

Do mandatory retirement contributions crowd out voluntary contributions?

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Abstract

A high contribution rate to employer-provided defined contribution (DC) pension plans is important for employees to maintain their standard of living during retirement. Yet, plans differ in whether employee or employer contributions are mandated, leaving a critical role for voluntary contributions. We study how employees respond to a shift in required contribution rates at a large public university. Starting in 2010, new employees experienced two changes relative to employees hired earlier: (1) the employer contribution rate fell by 1.5 percentage points (pp); and (2) a new mandatory employee contribution of 5% was established.

Economic theory predicts that required contributions will *crowd out* voluntary contributions by up to 5 pp. These predictions, however, may depend on whether required contributions are salient. Salience may take on particular importance in a complicated choice environment – as is the case for many pension plans.

We find evidence of incomplete crowd-out. We estimate a small and often statistically insignificant reduction of 3-6 pp in the share who make any voluntary contributions to the DC plan. Among those who continue to make voluntary contributions, we estimate a reduction in voluntary contributions of about 2.25 pp. The resulting crowd-out is only about 45%, falling well short of predicted crowd-out of 5 pp. These responses suggest a lack of salience of required contributions and reinforce evidence in other settings of passive saving behavior in response to required contributions.

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1. Introduction

Households are increasingly responsible for making their own decisions about how much to save for their retirement. As Social Security benefits decline, and with most employer-sponsored defined benefit (DB) plans frozen or eliminated, defined contribution (DC) plans are the major retirement savings vehicle that individuals control (Friedberg and Owyang 2002). The value of assets in private sector DC plans increased from \$74 billion in 1975 to over \$5 trillion in 2013, with more than 50% of future retirees expecting to rely on a DC pension as their primary source of retirement income (Saad 2017).

DC plan design places considerable responsibility on individuals to ensure the adequacy of retirement income. While traditional DB pensions promise specific future benefits that employers are responsible for funding, a DC pension accumulates contributions in an account, leaving future retirement resources uncertain. A relatively high contribution rate is required for employees to be able to maintain their standard of living during retirement (Ellis, Munnell, and Eschtruth 2014), but plans differ in whether employee or employer contributions are mandated, leaving a critical role for voluntary contributions. Questions remain, however, about how the level or mix of required employer and employee contributions affect voluntary contributions. In this paper, we study how employees respond to a shift in the level and mix required contribution rates at a large public university.

Although the goal of required contributions may be to ensure adequate resources in retirement, especially for people with a low propensity to save, economic theory in fact predicts that required contributions will *crowd out* voluntary contributions for those who would have saved on their own. Evidence of crowd-out in response to DC pensions dates back decades, often based on aggregate saving data or comparisons across employers that did or did not offer a DC pension.¹ Using employer-level data to

analyze changes in required contributions can shed more light on the magnitude of crowd-out, but obtaining access to such data is often difficult.

We consider the theoretical and empirical effects of a shift in mandatory contributions on voluntary DC plan contributions using ten years of administrative data from faculty at a large public university. Starting in 2010, new employees experienced two changes relative to employees hired earlier: (1) the employer contribution rate fell from 10.4% to 8.9%, a 1.5 percentage point (pp) decline; and (2) a new mandatory employee contribution of 5% was established. Consequently, the total mandatory contribution rate rose from 10.4% to 13.9%, a 3.5 pp increase. The policy changed following state legislation that increased contribution rates for all new state employees to alleviate chronic underfunding in the DB plan. This change can thus be viewed as exogenous for new employees at the university we study, rather than an endogenous response to employee preferences, for example.

Standard economic theory predicts that voluntary contributions by employees should fall by between 3.5 and 5 pp, ignoring momentarily employees with a low propensity to save. This reflects a *crowd-out effect*, which would lead to a full 5 pp reduction as voluntary contributions are replaced by the new employee contribution of 5%. The crowd-out effect is mitigated by a *compensation effect*, however, because the reduction in the employer contribution without an accompanying pay increase (which we find no evidence of) represents a cut in total compensation of 1.5 pp. While this compensation effect should range between 0-1.5 pp, we anticipate that it would be small, given that average compensation in our sample is relatively high and the average voluntary contribution rate in our sample of 6%-8%. An additional *participation effect* should arise among employees who would contribute small amounts in the absence of this policy change and are not able to respond by reducing voluntary contributions by the full crowd-out amount;

¹ Early research on the growth of DC plans found conflicting evidence about crowd-out, with Engen et al (1994) finding evidence in favor and Poterba et al. (1995) finding evidence against crowd-out. More recently, using novel data and novel sources of variation, some researchers (for instance Gelber (2011); Chetty et al. (2014)) find that the increase in DC pension balance represents new savings while others (e.g., Benjamin (2003); Engelhardt & Kumar (2007)) find that the changes in 401(k) savings accounts are shifts from some other financial accounts.

this would result in an overall reduction in voluntary contributions of less than 3.5-5 pp, while causing a reduction in the propensity to make any voluntary contributions at all.

We find evidence of incomplete crowd-out using an event-study design comparing new faculty hired before the policy change to those hired after. Voluntary contributions fell by 2.25 pp, on average. When compared to the 5% mandatory increase in employee contributions, this amounts to a “crowd-out rate” of 45%. This response falls short of the 3.5-5.0 pp decline predicted by standard theory, and suggests a lack of salience of required contributions. The lower bounds of the 95% confidence intervals consistently reject the 5 pp reduction predicted by the crowd-out effect. On the extensive margin, we estimate that participation in the voluntary plan fell between 3-6 pp (depending on how many months passed since the date of hire) among those who choose the DC plan, though the estimates are less precise. Since the potential for crowd-out on the participation margin was about 50% (representing the share of employees who contributed more than zero and less than 5% in the pretreatment period), this reduction due to the participation effect is modest. We also estimate a 3.6 pp increase in the probability of initially choosing the state DB plan rather than the employer DC plan that we are studying.² Overall, we find that an increase in mandatory employee contributions is effective at raising total retirement contributions.

Several empirical patterns support our interpretation that we are measuring the causal effect of the policy. We find little evidence that the composition of new employees changed, which might occur either in response to the new required contribution policy or because of the financial crisis and Great Recession, which began two years earlier. Our main findings are robust to different regression specifications and time periods studied. Finally, we conduct a placebo test of our event study design, based on the choice to invest with either of the two plan vendors (referenced here as Vendor A

and Vendor B) in the DC plan; this is a saving decision that should arguably not be impacted by the change in mandatory contributions but could be impacted by other conditions that were changing at the same time and that might also influence voluntary contribution rates. We fail to detect any difference in the choice of vendor after the policy change, as expected.

Our results contribute to research documenting passive saving behavior in response to mandated contributions. Chetty et al. (2014) study the impact of a 1 pp increase in mandatory contributions in Denmark and find less than a 0.2 pp reduction in pension saving. By contrast, the mandatory increase in our setting is five times larger, so understanding whether the incomplete crowd-out persists is important. In related work to ours, Card and Ransom (2011) study how the mix of required contributions impacts voluntary contributions among faculty using variation across 77 universities between 1986 and 1996. They estimate crowd-out rates between 60% and 80% in response to mandated employee contributions, but rates only half as large in response to employer contributions, even though the money is fungible. While we cannot separately distinguish the response to mandated employee versus employer contributions, our results reinforce their finding of incomplete crowd-out by exploiting variation within a university over time and during a much more recent period. Our estimate of a reduced crowd-out rate compared to Card and Ransom (2011) may reflect an increasingly complicated choice environment that employees face across their benefits plans.

The rest of this paper is organized as follows. Section 2 introduces a theoretical model that predicts how the average contribution rate to voluntary plans changes when the total contribution rate to the mandatory plan increases. Section 3 describes the institutional details of the large public university recorded in the data. Sections 4 to 6 describe, respectively, the data, empirical strategy, and the main results of this paper. Section 7 concludes.

² While there was no change in required contributions in the state DB plan, which would make it relatively more favorable after the change in contribution rates for the DC plan that we study, other provisions in the determination of DB benefits became less generous at the same date. Therefore, we do not have clear predictions for the DB versus DC choice margin, and in any case the increased share choosing the DB plan remains small relative to the large share choosing the DC plan.

2. Institutional details

The large public university that we study offers faculty a complicated set of retirement plan choices. Figure 1 provides a flow chart to summarize the sequence of retirement plan choices and available options. First, faculty face a one-time irrevocable choice at the outset of employment between the DB plan run by the state and the 401(a) DC plan with the mandatory contributions that we described earlier.³ As shown in Section 4, a large majority chooses the DC plan. Second, faculty must choose, for their mandatory contributions, among two vendors and numerous funds for each vendor.⁴ Third, faculty can choose voluntary contributions with a very limited match rate, of 50% for up to \$40 per month, which go into the university-run 403(b) plan. Fourth, faculty can choose additional voluntary contributions, which can be directed to the same 403(b) plan and to a state-run 457 plan, and, near the end of our sample period, to a university-run Roth 403(b) plan and a state-run Roth 457 plan.⁵ Fifth, faculty must choose among two vendors for 403(b) contributions, while the 457 plan has a single (different) vendor, and among numerous funds for each vendor, with fund menus differing for the 401(a), 403(b), and 457 plans. The focus of our paper is on the sum of voluntary contributions made in the third and fourth steps.

Conditional on choosing the 401(a) DC plan in the first step above, the total required contribution rate depends on the employees' hiring date, as detailed in Table 1. For employees hired before July 1, 2010, the university contributed 10.4% of their monthly pay to the DC plan, and employees were not required to contribute any money to the plan. A state law enacted in 2010 mandates a 5% employee contribution for all the state's employees. In response, the university reduced its employer contribution rate to 8.9% for employees hired

after July 1, 2010, resulting in a total contribution rate of 13.9%. The law was enacted to alleviate underfunding in the state DB plan, and it covered all state employees, even those few (i.e., faculty) who could opt out of the DB plan, in which case their 5% contribution went to their DC plan. This change in mandatory contribution rates can thus be viewed as an exogenous change for new faculty, rather than an endogenous response to new faculty preferences or an element of a broader set of changes in employer policy.

We exploit the exogenous shift in the mandatory contribution rates to investigate whether newly hired faculty who chose the DC plan alter their voluntary contribution rates in response. A few additional comments about changes in the voluntary contribution setting are in order. As noted above, a small employer match is available, of up to \$20 for voluntary contributions of \$40. Beginning in 2009, the university began to auto-enroll employees in the 403(b) plan with a contribution of \$40, so that they would automatically benefit from the match. Our empirical approach will account for this change from a default of \$0 to \$40 in voluntary contributions. Later, in 2013, the Roth options mentioned above became available. Because the Roth option does not change the maximum contribution amounts that may be made, we treat voluntary contributions to either the TDA or Roth accounts as equivalent, after adjusting for an imputed employee marginal tax rate.

The next section presents a simple theoretical model that predicts how employees respond to changes in mandatory contribution rates, and the section after introduces our empirical strategy to test whether employees respond as theory predicts.

³ We will refer to the 401(a) plan as the "university plan with required contributions" or the "mandatory DC plan," though it is only mandatory after the DB-DC choice; this terminology helps distinguish it from the voluntary DC plans that are our main focus. The state DB plan became a hybrid DB-DC plan in 2014, but that occurs in the last year of our sample and did not noticeably change the DB plan choice.

⁴ Employees can split contributions among the two vendors and among all the funds offered by each vendor.

⁵ The 403(b) and Roth 403(b) options are jointly subject to IRS contribution limits, just like 401(k) plans are. The 457 and Roth 457 options are jointly subject to *additional* IRS contribution limits, meaning that faculty are able to contribute twice as much to retirement plans as employees who work for most other types of employers are.

3. Model

This section introduces a simple theoretical model to explain how changes in required employer and employee contributions should affect employees' participation and contribution decisions regarding voluntary plans. We explore conditions under which mandatory contributions are predicted to crowd out voluntary contributions.

We highlight three features of the model that affect our predictions about voluntary contributions. One is the crowd-out effect, from an increase in the required employee contribution. The second is a compensation effect, which would alter voluntary contributions provided that total employer compensation to the employee (which includes employer contributions plus salary) changes. Third is a participation effect, which constrains the crowd-out effect for employees who would have contributed amounts that are too small to be fully crowded out.

3.1 Setup

Employees live for two periods. They work during the first period and earn a pretax income Y . Employees must contribute M_e to the mandatory retirement savings account, and the firm must contribute M_f . Employees then have a choice between contributing an additional non-negative amount M_v to a voluntary retirement savings account.⁶ Employees retire during the second period. The only source of income in the second period is the balance in their retirement savings accounts. For the sake of simplicity, we assume that both mandatory and voluntary retirement saving accounts have the same rate of return (r), employees cannot borrow in either period, and they do not have access to any other savings products.

3.2 Baseline model

In the baseline model, an employee maximizes her lifetime utility subject to the following constraint: since no borrowing is allowed, consumption in each period

cannot exceed resources available in that period.

Before the policy change, the firm is required to make a contribution to the retirement account, but the employee is not. Therefore, employee i hired before the policy change solves the following maximization problem:

$$\begin{aligned} \max_{M_v} & u_i(c_1^i) + \beta u_i(c_2^i) \\ \text{s. t.} & c_1^i = Y - M_v^i \\ & c_2^i = (1 + r)(M_v^i + M_f) \end{aligned}$$

where $u_i(\cdot)$ is a concave function and β is the discount rate. First-period consumption c_1^i equals first-period earnings Y minus the voluntary contribution M_v^i that employee i chooses. Meanwhile, the constraint against borrowing means that the employee cannot access the employer's mandatory contribution until retirement. Second-period consumption c_2^i equals the accumulated balance of the retirement account, which consists of the employer contribution M_f and the voluntary employee contribution M_v^i , along with interest earned on those contributions.

Now, consider employee j who is hired after the policy change, which reduces the required employer contribution and establishes a required employee contribution, leading to a higher required total. She solves the same maximization problem as employee i but faces modified budget constraints:

$$\begin{aligned} \max_{M_v} & u_j(c_1^j) + \beta u_j(c_2^j) \\ \text{s. t.} & c_1^j = (Y - M_e - M_v^j) \\ & c_2^j = (1 + r)(M_f + M_e + M_v^j) \end{aligned}$$

The new required employee contribution M_e now appears negatively in the first-period budget constraint and positively in the second-period budget constraint.

Figure 2 presents a graphical representation of the baseline model using actual numbers from the policy

⁶ We ignore income taxes, since the tax deferral available through the retirement plan does not change the model's predictions. According to institutional details the contribution to a voluntary retirement savings account receives an employer match of up to \$40 per month. This amount is small enough that we ignore it in the modeling as well. Even if it were included, none of the substantive predictions change.

change. BL_1 represents the budget line before the policy change. Applying the budget constraints for employee i , the two end points for BL_1 are $c_1 = Y$, $c_2 = (1+r)0.104Y$ and $c_1 = 0$, $c_2 = (1+r)1.104Y$, because the firm contribution before the policy change is 10.4% of monthly pay. Similarly, BL_2 is the budget line after the change. The two endpoints are $c_1 = 0.95Y$, $c_2 = (1+r)0.139Y$ and $c_1 = 0$, $c_2 = (1+r)1.089Y$. This illustrates that the policy change reduces employee j 's resources relative to employee i because of the reduction in the employer contribution of 1.5 pp—and not because of the new required employee contribution of 5%.

Suppose that employees i and j have the same preferences. Point A is an example of the optimal consumption bundle for employee i , hired before the policy change, and point B is an example for employee j , hired after the change, under the standard assumption that consumption in both periods are normal goods. The distance between Y and C_1^{before} is M_v^{before} , the voluntary contribution amount for employees hired before the policy change, which is apparent from the first budget constraint for employee i . Similarly, the distance between $0.95Y$ and C_1^{after} is M_v^{after} , the contribution amount to the voluntary plan for employees hired after the policy change.

The change in voluntary plan contributions is then

$$\begin{aligned} M_v^{after} - M_v^{before} &= 0.95Y - C_1^{after} - Y + C_1^{before} \\ &= -0.05Y + C_1^{before} - C_1^{after} \end{aligned} \quad (1)$$

Equation (1) demonstrates two effects on voluntary contributions. The *crowd-out effect* is reflected in the first term, $-0.05Y$, as the new required employee contribution makes it unnecessary to save the same amount in voluntary form. The *compensation effect* is reflected in the second term, which is positive (since C_1 shrinks) and, therefore, undoes part of the crowd-out effect. Because consumption in each period is a normal good, employees want to reduce consumption a little in both periods rather than experiencing a larger drop in period 2, and they do this by saving a little more than they would otherwise in period 1.

An important condition for the crowd-out effect to hold is that point A, showing the optimal location for employee i , lies above segment F of BL_1 . If so, then $0 \leq C_1^{before} - C_1^{after} \leq$ distance D on the graph. Since BL_2 is a parallel shift of BL_1 , distance D on the graph is the same as distance E on the graph. At $c_1=0$, $c_2 = (1+r)1.089Y$, we can plug the second term into the second budget constraint faced by employee j , yielding $M_v = 0.035Y$ for someone at point G. The x-coordinate of point G is $Y - 0.035$, and so

$$C_1^{before} - C_1^{after} \leq 0.965Y - 0.95Y = 0.015Y$$

Applying this inequality to equation (1) yields

$$\begin{aligned} -0.05Y &\leq M_v^{after} - M_v^{before} \leq -0.05Y + 0.015Y \\ \Rightarrow -0.05Y &\leq M_v^{after} - M_v^{before} \leq -0.035Y \\ \Rightarrow -0.05 &\leq \frac{M_v^{after}}{Y} - \frac{M_v^{before}}{Y} \leq -0.035 \end{aligned}$$

Therefore, the model predicts that employees decrease their voluntary contribution by an amount between 3.5 and 5 pp. This bounds the compensation effect at between 0 and 1.5 pp. However, it is likely to be closer to 0 than to the full 1.5 pp. One reason is that, as long as consumption in all periods is similarly valued, employees will want to spread the lost resources across many periods, which entails a smaller reduction in saving than 1.5 pp. Another reason is that the faculty whom we study are relatively well compensated and have a relatively high propensity to save, so the 1.5 pp reduction in pay is not likely to alter savings behavior by much. With a sample average of about a 7% voluntary contribution rate, a similarly scaled reduction in saving would be on the order of 7% of 1.5%, or a 0.105 pp reduction.

3.3 Model with non-participants

The predictions in our baseline model pertain to the case of relatively high voluntary contribution rates. If voluntary contributions for employees before the policy change are small or zero, however, that limits the crowd-out effect, replacing it instead with a participation effect.

In Figure 2, this case arises when the optimal choice A before the policy change is near or on segment F of BL_1 . Then, after the policy change, those employees will

bunch at point H on BL_2 . In this case, $C_1^{before} - C_1^{after} \leq Y - 0.95Y = 0.05Y$. Following the same analysis as earlier,

$$M_v^{after} - M_v^{before} = -0.05Y + \underbrace{C_1^{before} - C_1^{after}}_{\text{between 0 and } 0.05Y}$$

$$\Rightarrow -0.05Y \leq M_v^{after} - M_v^{before} \leq -0.05Y + 0.05Y$$

$$\Rightarrow -0.05 \leq \frac{M_v^{after}}{Y} - \frac{M_v^{before}}{Y} \leq 0$$

For those who cannot fully offset the crowd-out effect, contributions fall by an amount between 0 and 5 pp that is smaller than above. This *participation effect* represents the truncated outcome of the crowd-out effect, since employees who cannot reduce their contributions below zero instead stop contributing entirely to the voluntary retirement plan.

3.4 Summary

The model above assumes that employees are aware of all the aspects of their retirement plan. Different conjectures about what may be salient to employees leads to different model predictions. One possibility is that some employees are only aware of required employee contributions, which are deducted from their regular paycheck, but not required employer contributions, which might only be observed on their quarterly vendor statements; in this case, a full 5 pp crowd-out response may be more likely. Another possibility is that some employees are unaware of any required contributions at all, in which case they would not respond to the change in the level and mix of contributions that we study.

Table 2 summarizes theoretical predictions of the impact of decreasing the required employer contribution by 1.5 pp and establishing a new required employee contribution of 5%. The baseline model in which everyone makes substantial voluntary contributions predicts that the average voluntary contribution rate will decrease by 3.5 to 5 percentage points while the

average voluntary participation rate will stay the same, as the compensation reduction effect partially offsets the crowd-out effect. If instead, some contribute little or nothing voluntarily, then the average voluntary rate is predicted to decrease by smaller amounts (because some cannot reduce contributions by as much as they would like), while the average voluntary participation rate is also predicted to decrease.

4. Data

4.1 Data description

We construct a novel panel data set using a large university's administrative records. The administrative data contain monthly retirement plan information, semiannual demographics information, and annual earnings collapsed into bins in order to eliminate the possibility that an individual can be identified. Retirement plan information consists of employee and employer contribution rates (as a percent of earnings) to all available retirement savings plans each year. Demographic information consists of employee gender, age collapsed into bins (again, to maintain data confidentiality), marital status (which is incompletely collected), hiring year, and category of employment (faculty versus staff). To control for macroeconomic conditions, we merge in monthly levels of the S&P 500 stock index, inflated to January 2018.

We focus on five years before and after the change in contribution rates took place in 2010. The initial panel data contain 414,295 observations representing 6,519 faculty over 2005-2014. We focus only on contributions in the months of September through May, when faculty receive their full-time pay. We exclude a relatively small number of unusual observations.⁷

We compare voluntary contribution rates of new faculty hired before versus after July 1, 2010. We consider contribution rates each month in the first three years

⁷ Starting with records on 7,856 individual faculty, we exclude observations with arrears payments in any retirement savings plan in any year because arrears (when the employee should have contributed to the plan but did not) may reflect salary interruptions that could alter contribution decisions. We also exclude observations with annual income less than \$10,000 because these observations probably represent faculty who worked at the university for a very short period of time. These restrictions reduce the number of faculty to 7,445.

after being hired, when we view participants as reaching their steady state contribution rate. Madrian and Shea (2001), for example, show that retirement plan participation rates increase over time, apparently as employees overcome initial procrastination. We observe 2,867 new faculty hires during this period, and our three-year window results in 52,971 observations. Since we exclude observations from June through August, an individual can appear for a maximum of 27 months.

4.2 Descriptive statistics

The summary statistics in Table 3 use data from the end of the employee's first year to show demographics and employment characteristics for faculty before and after the policy change; the last two columns also report the mean difference between these two groups of faculty, and the corresponding p -value from that the test that means are equal. Appendix Figure A1 further shows trends in key demographic characteristics over time, which makes it clear that new faculty characteristics did not undergo any meaningful changes at the same time as the policy change.

The demographic characteristics we observe are age (in bands), gender, and marital status (incompletely collected by the employer), all of which are known to affect the propensity to save for retirement. Demographics across the two groups are generally balanced. Because age is grouped into bands (generally of 5 years) in order to protect the identity of individuals in our sample, we impute an exact age using the mid-point of the age bands. The average imputed age in our sample dropped slightly from 39.7 before 2010 to 39.0 after, a difference that is statistically significant but not economically important in explaining saving behavior. Forty-three percent of new faculty in the sample are female. Marital status is reported on an incomplete basis, because the university does not make use of information that it collects at the outset of employment for any personnel purpose, and many employees do not report or update their marital status. Roughly 44% of new faculty report being married and 25% report being single, while the remaining 30% do not report their marital status.

The key employment characteristics that we observe for faculty are full-time status and earnings. The share who are full-time stays the same, at 91%, before and after 2010. With earnings reported in bands, we use the midpoint of each band in calculating the means in Table 3.⁸ In real terms, average (imputed) salary rose from \$84,359 before 2010 to \$87,454 after, a modest increase that is marginally significant at the 10% level. Appendix Figure A1 shows that average salary by year is flat. These statistics demonstrate an important point – that there is little evidence of a permanent salary increase intended to compensate for the 1.5 pp decline in the employer contribution rate to the retirement plan. Lastly, the stock market did exhibit substantial changes during this period, with higher average levels for faculty hired after 2010. In Section 6 we exclude the period around the Great Recession as a robustness check and find similar patterns.

4.3 Retirement plan choices

Table 3 also shows raw statistics on retirement plan choices before and after 2010. The patterns that we find in our econometric analysis later on are evident in the raw data.

Recall from Section 2 that faculty first face a one-time irrevocable choice between the DB plan run by the state and the university DC plan with mandatory contributions on which we focus. Table 3 shows that the share choosing the DC plan changes little before and after 2010, with about 20% opting for the DB plan.

Next, we compare participation in the voluntary retirement plans (summing together both the 403(b) and 457 options) before and after 2010. These statistics adjust for two other changes in retirement plan structure during our time period. In 2009, auto-enrollment into the 403(b) plan began for new employees; the default monthly contribution was set at \$40 in order to provide employees with the maximum cash match of \$20. To deal with this change in the plan environment, we

⁸ In particular, salary is reported in \$5,000 bands below \$100,000 annual salary, and then \$20,000 bands to \$200,000, with top-coding above this level.

treat all participants with very small contribution levels consistent with the cash match as not making voluntary contributions, including employees making an active choice before 2009 to get the cash match. We do this so as not to distort our participation or contribution rate statistics with people either defaulting to or actively choosing such a small but subsidized contribution; we do not anticipate that anyone contributing just enough to get the cash match will respond to the crowd-out effect of the large shifts in required contributions that are our focus.⁹ In 2013, Roth versions of the voluntary retirement plans become available, and we include them (adjusted for their post-tax status using an imputed marginal tax rate) along with traditional tax-deferred accounts as voluntary plan options.¹⁰ Appendix B describes the imputation procedure that we used to construct the marginal tax rate.

Among faculty who chose the university DC plan with mandatory contributions, Table 3 shows the share choosing any voluntary DC plan at the end of their first year, before and after 2010, and Figure 3a shows the same for the first twenty-seven months (covering three years that exclude summer months) after hire. While the dynamics of participation in the first three years after hire seem to have changed a little, the general pattern is a slightly lower participation rate for new hires after 2010. New faculty before 2010 (shown with light bars) gradually reached a participation rate of over 80% in the later months of the window shown in Figure 3a. New faculty after 2010 (shown with dark bars) reached a

plateau somewhat sooner, but this plateau was lower, generally hovering just below 80%.¹¹

Figure 3b shows the voluntary contribution rate over the same period among those making positive contributions.¹² Here, the dynamics are a little different than for participation, with the differences in contribution rates narrowing slightly instead of widening slightly over time, while again remaining a little lower for new hires after 2010. In the first few months of hire, new faculty after 2010 (dark bars) chose voluntary contribution rates that were about 1.5 pp smaller, but in later months these differences shrank to less than 0.5 pp.¹³ Figure 3c plots voluntary contributions averaged over those who participate and those who do not, which is of ultimate interest when evaluating the adequacy of retirement saving. In combining the participation and the contribution margins, the change in behavior is clearer, with a stable decline in overall contribution rates of 0.5-1 pp across the first three years after hire, for faculty hired after versus faculty hired before the policy change.

To provide a sense of the distribution in contributions, Appendix Figure A2 shows quantile plots of voluntary contributions among both groups of employees 18 months after being hired. The bottom half and the very top of the distributions are similar across both groups, with larger declines in contributions observed between the 60th and 80th quantiles.

⁹ Since we do not observe dollar amounts of contributions in our data, we use the upper bound of the salary bin to construct the percentage contribution consistent with the cash match, and set to zero any contribution rates that are at or below that amount. For example, for someone in the [\$50k, \$55k] salary bin, we label 403(b) contributions below 0.8% as being consistent with the cash match and record this contribution as zero. Our results are robust to instead using the lower bound of salary. Since the salary bins are relatively narrow and the cash match amounts are small, the estimates are not sensitive to this definition. We choose the upper bound to be conservative in replacing small contributions with zeros.

¹⁰ While some participants began to choose the Roth options, total participation and contribution rates trended smoothly before and after this date.

¹¹ While it may be surprising to observe some months of decline in voluntary DC participation, this can occur for two reasons. The statistics focus on flows of monthly contributions, which faculty can change at any time, rather than stocks of assets; also, the composition of the group can change over time as some faculty exit employment.

¹² We winsorize voluntary contributions at the 99th percentile (equal to contributing about 50% of salary) to remove the influence of outliers on the mean.

¹³ Thus, higher contributors seem to have chosen to start participating somewhat later after hire in the post-treatment period than in the pretreatment period; however, we do not find any reason to think that the policy change itself would have caused a change in the dynamics of retirement plan participation over time.

5. Empirical strategy

5.1 Identification

The ideal experiment to estimate employee responses to a mandatory increase in contributions would be to randomly require some employees to make mandatory contributions while exempting others from doing so. The difference between the two groups would yield the overall effect of the policy. Our setting differs from this ideal setup in that all the new faculty whom we observe after 2010 experienced the change in contribution rates. Lacking such a control group, we instead compare participation and contribution rates among repeated cross-sections of new faculty hired before and after July 1, 2010.

The key identification assumption necessary for this approach is that newly hired faculty after the policy change do not differ systematically in their saving preferences compared to newly hired faculty before the policy change. We offer evidence that helps rule out several concerns with this assumption. One concern is that the willingness of faculty to accept job offers at the university we study changed as a result of the shift in required contributions. However, as we showed earlier in Table 3 and Appendix Figure A1, faculty changed little in their observable employment or demographic characteristics, and this reduces concerns that changes in hiring practices or the selection of faculty accepting job offers changed unobservably at the same time. A second concern is that other university policies changed concurrently. We have not found evidence of changes in the DC vesting schedule, compensation, or hiring policies. The DB plan, however, became less generous in 2010, which counteracts the relative compensation decline associated with DC participation that we study. Since we ultimately find only a small change in DB plan enrollment, we do not view this change as a threat to identification. A final concern is that other events in the broader economy changed at the same time as the policy. The July 1 implementation of the policy is standard for state law changes that were enacted months earlier, following weeks of debate, while the underfunding of the state DB pension had been in the news for almost two years, since the financial crash

of 2008. Therefore, it is unlikely that other events associated with the financial crash or with underfunding coincided exactly with the new policy. Moreover, the monthly frequency of our data reduces concerns that some other economy-wide factor, aside from the stock market index that we control for, affected voluntary contributions and changed precisely when mandatory contributions changed.

In order to validate that the timing of our policy change is unrelated to underlying trends in the broader economy, we examine nationally representative data reporting retirement plan behavior. We focus on the Survey of Consumer Finances, which is administered every three years and is typically viewed as the most reliable data set available on financial behavior. We extracted a sample with similar education and earnings and found that nationwide participation and contribution rates in voluntary DC plans varied little over our sample period. This evidence is described in more detail in Appendix Figure A3.

5.2 Econometric specification

We begin by evaluating the irrevocable choice to participate in the state DB plan rather than the mandatory DC plan using data from the employee's first month. We estimate the equation below using OLS:

$$y_i = \alpha + \beta_1 Post_i + \beta_2 Female_i + \beta_3 Single_i + \beta_4 Married_i + \beta_5 Fulltime_i + \beta_6 Stock_i + \sum_a \beta_a \mathbf{1}[Age_i = a] + \sum_j \beta_j \mathbf{1}[Income_i = j] + e_i \quad (2)$$

The key explanatory variable in (1) is $Post_i$, which takes a value of one if faculty member i was hired on or after July 1, 2010 and zero if hired before. We control for indicators of demographic and employment characteristics that might influence retirement contributions. The demographic characteristics, as we discussed in the previous section, are $Female$ for gender, $Married$ and $Single$ for marital status (where the omitted category is unknown marital status), and Age for the age ranges that we observe for our sample. The employment characteristics are $Income$, annual income measured in thousands of 2018 dollars and imputed from the income

bands that we observe for our sample; and *Full time*, an indicator that takes a value of one if the faculty is hired as a full-time employee. Lastly, we include *Stock return* the monthly level of the S&P 500 index in the employee's first month, because it captures changes in the attractiveness of retirement savings accounts and varies at a monthly frequency.

We then estimate an event study specification for voluntary DC plan participation and contribution rates for employees opting for the mandatory DC plan (and thus experiencing the changes in required contributions that we study). It is well known from other studies that employees gradually increase their participation in retirement plans, apparently as they overcome inertia in their decision-making (Madrian and Shea 2001). Therefore, we use a 3-year panel to trace out voluntary participation and contributions over time. We estimate the equation below using OLS:

$$\begin{aligned}
 y_{it} = & \alpha + \beta_1 Post_i + \beta_2 Female_i + \beta_3 Single_{it} \\
 & + \beta_4 Married_{it} + \beta_5 Fulltime_{it} + \beta_6 Stock_{it} \\
 & + \sum_a \beta_a \mathbf{1}[Age_i = a] + \sum_j \beta_j \mathbf{1}[Income_i = j] \cdot \\
 & + \sum_t \beta_t \mathbf{1}[tenure\ month = t] \\
 & + \sum_k \beta_k \mathbf{1}[tenure\ month = k] \times Post_i + u_{it} \quad (3)
 \end{aligned}$$

Here, the outcomes y_{it} are the voluntary participation and contribution rate decisions. In this specification we add the vector *tenure month* and then interact it with *Post*, where *tenure month* are indicator variables for each of the first twenty-seven months of employment (we omit the last month). The coefficients β_k on *tenure month* \times *Post* trace out the time pattern in voluntary contributions for new hires after 2010 compared to the coefficients β_t on *tenure month* alone, which trace out the time pattern for new hires before 2010. All other variables are the same as in the first specification.

We consider voluntary contributions conditional on participating, as well as overall voluntary contributions averaged over participants and non-participants. The possibility of crowd-out is only applicable for those with positive contributions, but, as we noted above, some people who would have participated with low contribution

rates should be crowded out into non-participation. Since no employee is subject to both policies, though, we are unable to observe which are pushed across the non-participation threshold, and a substantial participation effect would push down our estimate of the crowd-out effect.

6. Results

In this section, we report estimates of the impact of the shift in required DC plan contributions in July 2010. We are interested in the impact on faculty choices from the introduction of the new 5% required employee contribution, together with the 1.5 pp reduction in the required employer contribution. We expect at most a small change in the choice between the DB and DC plan, as DB plan benefits were cut at the same time. As summarized in Table 2, our baseline model predicts that voluntary contributions should decline by 3.5-5 pp, as the compensation reduction effect would partially (and, we expect, only slightly) offset the full crowd-out effect of 5 pp. If some employees stop contributing entirely, then the participation effect would mute the decline in average contributions, while causing a decline in participation in the voluntary plan instead.

We first consider the one-time choice between the state DB plan and the mandatory DC plan. The estimates in Table 4 show that the shift in required DC contributions, together with reduced DB benefits, led to a statistically significant 3.7 pp reduction in DC participation overall. Given a pre-2010 participation rate of 21%, DB plan participation rose around 18%. The magnitude of this response, which is relatively small, is perhaps consistent with more awareness of the DC policy change than the DB policy change.

We then report estimation results in Table 5 for voluntary participation and contribution rates, from our event study specifications among those who chose the university DC plan with mandatory contributions. We report a subset of the coefficient estimates on the interactions of *tenure month* and *Post*, focusing on the 9th, 18th, and 27th months of tenure, which correspond to the end of the first, second, and third years, and we also report the coefficient estimates on the age and earnings interval

dummies (while we omit coefficients on the additional demographic variables). Figure 4 displays the estimates with 95% confidence intervals for the full event study. The participation rate is measured in percentage points. In Figure 4, new faculty hired after the policy change are between 3 and 6 percentage points less likely to contribute to a voluntary retirement savings account than new faculty hired before the policy change, depending on the time since hired. Most of the estimates are not statistically significant, or only marginally so. The differences are generally larger after two years. This reflects the pattern that was evident in Figure 3, in which voluntary participation trended upward after hire by a greater amount before 2010 than after, leading to a growing gap. We can gauge our estimates by the potential for crowd-out on the participation margin, with about 50% of participants contributing more than zero and less than 5% in the pretreatment period. Compared to that, reductions of 3-6 percentage points suggest a modest participation effect.

We find more evidence of a response for the amount contributed, both overall and conditional on participating in at least one voluntary plan. Table 5 shows the estimated effect of the shift in required contributions on voluntary contributions at the end of each of the first three years, and Figures 3b and 3c show the estimates by month. Conditional on a positive contribution, new faculty hired after the policy change reduce their average voluntary contribution rate by 2.25-2.5 pp, a statistically significant reduction. Including those with zero contributions, the average reduction is generally between 1.5-2 pp. Both responses are fairly stable after the first few months.

Our results suggest a lack of salience of required contributions. The crowd-out and compensation effects should lead to a 3.5-5 pp reduction, and likely closer to 5 pp, yet the lower bounds of the 95% confidence intervals consistently reject a 5 pp reduction in contribution. Overall, we estimate a “crowd-out rate” of about 45%. Yet, the absence of a full crowd-out effect cannot be explained by a participation effect, which we also estimate to be fairly small.

We implement several robustness checks and do not find that the qualitative results are sensitive to different specifications: we continue to strongly reject full crowd-out. First, we estimate specification (3) without any of the control variables, which were for demographic and job characteristics and for financial market returns. Appendix Figure A4 shows that the response is weaker, with most estimates around a 1 pp reduction in contribution rates, and lower bounds of the 95% confidence interval above a 3 pp reduction. We also try narrowing the time frame, which is 2005-2014 in the main analysis, in different ways. We omit the period of the financial crash, September 2008 through end-2009, because financial choices may have changed during this window. The main estimates become somewhat larger (in absolute value), though we generally continue to reject a 5 pp reduction based on the lower bound of the 95% confidence intervals (Appendix Figure A5).

Finally, we perform a placebo test with our main sample, based on the choice to invest with either of the two plan vendors (referenced here as Vendor A and Vendor B) as the dependent variable. The choice of vendor is a decision made concurrently with first choosing the contribution rate, but should arguably not be affected by the mandatory increase in employee contributions. If other unobservable characteristics of employees who join the university after 2010 had changed, or if changes in financial markets or the macroeconomy had occurred at the same time, then this choice might change as well. Appendix Figure A6 shows that estimates of the policy change impact on the choice of vendor are very close to zero and are not statistically significant. Taken together, the results provide support to our finding of only partial crowd-out in response to the mandatory increase.

7. Discussion

In this paper, we study how employees respond to a shift in the level and mix of required contributions at a large public university. Standard economic theory highlights crowd-out effects of required contributions, which should generally reduce voluntary contributions among individuals who would have saved on their own. Our findings reject the predictions of standard theory.

We detect reductions of voluntary contribution rates of around 2.25 pp, on average, which represents 45% crowd-out in response to the 5 pp increase in mandatory employee contributions. Our 95% confidence intervals statistically reject the 5pp reductions predicted by theory. We estimate small, and often imprecise, declines in participation of around 3-6 pp, so the participation margin is responding weakly as well to the policy.

Our results suggest a high prevalence of passive saving and highlight the importance of salience. The impact of mandatory contributions overall, much less the equivalence of mandatory contributions from the employer or employee when holding total compensation constant, depends on awareness on the part of employees. The lack of salience of mandatory contributions accords with results in other retirement planning settings (Chetty et al. 2014).¹⁴ The role of salient elements of the choice environment may help explain the power of defaults in affecting DC wealth accumulation (Beshears et al 2008).

Salience may take on particular importance in a complicated choice environment – as is the case for retirement planning in general, which requires individuals to make decisions over lengthy time horizons under considerable uncertainty, and for many pension plan settings in particular. In fact, we find a lower crowd-out rate from required contributions than Card and Ransom (2011) did using data from 20-30 years ago in a cross-university setting. This may be because the choice environment has grown increasingly complicated since then, including at the university we study, with the

addition of further DC options (like Roth plans and catch-up contributions), the proliferation of fund offerings (until a recent move by many university employers to simplify fund lineups), and the increasing prevalence of accounts offered to manage not just retirement saving but also health insurance costs (through Flexible Spending Accounts and now Health Savings Accounts, which have features that resemble retirement accounts (Leive 2019)).¹⁵

The magnitudes of our results have important implications for policy aimed at increasing retirement saving. Since the change in mandatory contributions was roughly equal to the average voluntary contribution rate, incomplete crowd-out raised total contributions. While we are unable to measure saving by these employees in other financial accounts, the roughly 1 pp increase, on average, in total contributions after the change is meaningful. A potential concern, however, with a large increase in mandatory contributions is that some employees may be forced to forego more present consumption than they otherwise would prefer, with some of those facing tight liquidity constraints worse off because they must make large mandatory contributions. In our setting, however, the incidence of borrowing by participants against DC plan balances is quite infrequent, with less than 2% taking out any loans. Moreover, the absence of large participation responses is indicative that most employees do not face such constraints. Our results suggest that policies targeted at passive saving behavior have scope to improve preparation for retirement.

¹⁴ Some similarly powerful results about salience arise in the tax literature. Traditional economic theory predicts that it does not matter whether consumers or producers are taxed; the impact of the tax on welfare, prices, and the quantity demanded and supplied are independent of who legally pays the tax. We demonstrate a parallel result in our theoretical analysis of whether the employee or employer is required to contribute to a retirement plan. Chetty, Looney, and Kroft (2009), however, demonstrate that taxes on consumers are much more salient in their demand choices than are taxes on producers, a result that may parallel the situation that we analyze.

¹⁵ Moreover, a common scenario is that households own one 401(k) account from current employer and one Individual Retirement Account (IRA) for rollovers from previous employers. See Munnell et al. (2018) for a brief discussion of why multiple accounts makes optimal retirement planning more complicated.

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Table 1. Summary of policy change to contribution rates, percent of salary

	Hired Before July 1, 2010	Hired After July 1, 2010
Mandated employee contribution rate	0%	5%
Mandated employer contribution rate	10.4%	8.9%
Total contribution rate	10.4%	13.9%

Note: This table summarizes the changes in the university 401(a) DC plan based on the employee's date of hire. Employees faced a one-time irrevocable choice between a state DB plan and this DC plan.

Table 2. Summary of model predictions

	Average voluntary contribution rate	Average voluntary participation rate
Baseline case (<i>with crowd-out and compensation reduction effects</i>)	Decrease between 3.5 and 5 pp	No change
Low saving rate case (<i>with additional participation effect</i>)	Smaller decrease than above	Decrease

Note: This table summarizes the model's predictions for participation and voluntary contributions in response to the required increase in contributions in the university DC plan. Under the baseline case, employees offset the required 5% increase in mandatory contributions by reducing their contributions between 3.5pp and 5pp. The 5% reduction represents the crowd-out effect in which lower employee contributions completely offset the 5% increase in required contributions. The reduction could be as low as 3.5pp due to the compensation effect, though this effect is likely to be small if that the 1.5pp reduction is scaled by the average contribution rate of 6%-8%. For employees who contribute small enough amounts that they cannot fully reduce their contributions, they are predicted to stop participating by making zero contributions, reflecting a participation effect.

Table 3. Descriptive statistics

	Pre: Hired 2005-2009		Post: Hired 2010-2014		Difference (Post-Pre)	p-value of difference
	Mean	SD	Mean	SD		
Choice between the DB plan or mandatory DC plan:						
DB plan participation	0.210	0.407	0.194	0.396	-0.016	0.315
Mandatory DC plan participation	0.790	0.407	0.806	0.396	0.016	0.315
If in the mandatory DC plan:						
Voluntary DC participation rate	0.761	0.427	0.754	0.431	-0.007	0.702
Voluntary DC contribution rate, %	5.231	8.987	4.362	8.528	-0.869	0.023
Voluntary DC contribution rate, % (if positive)	7.273	11.754	6.026	10.614	-1.247	0.028
Demographic and job characteristics:						
Female	0.429	0.495	0.432	0.496	0.003	0.874
Married	0.439	0.496	0.442	0.497	0.004	0.852
Single	0.243	0.429	0.256	0.437	0.013	0.433
Marital status unknown	0.319	0.466	0.302	0.459	-0.017	0.352
Full-time	0.911	0.285	0.909	0.287	-0.002	0.879
Annual salary (inflation-adjusted)	84,359	43,301	87,454	44,830	3,095	0.106
Age	39.73	9.07	38.97	9.16	-0.75	0.033
S&P 500 Index (inflation-adjusted)	1261	225	1729	289	468	0.000
<i>N</i>	1808		1047			

Notes: Administrative data on faculty at a large public university, statistics from their ninth month of hire. The final column lists the *p*-value from the *t*-test the means are equal between employees hired in 2005-2009 vs. employees hired in 2010-2014. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each. The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary. Age and annual salary are reported in bins to preserve confidentiality of individuals in the data set. Age is grouped into bands, generally of five years, and we impute individual age as the mid-point of the age bands. We impute salary as the midpoint of salary bands, winsorized at the 5th and 95th percentiles to remove the influence of outliers on the mean. Both salary and the S&P index are inflation-adjusted to 2018.

Table 4. OLS regression estimates, DB plan choice

	Estimate	SE
Post-2010 policy change	0.0371**	(0.0187)
Age, relative to [25,30)		
[30,35)	0.0499*	(0.0272)
[35,40)	0.0814***	(0.0287)
[40,45)	0.0816**	(0.0320)
[45,50)	0.0866**	(0.0367)
[50,55)	0.0552	(0.0388)
[55,60)	0.154***	(0.0499)
[60+)	0.137***	(0.0505)
Salary, relative to [20k-25k)		
[25k-29k)	-0.115**	(0.0467)
[30k-35k)	-0.0324	(0.0513)
[35k-39k)	0.0452	(0.0537)
[40k-45k)	0.242***	(0.0541)
[45k-49k)	0.205***	(0.0524)
[50k-55k)	0.0943*	(0.0499)
[55k-59k)	0.0123	(0.0565)
[60k-65k)	-0.0238	(0.0535)
[65k-69k)	-0.0164	(0.0543)
[70k-75k)	-0.0551	(0.0542)
[75k-79k)	-0.0507	(0.0606)
[80k-85k)	-0.139**	(0.0549)
[85k-89k)	-0.131**	(0.0541)
[90k-95k)	-0.162***	(0.0521)
[95k-99k)	-0.159***	(0.0526)
[100k-120k)	-0.214***	(0.0399)
[120k-140k)	-0.0995*	(0.0539)
[140k+)	-0.174***	(0.0451)
N	2,717	

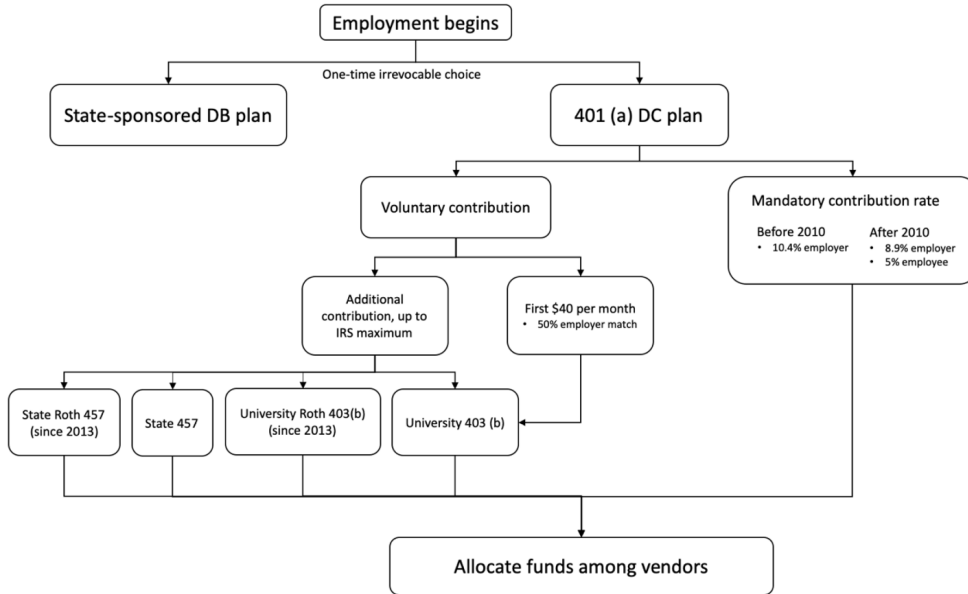
Notes: Administrative data on faculty at a large public university, statistics from their ninth month of hire. Coefficient estimates with robust standard errors in parentheses, and statistical significance represented by *** (1%), ** (5%), or * (10%). Faculty face a one-time irrevocable choice when hired between the state DB plan and the university DC plan. Age and annual salary are reported in bins to preserve confidentiality of individuals in the data set. Regressions also include indicators for sex, full-time employee, marital status, the level of the S&P 500 on the 1st of each month, and a constant.

Table 5. OLS Regression estimates, voluntary participation and contributions

	Voluntary Participation Decision		Voluntary Contribution Rate (if positive)		Voluntary Contribution Rate	
	Estimate	SE	Estimate	SE	Estimate	SE
Selected Post-2020 coefficient estimates						
Post-2010 x Tenure month 9	-0.0367	(0.0239)	-2.447***	(0.755)	-1.732***	(0.509)
Post-2010 x Tenure month 18	-0.0672**	(0.0314)	-2.272**	(0.920)	-2.018***	(0.690)
Post-2010 x Tenure month 27	-0.0265	(0.0480)	-2.260	(1.580)	-1.644	(1.336)
Age, relative to [25,30)						
[30,35)	-0.0153	(0.0352)	0.0113	(0.733)	-0.181	(0.482)
[35,40)	-0.0270	(0.0369)	1.536*	(0.794)	0.878	(0.540)
[40,45)	-0.0486	(0.0390)	1.778**	(0.876)	0.935	(0.592)
[45,50)	-0.0933**	(0.0430)	3.191***	(1.148)	1.520*	(0.784)
[50,55)	-0.0970**	(0.0466)	7.280***	(1.641)	4.161***	(1.153)
[55,60)	-0.0492	(0.0493)	3.312**	(1.313)	1.854**	(0.928)
[60+)	-0.152***	(0.0558)	2.082	(1.496)	0.258	(1.017)
Salary, relative to [20k-25k)						
[25k-29k)	0.0818	(0.0530)	0.813	(1.682)	1.194*	(0.691)
[30k-35k)	0.0982*	(0.0534)	0.320	(1.492)	1.042*	(0.623)
[35k-39k)	0.133**	(0.0532)	-0.982	(1.414)	0.390	(0.569)
[40k-45k)	0.127**	(0.0538)	1.596	(1.679)	1.511**	(0.704)
[45k-49k)	0.230***	(0.0505)	0.907	(1.530)	2.134***	(0.773)
[50k-55k)	0.269***	(0.0475)	0.203	(1.492)	1.900**	(0.760)
[55k-59k)	0.296***	(0.0507)	1.341	(1.553)	2.889***	(0.857)
[60k-65k)	0.323***	(0.0483)	1.518	(1.808)	2.782***	(0.935)
[65k-69k)	0.303***	(0.0516)	2.080	(1.607)	3.169***	(0.841)
[70k-75k)	0.346***	(0.0495)	0.250	(1.429)	2.457***	(0.737)
[75k-79k)	0.329***	(0.0527)	0.193	(1.621)	2.205**	(0.889)
[80k-85k)	0.321***	(0.0520)	1.588	(1.621)	3.193***	(0.905)
[85k-89k)	0.374***	(0.0540)	0.889	(1.518)	3.077***	(0.899)
[90k-95k)	0.354***	(0.0525)	2.760	(1.744)	4.389***	(1.080)
[95k-99k)	0.315***	(0.0554)	3.165*	(1.793)	4.121***	(1.028)
[100k-120k)	0.413***	(0.0417)	5.828***	(1.421)	7.313***	(0.711)
[120k-140k)	0.363***	(0.0510)	3.751**	(1.678)	5.314***	(1.029)
[140k+)	0.367***	(0.0466)	1.965	(1.427)	3.837***	(0.719)
N	41,690		31,986		41,690	

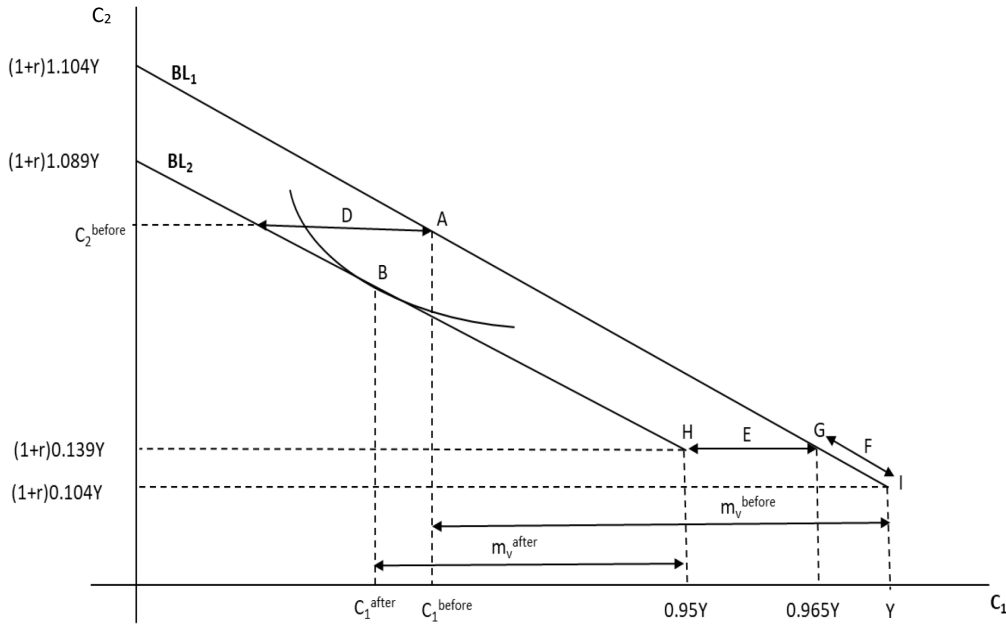
Notes: Administrative data on faculty at a large public university, statistics from their first month of hire. Coefficient estimates (with standard errors clustered by employee); statistical significance represented by *** (1%), ** (5%), or * (10%). Faculty who chose the university DC plan with mandatory contributions when hired can then choose voluntary DC contributions. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each; The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary. Regressions also include indicators for sex, full-time employee, marital status, the level of the S&P 500 on the 1st of each month, and a constant.

Figure 1. Flow chart of retirement saving choices



Note: Figure displays the sequence of choices and available options for retirement plans at the University. The first choice is between the state-sponsored DB plan and the 401(a) DC plan. The main policy of interest is the change in the mandatory contribution rate in the 401(a) DC plan that occurred in 2010. Faculty can choose voluntary contributions with a very limited match rate, of 50% for up to \$40 per month, which go into the university-run 403(b) plan. Faculty can choose additional voluntary contributions, which can be directed to the same 403(b) plan and to a state-run 457 plan, and, near the end of our sample period, to a university-run Roth 403(b) plan and a state-run Roth 457 plan. In the last step, employees have choices between two vendors and then numerous plans within each vendor.

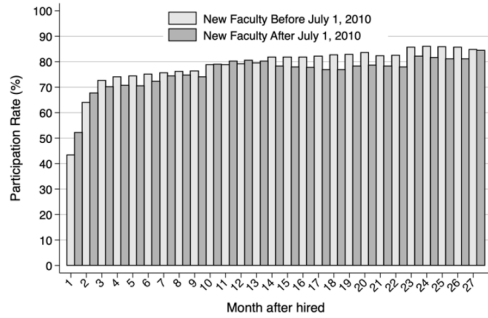
Figure 2. Graphical representation of the theoretical model



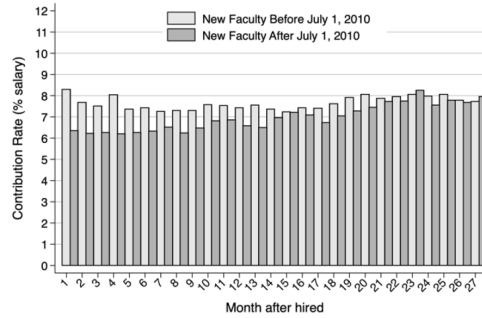
Notes: This graph sketches the predictions of the standard theory of retirement savings crowd-out. Point A represents the optimal consumption bundle for employees hired before the policy change (without mandatory contributions). Point B represents the optimal consumption bundle for employees with the same preferences hired after the policy change, who are now subject to a 5% mandatory employee contribution and receive 8.9% in employer contributions, down from 10.4%. The graph is not drawn to scale to maintain visual clarity. Both mandatory and voluntary saving are assumed to have the same rate of return r . M_v represents the amount contributed to the voluntary DC plan. The change in voluntary contributions, $M_v^{after} - M_v^{before}$, is composed of the sum of a crowd-out effect (equal to $-0.05Y$) and a compensation effect (equal to $C_1^{before} - C_1^{after}$). If Point A were located along segment F, then voluntary contributions could not be fully reduced in response to the higher mandatory contributions, and the employee would stop participating and locate at point H.

Figure 3. Voluntary participation and contribution rates by tenure month, newly hired faculty

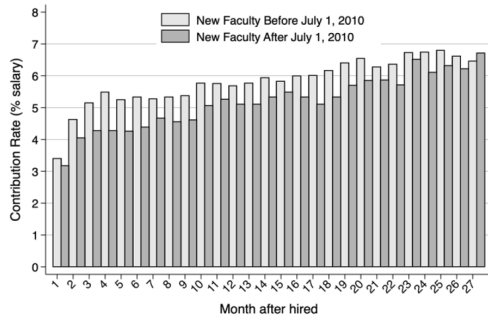
(a) Voluntary participation rate



(b) Voluntary contribution rate, if positive



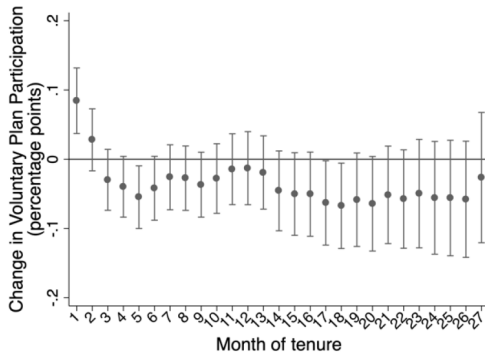
(c) Voluntary contribution rate



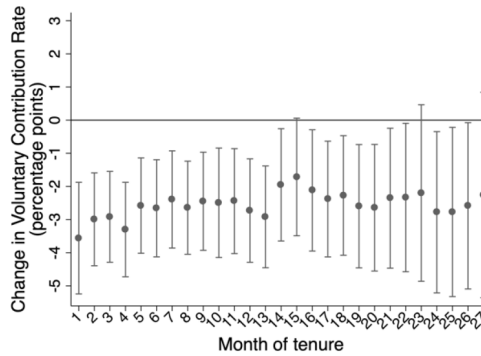
Notes: Figure plots mean participation rates and contribution rates by month since the month faculty are hired. Administrative data on faculty at a large public university, statistics from their first twenty-seven months of hire, which covers their first three years excluding June through August, when many faculty do not receive a salary. Faculty who chose the university DC plan with mandatory contributions when hired can then choose voluntary DC contributions. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each. The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary.

Figure 4. Voluntary participation and contribution rates by tenure month, newly hired faculty

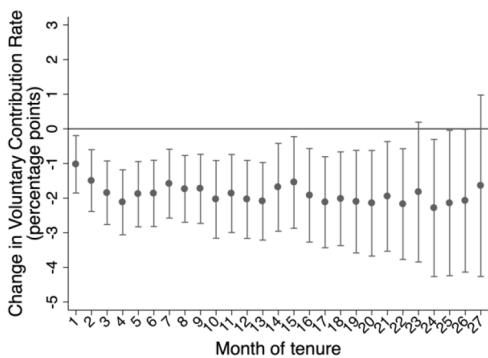
(a) Voluntary participation rate



(b) Voluntary contribution rate, if positive



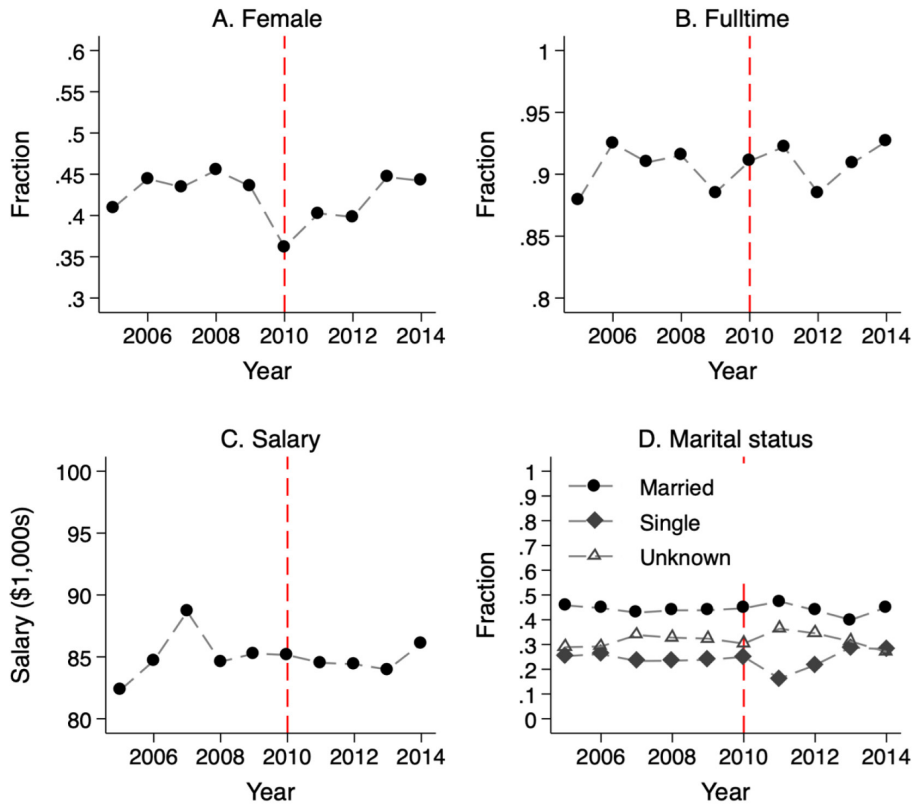
(c) Voluntary contribution rate



Notes: Figure plots OLS estimates of the interaction between indicators for tenure month and an indicator for being hired after July 2010 from the event study regressions corresponding to equation (3). Whiskers denote 95% confidence intervals with standard errors clustered by employee. Additional control variables include the monthly S&P 500 index, and indicators for tenure month, female, full-time employee, married, single, and income and age bands. Administrative data on faculty at a large public university, statistics from their first twenty-seven months of hire, which covers their first three years excluding June through August, when many faculty do not receive a salary. Faculty who chose the university DC plan with mandatory contributions when hired can then choose voluntary DC contributions. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each. The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary.

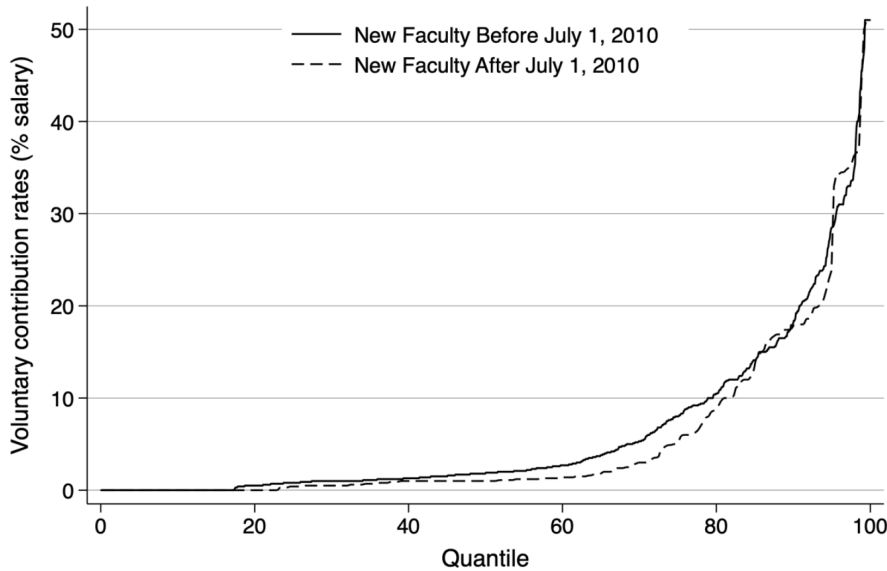
Appendix figures

Figure A1. Means of demographics and salary by year of hire, 2005-2014



Notes: Administrative data on faculty at a large public university, statistics from their first month of hire. Figures plot the averages among employees hired each year from 2005 to 2014. The vertical line at 2010 denotes the year of the policy change.

Figure A2. Quantile plot of voluntary contribution rate by date of hire



Note: Figure plots the ordered values of voluntary contribution rates against quantiles, separately for faculty hired before July 1, 2010 and faculty and faculty hired after this date, in their 18th month of tenure. Sample excludes faculty who choose the DB plan. Voluntary DC contributions consist of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each; it excludes contributions that are smaller than 0.5% of salary, which represents the average contribution rate for a contribution of \$40 per month, yielding the maximum allowable cash match of \$20 per month. Roth contributions are adjusted for their post-tax status, and is reported relative to annual salary.

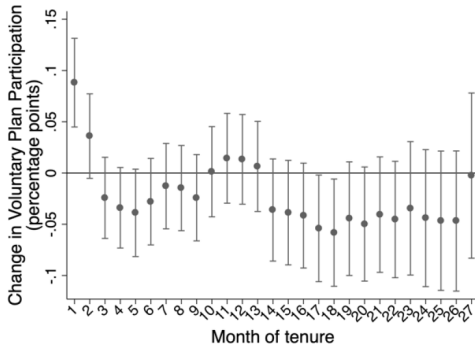
Figure A3. Mean participation and contribution rates in U.S. from survey of consumer finances

	Subsample: employer offers DC plan, employee has BA degree, and earns salary > \$50k	
	Participation (%)	Contribution (% salary)
2004	81.8%	8.3%
2007	79.0%	7.9%
2010	82.5%	8.0%
2013	84.0%	7.8%
2016	81.6%	7.9%

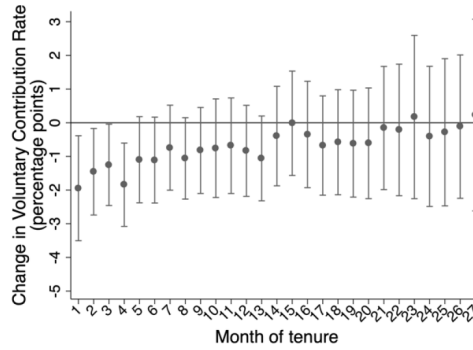
Note: Table reports means weighted using survey sample weights from the Survey of Consumer Finances from the 2004, 2007, 2010, 2013, and 2016 surveys. We restrict analysis to employees whose employers offer DC plans to maintain comparability with our setting. We further restrict to employees who have a BA degree or higher, and who earn annual salaries exceeding \$50,000. The means are calculated using the survey's sample weights and correspond to the individual level (the respondent answers for the spouse, if applicable, whose information we also include if they are also offered a DC plan).

Figure A4. Robustness: Voluntary participation and contribution rates by tenure month without controls, newly hired faculty

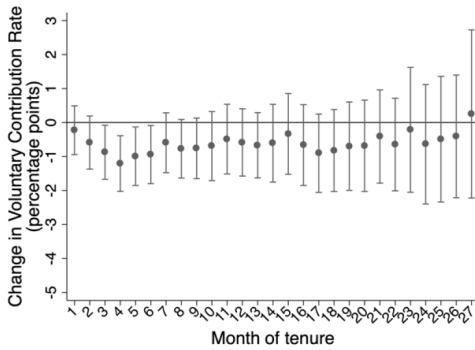
(a) Voluntary participation rate



(b) Voluntary contribution rate, if positive



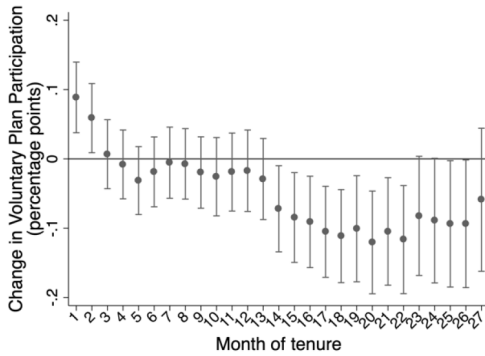
(c) Voluntary contribution rate



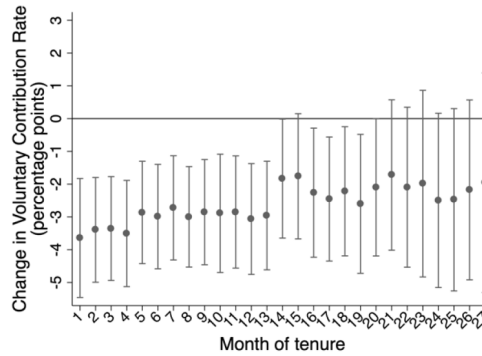
Notes: Figure plots OLS estimates of the interaction between indicators for tenure month and an indicator for being hired after July 2010 from the event study regressions corresponding to equation (3). Whiskers denote 95% confidence intervals with standard errors clustered by employee. Additional include indicators for tenure month and a constant but exclude other controls. Administrative data on faculty at a large public university, statistics from their first twenty-seven months of hire, which covers their first three years excluding June through August, when many faculty do not receive a salary. Faculty who chose the university DC plan with mandatory contributions when hired can then choose voluntary DC contributions. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each. The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary.

Figure A5. Robustness: Voluntary participation and contribution rates by tenure month, newly hired faculty, excluding Sept. 2008–Dec. 2009

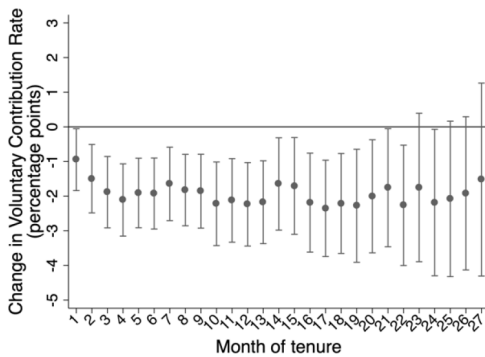
(a) Voluntary participation rate



(b) Voluntary contribution rate, if positive

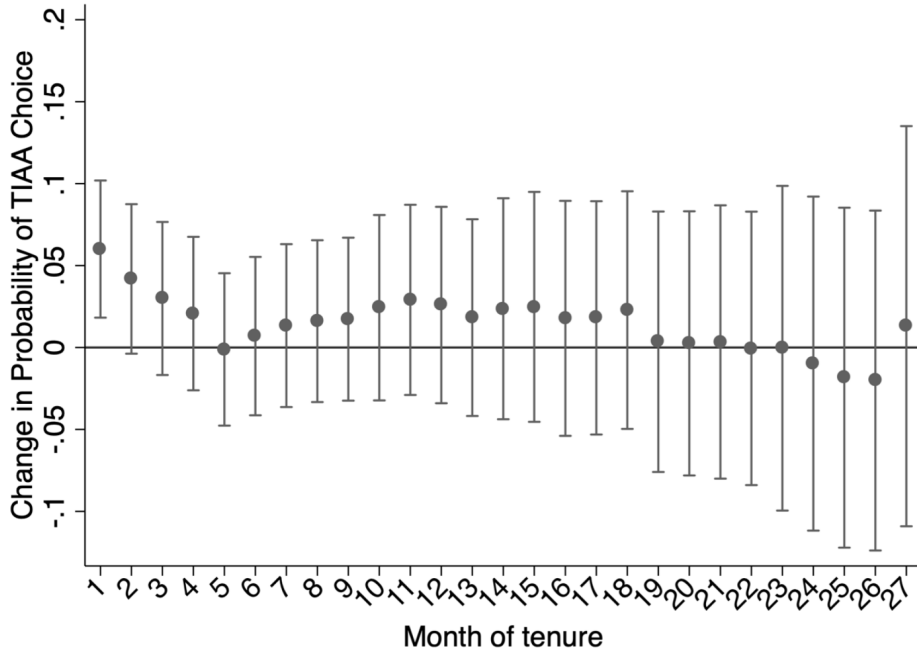


(c) Voluntary contribution rate



Notes: Figure plots OLS estimates of the interaction between indicators for tenure month and an indicator for being hired after July 2010 from the event study regressions corresponding to equation (3). Whiskers denote 95% confidence intervals with standard errors clustered by employee. The sample excludes observations from September 2008 to December 2009, inclusive. Additional control variables include the monthly S&P 500 index, and indicators for tenure month, female, full-time employee, married, single, and income and age bands. Administrative data on faculty at a large public university, statistics from their first twenty-seven months of hire, which covers their first three years excluding June through August, when many faculty do not receive a salary. Faculty who chose the university DC plan with mandatory contributions when hired can then choose voluntary DC contributions. Voluntary DC participation consists of contributions to either the 403(b) plan or the 457 plan, or, beginning in 2013, Roth options of each. The voluntary DC contribution rate is defined similarly, with Roth contributions adjusted for their post-tax status, and is reported relative to annual salary.

Figure A6. Placebo test: Choice of vendor A vs. vendor B



Notes: Figure plots OLS estimates of the interaction between indicators for tenure month and an indicator for being hired after July 2010 from the event study regressions corresponding to equation (3). The dependent variable is an indicator for choosing Vendor A (vs. Vendor B) as the account for voluntary contributions. Whiskers denote 95% confidence intervals with standard errors clustered by employee. Additional control variables include the monthly S&P 500 index, and indicators for tenure month, female, full-time employee, married, single, and income and age bands. Administrative data on faculty at a large public university, statistics from their first twenty-seven months of hire, which covers their first three years excluding June through August, when many faculty do not receive a salary.

Appendix B. Imputation of marginal tax rates

This Appendix describes the procedure to impute marginal tax rates for each employee in our data. The marginal tax rates are used to adjust contributions to Roth accounts, which became available in the later period we examine, to a pretax basis. Our administrative records lack several pieces of information required for a direct calculation of the employee's marginal tax rate, including information about spousal earnings, children, other sources of income, home ownership, and relevant deductions. In addition, marital status is reported incompletely and salary is recorded in bands to protect data confidentiality. Our approach is, therefore, to calculate marginal tax rates for respondents of the American Community Survey (ACS) using the National Bureau of Economic Research's TAXSIM, and then to use hot-deck imputation to assign a marginal tax rate for the employees in our sample by matching on income, age, and gender.

Step 1. ACS data. We use ACS surveys between 2011 and 2017, which record relatively comprehensive information that helps us calculate marginal tax rates. In particular, we use the following information from the survey: wage and salary income of respondent and spouse, interest received, retirement income and Social Security benefits, supplemental security income and public assistance income, state, marital status, age, number of dependents, and number of children under 13.

Step 2. Marginal tax rate calculation. For each ACS observation, we use NBER TAXSIM to estimate the federal and state marginal tax rates based on the variables in the list above.

Step 3. Hot-deck imputation. We match individuals between our administrative data and the ACS by year, age band, income band, and gender. We then use hot-deck imputation to assign a marginal tax rate to the matched employees in our sample. The imputation is repeated five times and we take the average to construct our estimate of the employee's marginal tax rate.

About the authors

Leora Friedberg is an Associate Professor of Economics and Public Policy at the University of Virginia. She is also Co-Chair of the Retirement Income Institute, and is an affiliated researcher of the Michigan Retirement and Disability Research Center and a Research Fellow of the TIAA Institute. She is a member of the Editorial Board of the Journal of Pension Economics and Finance and previously served on the Board of Trustees of the Southern Economic Association and as a member of the Retirement Security Advisory Panel for the U.S. Government Accountability Office.

Friedberg's fields of interest are public and labor economics. Her research focuses on retirement and saving behavior of older Americans, including the Social Security earnings test, the design of employer pension benefits, and the interaction between Medicaid long-term care benefits and household saving and insurance decisions. Additional research studies marriage and divorce in response to bargaining theory, family law, and the U.S. tax code. Her research has been funded by the National Institute on Aging, the U.S. Social Security Administration, and the TIAA Institute.

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