended, Actual and Perceived Annual Rate of 401(k) Plan Saving by Employee Age



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.

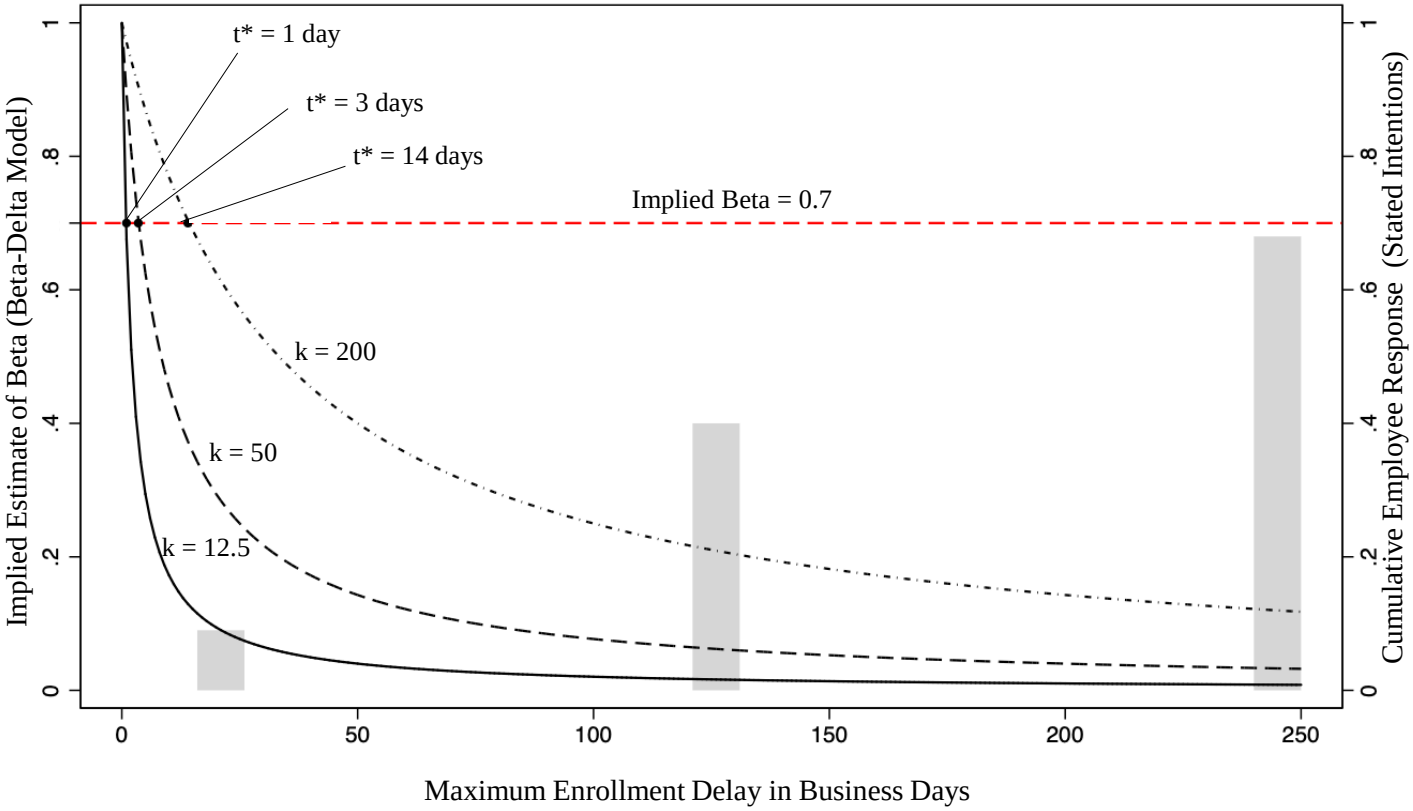
Share of Increased 401(k) Plan Contributions in Response to Match Clarification and Small Reward by 12-month Value of Foregone Match - Low Saving Arm



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.

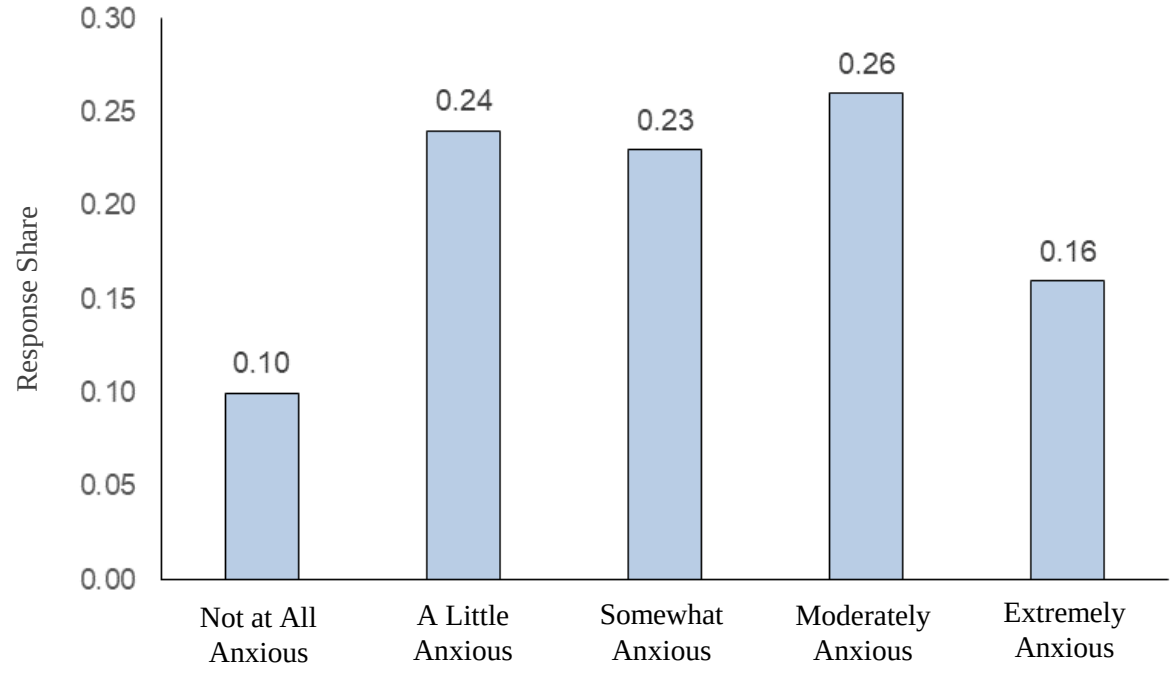
Delay in 401(k) Plan Enrollment Implied by Beta-Delta Model and Stated Intentions of Employees



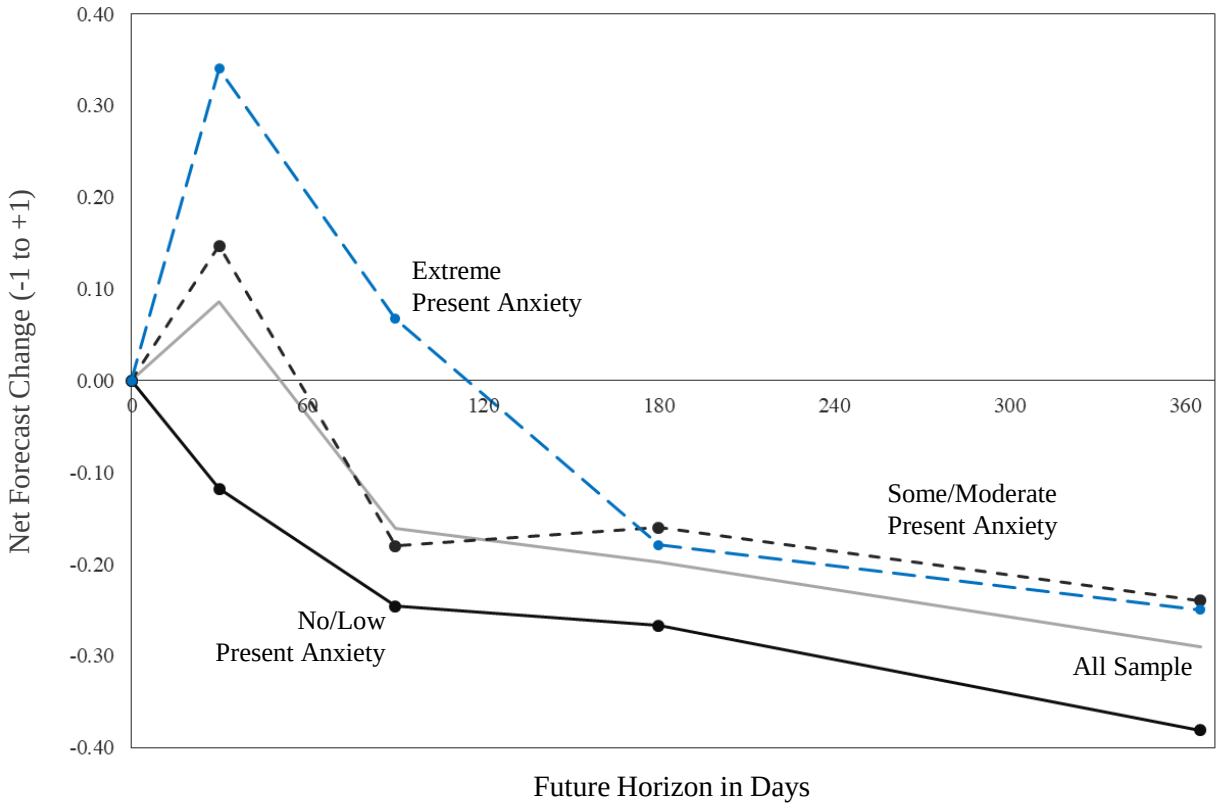
Note: This figure reports the value of beta required to rationalize varying durations of delay in 401(k) plan enrollment as implied by the beta-delta model (assuming sophistication). The plot separately displays estimates of beta assuming enrollment costs of k = 12.5, 50, and 200 and annotates the delay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

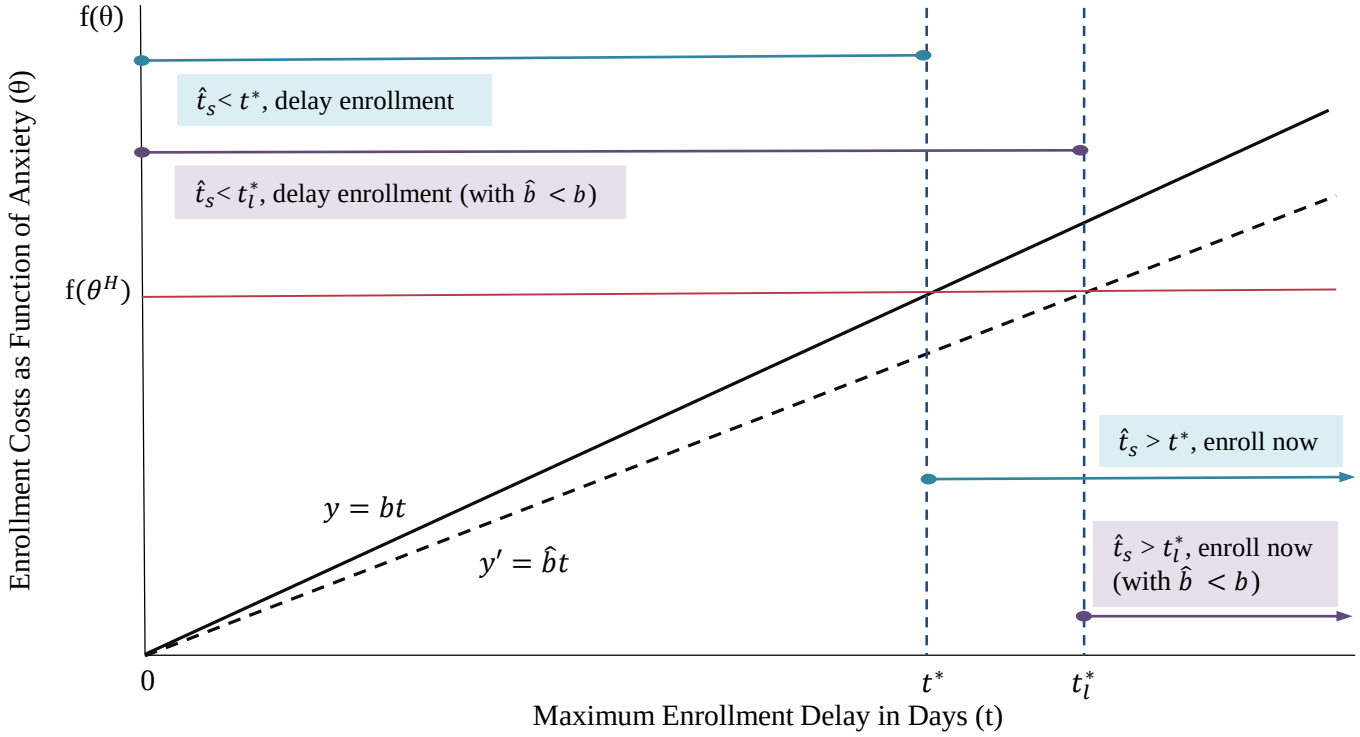


Note: This figure describes present and forecasted change in financial anxiety among a supplementary survey sample of US employees. Panel A depicts the distribution of self-reported present financial anxiety on a scale ranging from not at all to extremely anxious. Panel B reports the net forecast change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

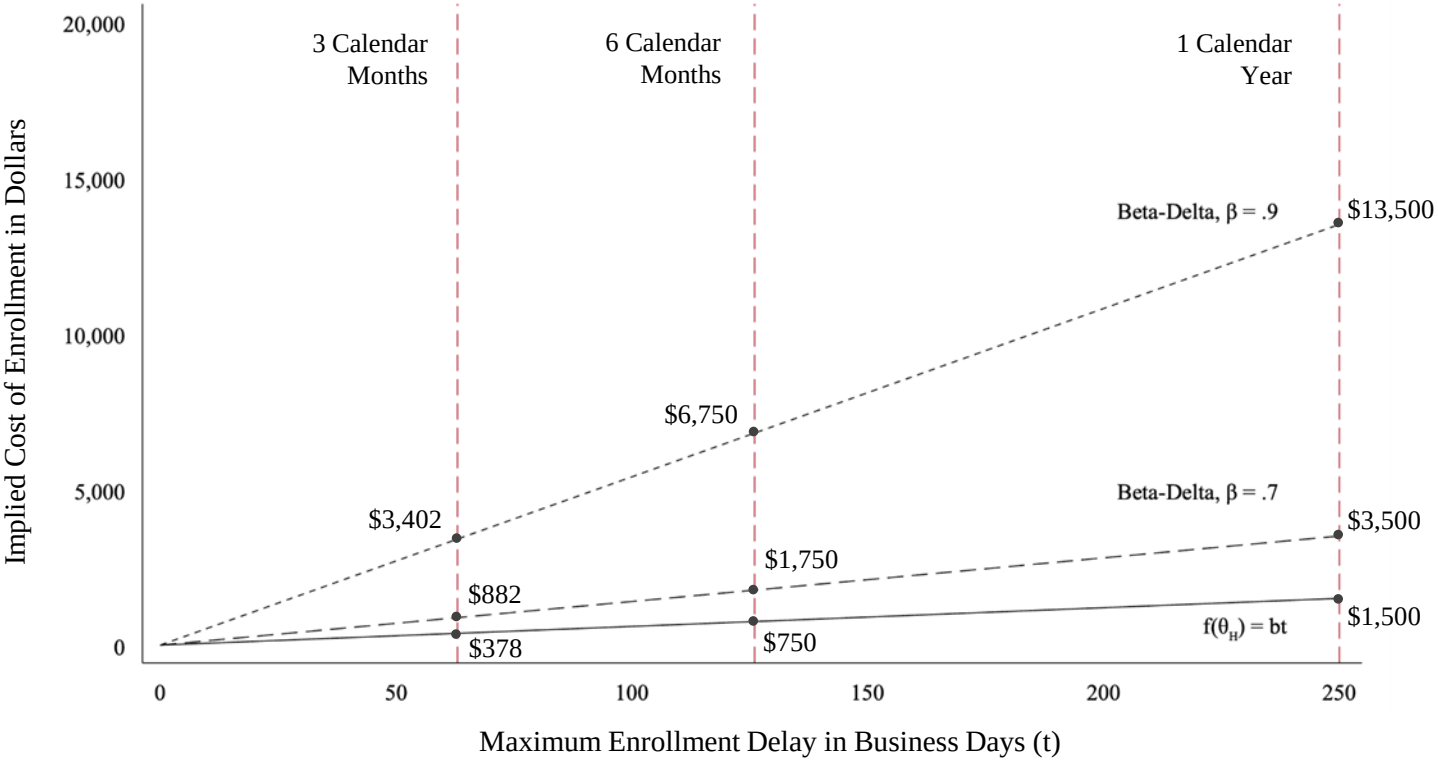
Figure 8.

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

Panel A. Stylized Costs and Benefits of Enrollment Delay



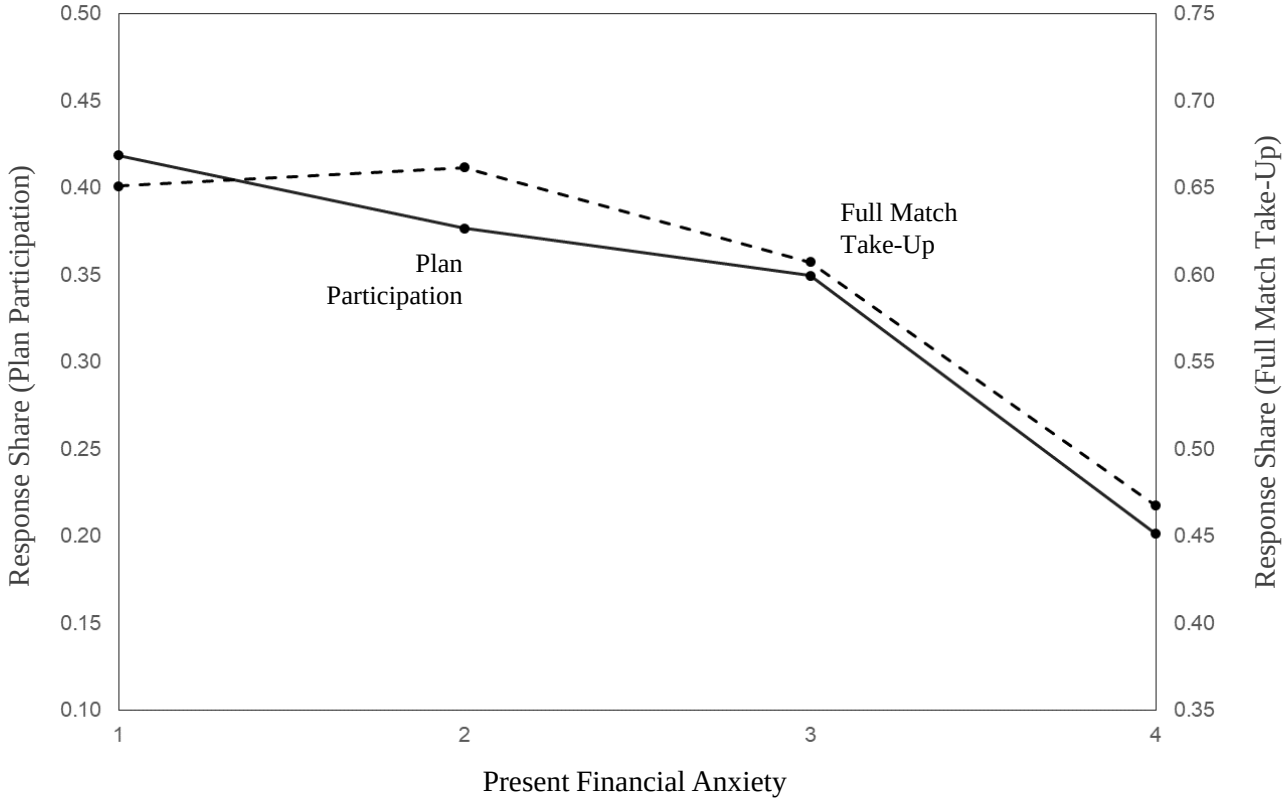
Panel B. Implied Enrollment Costs by Duration of Delay in Beta-Delta and Serenity Models



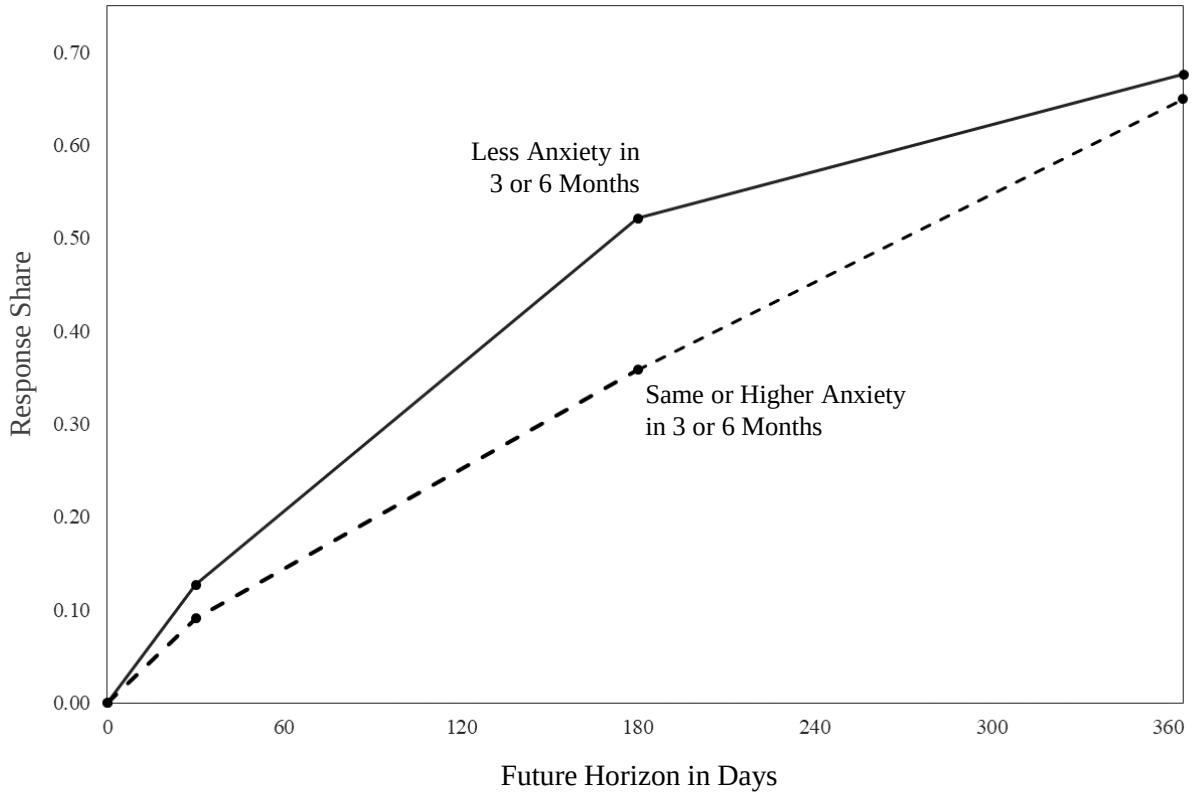
Note: This figure describes the delay in 401(k) plan enrollment implied by the Serenity Model. Panel A depicts the marginal cost (due to the foregone plan match) and benefits (due to potential reductions in anxiety costs) of enrollment delay for the model. The graph separately plots the cost of delay 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		Difference Tests (p-value)
		No	Yes	
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

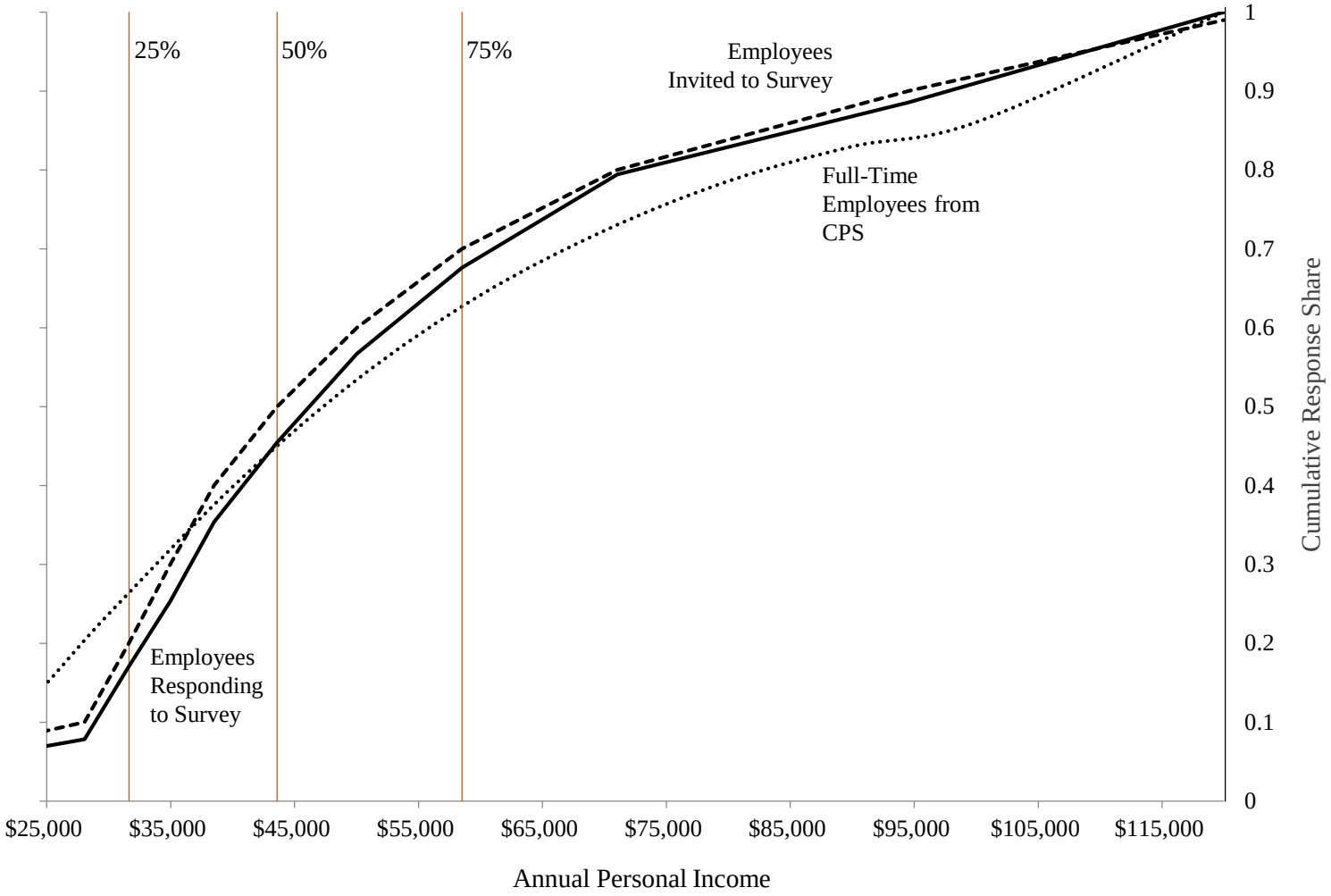
Note: This table summarizes discrepancies between the self-reported and administrative 401(k) plan engagement of employees. Each row reports the average discrepancy associated with the indicated measure for the entire employee sample and for subsamples distinguished by administrative participation. The 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.

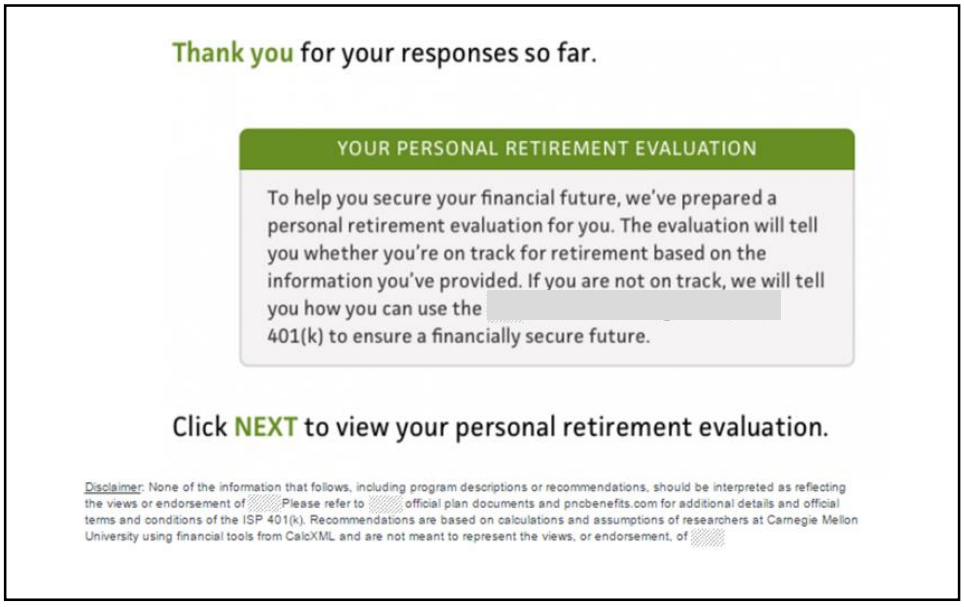
Appendix Figure A1.
Comparison of Income Distribution from Field Study and Employees in 2015 Current Population Survey



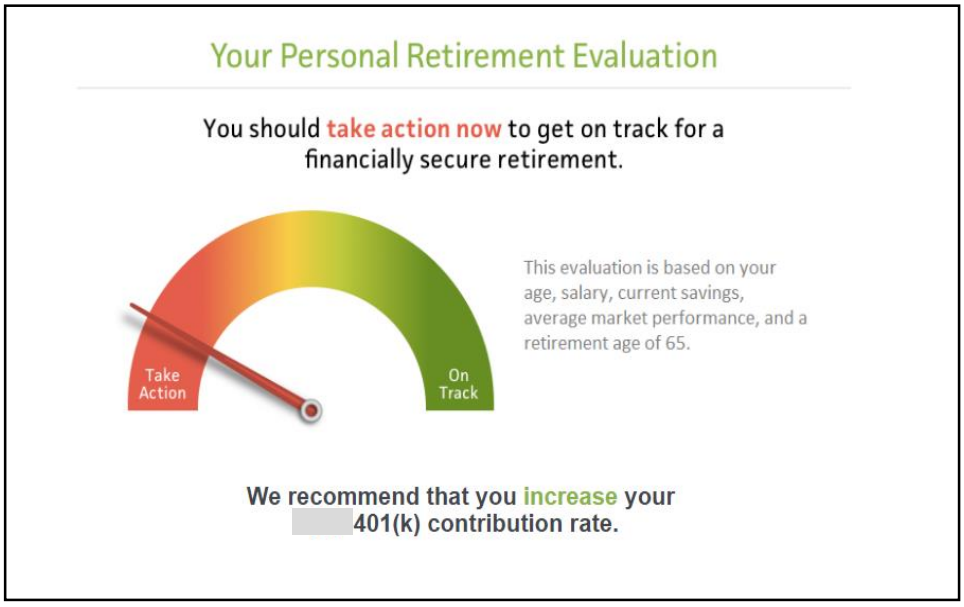
Note: This figure compares the distribution of annual salary of employees from the field study with annual salary for a national sample of employees from the Current Population Survey (CPS). Specifically, the plot depicts the cumulative distribution of annual salary for employees responding to the field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

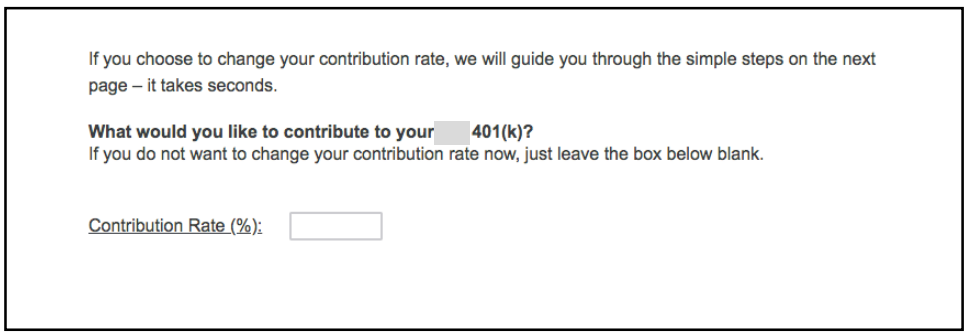
Screenshots of Baseline Retirement Assessment Web-Flow from Field Study
(Generic Recommendation)



Introductory Screen



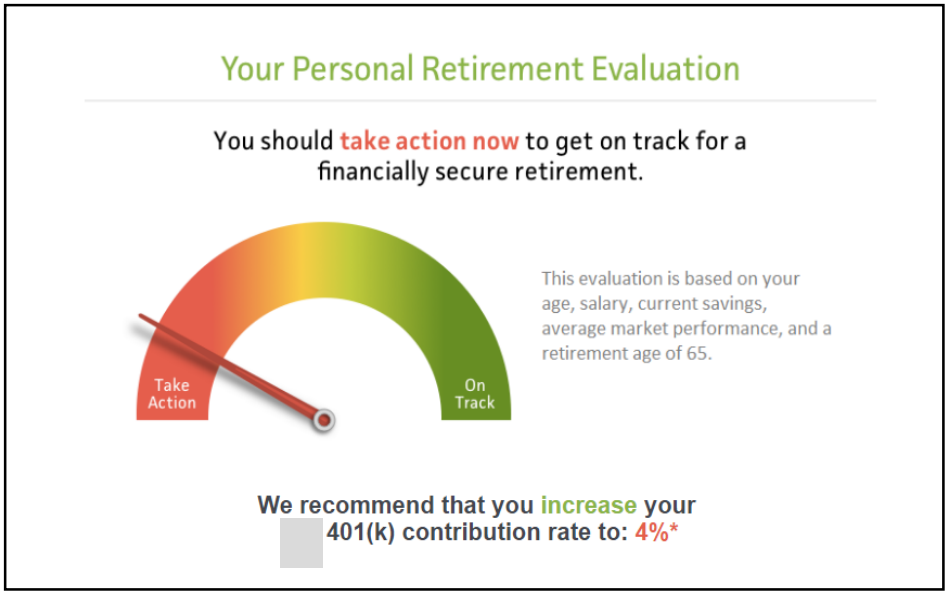
Retirement Assessment
(Generic Recommendation)



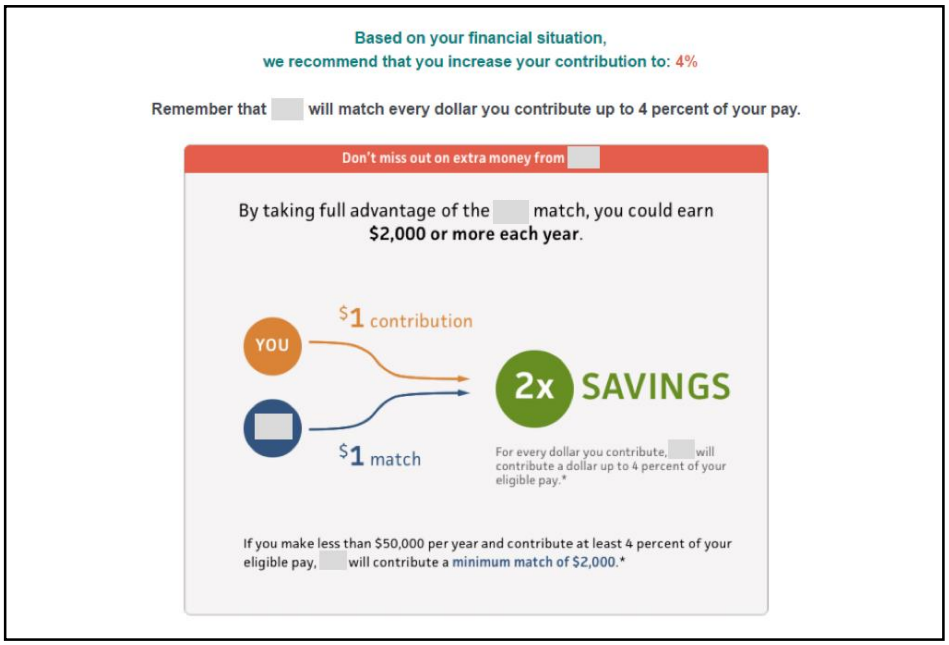
Saving Prompt
(Prior to Benefit Portal Link)

Appendix Figure A3.

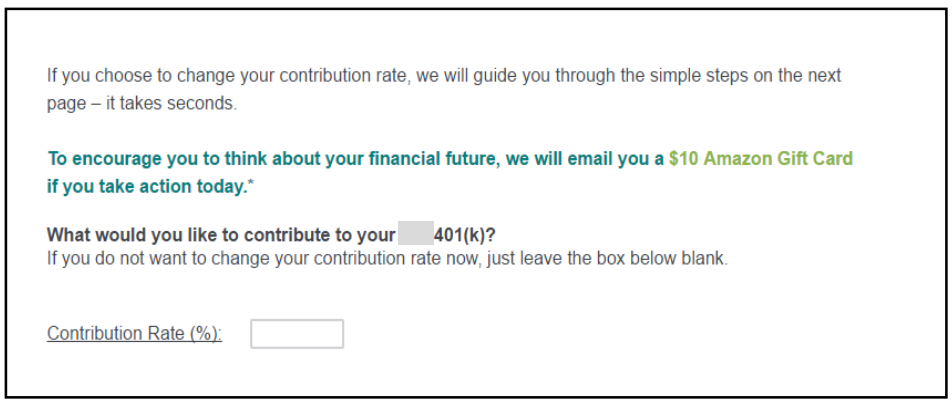
Screenshots of Experimental Variation in Retirement Assessment Web-Flow from Field Study



Specific Recommendation

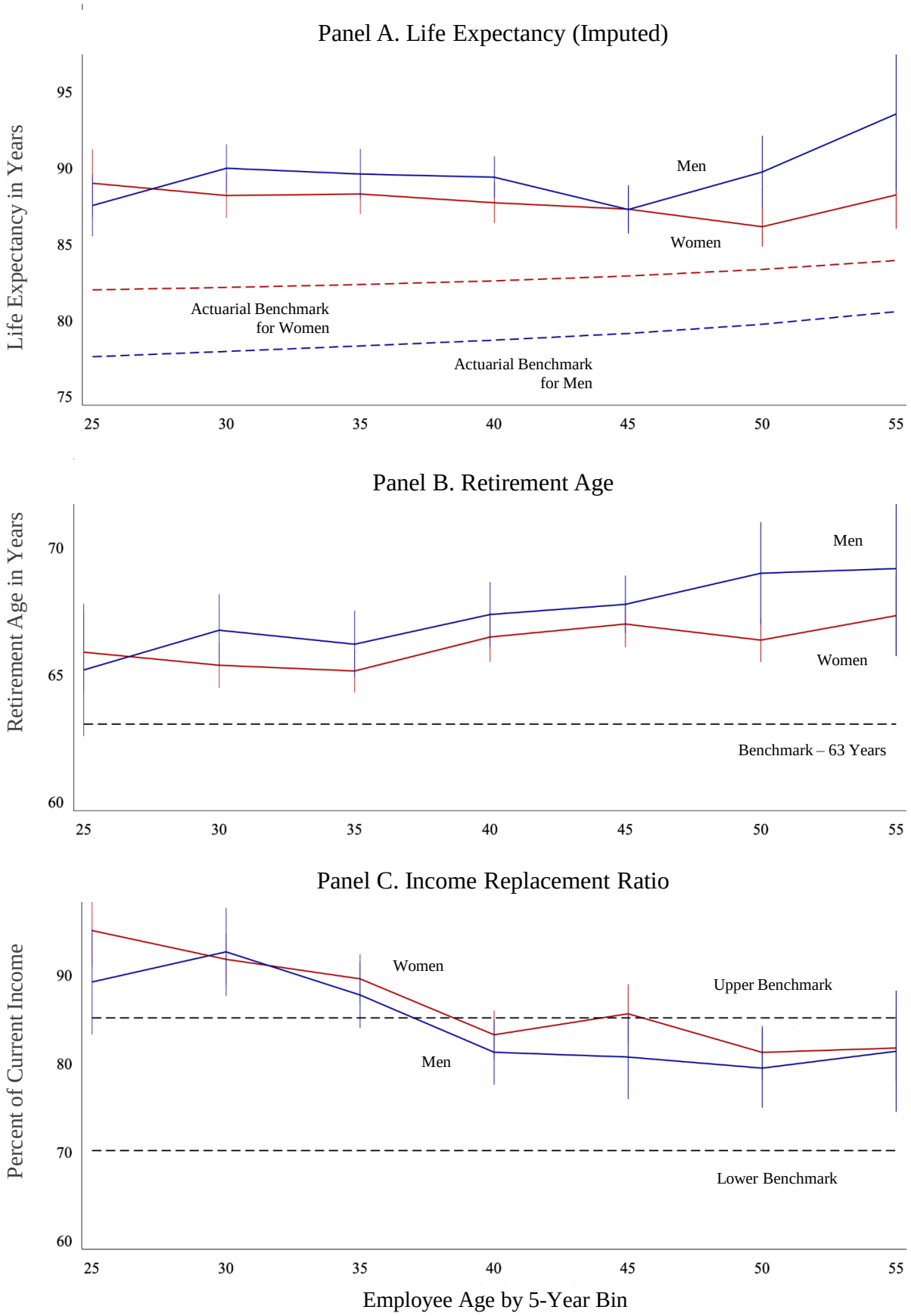


Match Clarification



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.