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John Beshears
James J. Choi
David Laibson
Brigitte C. Madrian

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ABSTRACT

Can governments increase private savings by taxing savings up front instead of in retirement? Roth 401(k) contributions are not tax-deductible in the contribution year, but withdrawals in retirement are untaxed. The more common before-tax 401(k) contribution is tax-deductible in the contribution year, but both principal and investment earnings are taxed upon withdrawal. Using administrative data from eleven companies that added a Roth contribution option to their existing 401(k) plan between 2006 and 2010, we find no evidence that total 401(k) contribution rates differ between employees hired before versus after the Roth introduction, which means that the amount of retirement consumption being purchased by 401(k) contributions increases after the Roth introduction. A survey experiment suggests two behavioral factors play a role in the unresponsiveness of contribution rates to their tax treatment: (1) employee confusion about or neglect of the tax properties of Roth balances and (2) partition dependence.

John Beshears
Harvard Business School
Baker Library 439
Soldiers Field
Boston, MA 02163
and NBER
jbeshears@hbs.edu

James J. Choi
Yale School of Management
165 Whitney Avenue
P.O. Box 208200
New Haven, CT 06520-8200
and NBER
james.choi@yale.edu

David Laibson
Department of Economics
Littauer M-12
Harvard University
Cambridge, MA 02138
and NBER
dlaibson@gmail.com

Brigitte C. Madrian
Harvard Kennedy School
79 JFK Street
Cambridge, MA 02138
and NBER
Brigitte_Madrian@Harvard.edu

Choosing the right retirement savings rate is complicated. As a result, many employees seem to choose their 401(k) contribution rates using rules of thumb such as "contribute the minimum amount necessary to earn the maximum employer match," "contribute the maximum amount allowed by the plan," or "contribute 10% of my pre-tax income" (Choi et al., 2002; Benartzi and Thaler, 2007; Choi et al., 2013). These heuristics are not contingent on the tax treatment of the particular type of 401(k) account used. Even savings recommendations by sophisticated practitioners frequently do not vary according to how the savings vehicles used are taxed (e.g., Ibbotson et al., 2007).[1] If individuals neglect taxes when choosing how much to save, it may be possible for governments to increase the after-tax stock of private savings without altering the present value of taxes by shifting the timing of taxation. Rather than allowing savings to be deducted from taxable income today and then taxing withdrawals (both principal and interest) in retirement, have individuals save with after-tax dollars today and then exempt the accumulated savings from taxation in retirement.

The following two-period example illustrates how this mechanism would work. Suppose that an individual earns \$100 of pre-tax income in period 1, and he follows a rule of thumb when making his savings decision, setting aside 10% of his pre-tax income regardless of the tax rules. The income tax rate is 20%, and the rate of return from period 1 to period 2 is r.

First consider the case in which savings are tax-deductible initially and principal and investment earnings are taxed in period 2. In this case, the individual saves \$10 in period 1 (following the 10% rule of thumb); the government collects (\$100 – \$10) × 20% = \$18 in tax revenue; and the individual consumes the rest of his income, \$72. In period 2, the individual has \$10 × (1 + r) × (1 – 0.2) = \$8 × (1 + r) of savings available to consume, and the government collects \$2 × (1 + r) in taxes.

Now consider the case in which savings cannot be deducted from taxable income initially but principal and investment earnings are not taxed in period 2. In this case, the individual saves \$10 in period 1 (following the 10% rule of thumb); the government collects \$100 × 20% = \$20 in tax revenue; and the individual consumes the rest of his income, \$70. In period 2, the individual has \$10 × (1 + r) of savings available to consume—a 25% increase over the first scenario. This increase in period 2 consumption occurs because period 1 savings did not fall in response to the

[1] See de Bartolome (1995), Duflo et al. (2006), Bettinger et al. (2009), Chetty, Looney, and Kroft (2009), Finkelstein (2009), Jones (2010), and Chetty and Saez (2013) for other examples of tax neglect.

fact that, in the second scenario, each dollar of savings in period 1 buys more consumption in period 2. The increase in period 2 consumption is financed by the $2 decrease in period 1 consumption, which is necessitated by the fact that savings are not deductible from taxable income. The government collects $0 in taxes in period 2 in this second scenario, but in both scenarios, the present value of taxes is the same, $20.

The introduction of Roth 401(k)/403(b) savings plans allows us to test whether the above mechanism plausibly exists. Since January 1, 2006, U.S. employers have had the option to include a Roth contribution alternative in their 401(k) or 403(b) retirement savings plan. The Plan Sponsor Council of America (2012) reports that 49% of 401(k) plans offered a Roth option in 2011. Like contributions to a Roth IRA, employee contributions to a Roth 401(k)/403(b) are not deductible from current taxable income, but withdrawals of principal, interest, dividends, and capital gains in retirement are tax-free. In contrast, before-tax 401(k)/403(b) contributions—the most common type of 401(k)/403(b) contribution—are deductible from current taxable income, but the entire principal and all investment earnings are taxed upon withdrawal. Therefore, a dollar of Roth balances purchases more retirement consumption than a dollar of before-tax balances if the marginal tax rate in retirement is positive. If people neglect taxes in making savings decisions, the total dollars contributed to the 401(k) will not change when a Roth becomes available, causing effective retirement savings to increase (and current consumption to fall) provided that some of those dollars are contributed to the Roth.

We use administrative 401(k) plan data from eleven companies that introduced a Roth 401(k) option between 2006 and 2010 to analyze the impact of a Roth option on savings plan contributions. We find no evidence that total contribution rates are different between employees hired after a Roth option is introduced and employees hired before. If anything, contributions rise slightly when the Roth is available. Our null finding does not appear to be driven by low adoption of the Roth option, since the Roth effect on total contributions is not decreasing across companies in the average Roth contribution rate for the post-Roth hire cohort.

The unresponsiveness of total 401(k) contributions to a Roth introduction could be due to the fact that the Roth option makes 401(k) savings more attractive. Savings that would otherwise occur outside the 401(k) (e.g., in a Roth IRA) may shift into the 401(k). Because we have only 401(k) data, we are unable to rule out such a shift. In addition, the introduction of the Roth weakly increases the employee's after-tax expected return from saving. If the substitution effect is large enough relative to the income effect, total desired savings weakly increases, and the 401(k) contribution rate should be the margin of adjustment. These forces could in combination fully offset the drop in 401(k) contributions that would otherwise be expected when a Roth becomes available.

To gauge the importance of these non-behavioral factors, we ran an online survey experiment on 7,000 defined contribution plan participants. Respondents were asked to make a 401(k) contribution rate recommendation for a fictional couple, Jack and Cindy, for whom asset shifting and substitution effects are not relevant. Jack and Cindy earn $100,000 per year, have minimal existing savings, and wish to do all of their saving over the next year in Jack's 401(k), so 401(k) contributions represent the couple's entire savings flow. In addition, Jack and Cindy aim to have a material standard of living that does not change for the rest of their lives; that is, their substitution effect is zero. Respondents were randomly assigned to make a recommendation for a scenario where Jack and Cindy have access to (1) only a before-tax 401(k) account, (2) only a Roth 401(k) account, or (3) both before-tax and Roth 401(k) accounts. We also asked four questions to test knowledge of 401(k) tax rules.

Despite the absence of asset shifting and substitution effect considerations, we find that respondents barely decrease their average contribution rate recommendation from 11.2% of income when only a before-tax 401(k) is available to 10.7% of income when only a Roth 401(k) is available. This means that relative to the before-tax-only scenario, respondents are delivering less current consumption and more retirement consumption to Jack and Cindy in the Roth-only scenario as long as their marginal income tax rate today and in retirement is greater than 4.5%—conditions that are quite likely to be true.[2] Given Jack and Cindy's desire for a flat consumption path, moving present consumption and future consumption in opposite directions cannot be optimal; either respondents should deliver weakly more consumption to both periods or strictly less consumption to both periods. Consistent with confusion about 401(k) tax rules being an important reason why contribution amounts are unaffected by the availability of a Roth option in field data, each of the four tax questions was answered correctly less than half the time. Among the least knowledgeable respondents, contribution recommendations fall by a statistically

[2] The lowest U.S. federal marginal income tax rate in 2014 is 10%. Only 3.7% of married U.S. households filing jointly with expanded cash income between $100,000 and $200,000 had zero or negative federal income tax liability in 2013 (Williams, 2013). Expanded cash income includes not only wages but also, among many other things, tax-exempt employer contributions to health insurance and the employer share of payroll taxes. See http://www.taxpolicycenter.org/taxtopics/Explanation-of-Income-Measures-2013.cfm.

insignificant 0.4% of income as we move from the before-tax-only condition to the Roth-only condition. Among the next most knowledgeable respondents, contribution rate recommendations fall by a marginally significant 0.5% of income. And among the most knowledgeable respondents, contribution recommendations fall by a significant 0.9% of income. However, even a 0.9% savings rate decline is a very modest one, suggesting that those who know the relevant tax rules often neglect to fully take them into account when making 401(k) contribution choices.

Among survey respondents who were told that Jack and Cindy have access to both a before-tax and a Roth 401(k) account, some were asked to first give a total recommended contribution rate and then to divide this across the two account types, while others were simply asked to give a recommended contribution rate for each of the two accounts. When respondents were not first asked to give a total recommended contribution rate, they recommend a before-tax plus Roth contribution rate that is substantially higher than the contribution rate recommended in the single-account scenarios: 13.1% of income. Partition dependence (Fox, Ratner, and Lieb, 2005), which is the sensitivity of choices to the partitioning of the action space due to the psychological bias towards allocating an equal amount to each partition, appears to explain nearly all of this increase. If current consumption is an allocation category in addition to the 401(k) account(s), then moving from two partitions—{current consumption, before-tax} or {current consumption, Roth}—to the three partitions {current consumption, before-tax, Roth} would cause the allocation to current consumption to fall. Consistent with partition dependence causing nearly all of the total contribution rate increase, when we instead asked respondents in the both-accounts condition for the recommended sum of the before-tax and Roth contribution rates—thus creating only the two partitions {current consumption, total 401(k) contributions}—respondents recommend a total contribution rate of 11.4%, which is close to the recommendations in the single-account conditions. In real-world 401(k) plans, a Roth option cannot legally be offered without also offering a before-tax account, and employees are not usually asked to choose a total contribution rate before specifying how that contribution rate should be split between the before-tax and Roth accounts. Thus, partition dependence may be a force that acts along with tax ignorance/neglect to create the (statistically insignificant) increase in total contributions that we observe in our field data upon Roth introduction.

The remainder of the paper proceeds as follows. In Section I, we summarize the key institutional rules surrounding the tax treatment of 401(k) savings and the implications of those rules for optimal savings choices. Section II describes our 401(k) data. Section III discusses our estimates of the impact of Roth 401(k) introduction on total 401(k) contribution rates, and Section IV presents our survey experiment. Section V concludes.

I. The tax treatment and economics of 401(k) contributions[3]

The 401(k) has its origins in a provision of the Revenue Act of 1978 that allows for tax-preferred treatment of elective employee contributions to employer-sponsored retirement savings plans. This provision of the law, Internal Revenue Code Section 401(k), went into effect on January 1, 1980, and the regulations governing 401(k) plans were issued in November 1981 (see Employee Benefit Research Institute, 2005, for a brief history of 401(k) plans).

As first established, 401(k) savings plans allowed employees to make before-tax 401(k) contributions that were deductible from current-year taxable income (that is, taxable ordinary income was reduced by the contribution amount in the year the contribution was made); in lieu of current taxation, the principal, interest, dividends and capital gains would be taxed at the individual's ordinary income tax rate upon withdrawal. Hence, the marginal dollar of pre-tax income buys $(1 + r)(1 - \tau_1)$ of future consumption if it is contributed to a before-tax 401(k) account, where r is the return earned on the contribution between the contribution and withdrawal dates and τ_1 is the household's marginal ordinary income tax rate in the year of the withdrawal plus an adjustment if the withdrawal generates an increase in the taxation of Social Security benefits or a reduction in means-tested benefits (such as the Earned Income Tax Credit). An additional 10% tax penalty applies to both the principal and earnings withdrawn if the account owner is younger than 59½ years old.

The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) included a provision allowing employers to add a Roth contribution option (so-called because the tax treatment of Roth 401(k) contributions is similar to that of contributions to the already extant Roth IRAs) to their 401(k) plans starting in 2006. In contrast to contributions to a traditional before-tax 401(k), Roth contributions are not deductible from current-year taxable income, but principal, interest, dividends, and capital gains may be withdrawn tax-free if the withdrawal is considered "qualified" because (i) the account has been held for at least five years and (ii) the account owner is either older than 59½, disabled, or deceased. The marginal dollar of pre-tax

[3] This section borrows heavily from Beshears et al. (2013a).

income can thus purchase $(1 - \tau_0)(1 + r)$ of future consumption if a Roth account is used as the savings vehicle and the balance is accessed through a qualified withdrawal, where τ_0 is the household's marginal ordinary income tax rate plus the marginal reduction in means-tested benefits due to the additional dollar of taxable income in the year of the contribution. Put another way, each dollar contributed to a Roth account buys $1 + r$ of future consumption. For non-qualified withdrawals, the withdrawn principal is not taxed, but the earnings are subject to ordinary income tax and may reduce means-tested benefits and increase taxation of Social Security benefits received in the year of the withdrawal. If the account owner is younger than 59½, the withdrawn earnings are also assessed a 10% tax penalty under most circumstances.

Some 401(k) plans also allow participants to make after-tax contributions, an option that has been permissible even before the law allowed for Roth contributions. Like Roth contributions, after-tax 401(k) contributions are not deductible from current taxable income, and principal can be withdrawn tax-free from after-tax accounts. In contrast to Roth contributions, however, earnings on after-tax contributions are taxed at the ordinary income tax rate when withdrawn, and this earnings income may affect means-tested benefits and taxation of Social Security benefits. If an after-tax 401(k) account is used, the marginal dollar of pre-tax income can buy $(1 - \tau_0)[1 + (1 - \tau_1)r]$ of future consumption; equivalently, each dollar contributed to an after-tax account buys $1 + (1 - \tau_1)r$ of future consumption. An additional 10% tax penalty applies to earnings (but not principal) withdrawn by account owners younger than 59½.

An interesting economic question, although not the focus of this paper, is whether it is better to make before-tax or Roth 401(k) contributions. The answer to this question is not straightforward. If there are no employer matching contributions in the 401(k), withdrawals occur late enough to be considered qualified by the Roth criteria, and investment earnings are positive, then saving the next pre-tax dollar in the Roth is a better financial deal than saving it before-tax if and only if $\tau_0 < \tau_1$, where τ_0 is the tax rate when contributions are made and τ_1 is the tax rate at the time of withdrawal. In a progressive tax system with rules that stay fixed over time, τ_1 will typically be less than τ_0 because non-401(k) income in retirement will typically be lower than current income, causing most before-tax 401(k) withdrawal dollars to be taxed at a lower rate than the last dollar of income today. McQuarrie (2008) uses this observation to argue that the Roth 401(k) is inferior to a before-tax 401(k) for many households whose current income pushes them above the lowest marginal tax bracket.[4] Others, however, have argued that marginal tax rates are likely to increase in the future for individuals at all income levels as the federal government is eventually forced to confront the consequences of budget deficits and government debt. Such an increase in future tax rates could make Roth contributions attractive even if in a static tax environment they are not superior to before-tax contributions.

The relative appeal of the Roth relative to before-tax contributions increases with the probability of withdrawal before age 59½, since Roth principal is exempt from the 10% early withdrawal penalty but before-tax principal is not. Roth contributions are always a better deal than after-tax contributions if the money is held in the 401(k) long enough to meet the Roth qualifying withdrawal criteria and investment earnings are positive, since earnings income is not taxed in a qualifying Roth withdrawal but is taxed in an after-tax withdrawal. Not surprisingly, after-tax contributions are not very common (and were not very common before the availability of a Roth option). However, after-tax contributions are sometimes more liquid before age 59½, since some 401(k) plans allow younger employees to make withdrawals from after-tax balances while still employed by the company without demonstrating financial hardship.

Although employers can structure their savings plans to allow Roth, before-tax, and after-tax employee contributions, employer matching contributions must be made using before-tax dollars, meaning that the entire principal and earnings of the match balance are subject to ordinary income tax upon withdrawal. A company might not match certain types of employee contributions (e.g., after-tax contributions), but among the types of contributions it does match, the match formula typically does not vary by the type of contribution. This invariance reduces the attractiveness of Roth and after-tax contributions if the employee's marginal 401(k) contribution dollar is being matched. To see this, let m be the rate at which employee contributions are matched. The marginal pre-tax dollar can earn m match dollars if it is saved using a before-tax account, but only $(1 - \tau_0)m$ match dollars if it is saved using a Roth or after-tax account (since τ_0 dollars must be paid in taxes, thereby preventing the entire dollar from being contributed to the savings plan). The condition under which employees who have no probability of making a non-qualified withdrawal are better off contributing to the Roth rather

[4] McQuarrie (2008) also considers how tax laws may change in his analysis. Burman, Gale, and Weiner (1998) find that between 1980 and 1995, changes in tax laws had a much larger effect on individuals' marginal tax rates than variation induced by lifecycle income patterns. See Ahern et al. (2005) and Kotlikoff, Marx, and Rapson (2008) for other analyses of the relative merits of the Roth 401(k).

than the before-tax account is now more restrictive; with an employer match, the Roth is a better financial deal than contributing before-tax if and only if

$$(1 - \tau_0)[1 + m(1 - \tau_1)] > (1 - \tau_1)(1 + m). \qquad (1)$$

Despite the Roth's disadvantaged position with respect to the match, it is still the case that one needs to contribute less than \$1 to the Roth in order to buy as much retirement consumption (including what the match would fund) as one would get from contributing \$1 before-tax and earning the match, provided $\tau_1 > 0$.[5]

Another factor affecting the attractiveness of Roth versus before-tax contributions is whether employees are constrained by the contribution limits on 401(k) plans. Internal Revenue Service regulations stipulate that an individual's combined before-tax plus Roth contributions in a calendar year cannot exceed a certain limit that is adjusted each year. For individuals younger than 50, this limit was \$14,000 in 2005 (the last year before Roth contributions were allowed); it has been increased several times since then and stands at \$17,500 in 2014. Those age 50 and older are allowed an additional "catch-up" contribution; this additional amount was \$4,000 in 2005 and has since been increased to its current (2014) level of \$5,500. In addition to the limits on employee contributions, there is a limit on the combined employer plus employee contribution to 401(k) accounts. This aggregate limit was set at \$42,000 in 2005 and has since been raised to \$52,000 in 2014 for people under the age of 50. Because a dollar of Roth balances buys weakly more retirement consumption than a dollar of before-tax balances, people who are constrained by the before-tax plus Roth contribution ceiling could find it advantageous to make Roth contributions instead of before-tax contributions in order to extend the 401(k) tax shelter over more effective dollars.

Given the complexities of assessing which type of savings plan contribution is optimal, an interesting economic and policy question is how well individuals do in assessing which type of contribution is best for them. In this paper, we are interested in a separate but related question, namely whether employees respond to the introduction of a Roth option in their 401(k) plan by reducing their saving plan contributions. Because a dollar contributed to a before-tax 401(k) buys more retirement consumption than a dollar contributed to a Roth account as long as $\tau_1 > 0$, the contribution rate required to obtain a target level of retirement consumption is lower if employees contribute to a Roth account than if they contribute to a before-tax account.

[5] Specifically, one needs to contribute $[(1 - \tau_1) + m(1 - \tau_1)]/[1 + m(1 - \tau_1)]$ dollars, which is less than 1 if $\tau_1 > 0$.

II. Data description

For our analysis, we use administrative data from the 401(k) plans of eleven U.S. firms that introduced a Roth option to their savings plan between 2006 and 2010. The data come from Aon Hewitt, a large benefits administration and consulting firm. For each firm, we have repeated cross-sectional snapshots of all employees at the end of each calendar year. Each snapshot contains individual-level data on every employee's current plan participation status, plan enrollment date, monthly contribution rates, plan balances, birth date, hire date, salary (for eight of the eleven companies), and gender.[6] We restrict our sample to employees between the ages of 20 and 69.

Table 1 shows the characteristics of the eleven companies as of year-end 2010. In order to preserve anonymity, we refer to each company by the letters A through K and only disclose approximate employee counts. The companies are all large, ranging from approximately 10,000 employees to 100,000 employees. Seven of the eleven companies are in the financial services industry, and average salaries exceed $100,000 for Companies A, D, E, and H. Hence, the employees at these firms are likely to be more financially sophisticated than the typical U.S. employee. Average employee age ranges from 35 to 48 years; average tenure at the companies ranges from five years to sixteen years; and the percentage male ranges from 33% to 76%.

Table 2 summarizes the key features of the 401(k) plan at each company in the year that the Roth option was introduced. Five companies introduced the Roth option in 2006, one in 2007, two in 2008, one in 2009, and two in 2010. Four companies automatically enrolled their employees in the 401(k) at before-tax contribution rates between 2% and 6% of income. Consistent with findings from the previous literature, the 401(k) participation rate among employees who have 11 months of tenure at the end of the calendar year in which the Roth was introduced is substantially higher at firms with automatic enrollment than at firms with opt-in

[6] Month-end before-tax and after-tax contribution rates are missing in January 2006 for Company C. Month-end before-tax contribution rates are missing in April and June 2006 for Company F and in October 2007 for Company G. Month-end Roth contribution rates are missing in our data for the first few months after the Roth is introduced at the following firms: Company C (January to March 2006), Company F (January to April and June 2006), Company H (January to March 2006), and Company I (January to February 2009). We assign the first observed contribution rate after the missing period to prior missing month-ends unless the employee was not enrolled in the 401(k) at that month-end, in which case we assign a 0% contribution rate. Contribution rates for a newly enrolled employee are also sometimes missing for the first few months after his or her enrollment, in which case we perform a similar imputation. Almost all of these missing new-enrollee contribution rates occur between January and March 2006 in Company H.

enrollment schemes: 92% vs. 54%. Nine companies match employee contributions up to a threshold between 2% and 8% of income at rates between 25% and 133%. The maximum percent of a paycheck that can be contributed to the 401(k) ranges from 20% to 100%. As described in Section I, contribution amounts are additionally subject to IRS restrictions on the total dollar amount that can be contributed within a calendar year.

III. The impact of Roth introduction on total 401(k) contribution rates

The empirical strategy we use to estimate the impact of Roth introduction on retirement savings is to compare the total 401(k) savings plan contribution rates (before-tax plus after-tax plus Roth, if available) of employees hired prior to the introduction of a Roth option to those of employees hired following the introduction of a Roth option when these employees are at equivalent levels of tenure. Our identifying assumption is that conditional on one's employer, whether an employee has access to the Roth immediately upon hire or shortly after hire is orthogonal to savings preferences, an assumption that seems plausible. Because there may be seasonal patterns in the types of employees hired by firms at different times of the year, we restrict our analysis to employees hired in the same calendar month at each firm; specifically, we compare employees hired in the twelfth month prior to the introduction of the Roth option to employees hired one year later, in the month immediately following the introduction of the Roth. This allows us to follow the contributions of newly hired employees through eleven months of tenure (after which the pre-Roth hire cohort then becomes eligible to contribute to a Roth account).

Table 3 shows the average age at hire, average annual salary in the year of hire, and gender composition of the pre-Roth and post-Roth hire cohorts at each company. Companies F, G, and K do not have salary data available. Five companies—B, D, E, F, and G—experienced no statistically significant changes in their observed variables. The other six companies experienced at least one statistically significant change across cohorts. We will control for age, salary (when possible), and gender in the regressions that follow, but it is possible that companies in which observed characteristics change across cohorts are more likely to have unobserved characteristics change across cohorts as well. We will therefore examine effects averaged across all companies and across the subset of companies where no observable characteristics changed significantly.

We start our analysis in Figure 1 by plotting the average total 401(k) contribution rate (pre-tax plus after-tax contribution rates for the pre-Roth cohort, and pre-tax plus after-tax plus Roth contribution rates for the post-Roth cohort) of each hire cohort against tenure (through eleven months of tenure, the maximum tenure the pre-Roth cohort achieves before the Roth was introduced) for all eleven companies combined. Non-participants in both cohorts are coded as having a total contribution rate of zero. The average total contribution rate of both cohorts increases with tenure, particularly in the early months of employment, a trend that largely reflects increases in savings plan participation with tenure. Comparing the total contribution rates of the two cohorts, we see that the lines in Figure 1 lie nearly on top of each other (particularly after the third month of tenure); this pattern suggests that adding a Roth contribution option to the 401(k) plan does not cause total 401(k) contributions to decline.

In Table 4, we show the average total contribution rates for the pre-Roth and post-Roth cohorts separately for each company at six and eleven months after hire.[7] The only difference that is statistically significant at the 5% level at six months is that for Company A, where the post-Roth cohort contributes 0.95% of income less; the six-month difference for Company B is statistically significant at the 10% level, although at this firm the post-Roth cohort contributes 1.89% of income *more* than the pre-Roth cohort. At eleven months, the only statistically significant differences at either the 5% or the 10% level are at Companies A and G, where the post-Roth cohorts contribute 1.25% and 0.78% of income less, respectively. Pooling together all eleven companies yields a statistically insignificant and economically small average contribution rate decrease of 0.02% of pay at six months of tenure, and a statistically insignificant and economically small average contribution rate increase of 0.06% of pay at eleven months of tenure. Restricting the analysis to companies with no significant observable changes in employee characteristics across hire cohorts yields insignificant average contribution rate increases of 0.18% and 0.03% of income at the same time horizons.

Because the averages in Figure 1 and Table 4 do not account for potential changes in the demographic composition of the employees hired before versus after Roth introduction, in Table 5 we regress total contribution rates at six or eleven months of tenure on a post-Roth hire cohort dummy, age, age squared, a male dummy, and log salary. As in Table 4, we report the results first company by company, and then for all of the firms combined. The regression results are

[7] Appendix Table 1 shows the before-tax, after-tax, and Roth contribution rates separately for each hire cohort.

qualitatively similar to the results from the simple mean comparisons in Table 4. Out of 22 post-Roth hire cohort dummy coefficient estimates (eleven at six months of tenure and eleven at eleven months of tenure), only one is significant at the 5% level, about what one would expect by chance. Pooling together all eight companies with complete employee demographic data yields insignificant estimates of the effect of Roth introduction on the total contribution rate equal to 0.10% and 0.35% of income at six and eleven months of tenure, respectively. Excluding companies with significant observable employee characteristic yields insignificant Roth effects of -0.01% of income at six months of tenure of 0.30% at eleven months of tenure.

Our analysis thus far indicates that introducing a Roth option to the 401(k) does not significantly change total contributions to the 401(k); if anything, our point estimates suggest that contribution rates increase somewhat (although these effects are not statistically significant). An unchanged total contribution rate translates into higher potential after-tax retirement consumption if some of those contributions are directed to the Roth and the balances are kept in the Roth for a long enough period of time. If, however, post-Roth employees do not contribute to the newly available Roth accounts, we would not expect any change in average total contribution rates. To examine whether insufficient Roth participation could account for the trivial savings effects that we estimate, we examine the correlation across firms between the estimated Roth treatment effects in Table 5 and the average Roth contribution rates for the post-Roth cohort in Appendix Table 1. If the statistically insignificant average savings effects in Tables 4 and 5 arise from low Roth contribution rates, we would expect to see a negative correlation between the Roth treatment effect at a company and the average Roth contribution rate at that company.

Figures 2A and 2B graph the estimated Roth introduction effect at each company (from Table 5) against the average Roth contribution rate in the company's post-Roth cohort (from Appendix Table 1) at six and eleven months after hire, respectively. The average Roth contribution rate ranges from 0.1% to 1.1% of pay at six months, and that range widens to between 0.1% and 1.6% of pay at eleven months. The fitted regression lines indicate that weighting each company equally, there is an insignificant negative association between the estimated treatment effect and the average Roth contribution rate at six months of tenure (slope = -0.93, t = -1.45, p = 0.179) and an insignificant positive association at eleven months of tenure (slope = 0.745, t = 0.532, p = 0.195). At both time horizons, the point estimate of the Roth introduction effect is positive at the three companies with the highest average Roth contribution rates. Overall, there is little support for the notion that our null effects for the impact of Roth introduction on total 401(k) contributions are due to limited Roth participation.

A second potential explanation for why we might fail to observe any difference in average total contributions in the pre-Roth versus post-Roth regimes is that the employer match generates kinks in the budget set where employees may not be very responsive to changes in savings incentives. To assess the importance of this explanation, Figures 3A and 3B graph the estimated Roth introduction effect at each company (from Table 5) against the fraction of the pre-Roth hire cohort contributing at a match threshold at six and eleven months after hire, respectively.[8] The fraction of employees at a match threshold ranges from a low of 0% (at the two companies with no match) to a high of 66% at six months of tenure and 65% at eleven months of tenure (at Company J, which has a tiered match). At both time horizons, there is no relationship between the estimated Roth effect at each firm and the fraction of pre-Roth employees who are at a match threshold; the regression lines in Figures 3A and 3B are practically flat, and the slope coefficients are both small and statistically insignificant (slope = 0.002, $t = 0.21$, $p = 0.841$ at six months; slope = 0.007, $t = 0.57$, $p = 0.582$ at eleven months). If we look at the predicted Roth effect when there are no employees at the match threshold (and thus the match kink is not a plausible explanation for the absence of a Roth effect), we see that at six months, the intercept of the regression line in Figure 3A is not significantly different from zero, and the point estimate is small and positive (intercept = 0.049, $t = 0.17$, $p = 0.871$). At eleven months, the intercept of the regression line in Figure 3B is also not significantly different from zero, although the point estimate in this case is negative (intercept = -0.221, $t = -0.62$, $p = 0.548$). Overall, there is no compelling evidence that our null Roth introduction effects are due to employee clustering at match kinks both before and after Roth introduction.

We noted in Section I that the introduction of the Roth relaxes the effective 401(k) contribution limit because the same dollar limit applies to both Roth and before-tax contributions, even though Roth dollars are more valuable in retirement than before-tax dollars. Suppose somebody with only a before-tax 401(k) contribution option would like to contribute $50,000 in before-tax dollars to the 401(k) in 2010. He is constrained to contribute only $16,500 in before-tax dollars, the IRS contribution limit in 2010. Suppose instead that his company had

[8] The match thresholds include the maximum contribution rate up to which employee contributions are matched as well as lower contribution rates where the rate at which the employer matches contributions changes. The latter category is relevant at Company J, which has a tiered match schedule.

introduced a Roth option at the beginning of 2010. He might then have chosen to contribute $16,500 in Roth dollars instead because doing so gets him closer to the retirement consumption he would have been able to afford with a $50,000 before-tax contribution. For this person, the insensitivity of total contributions with respect to Roth availability is created by the fact that the contribution limit binds both with and without the Roth option.

Such a censoring mechanism is unlikely to explain why we find total contribution rate insensitivity in our data. In the calendar year of their hire, only 3.1% of employees in the pre-Roth hire cohort across all of our sample companies were at the employee before-tax contribution limit, were at the combined employee plus employer contribution limit, or were contributing the maximum percentage of salary allowed by their 401(k) plan for the entire year. This proportion is similar to the 2.8% of employees in the post-Roth hire cohort who were analogously constrained. Appendix Table 2 shows the results from tobit regressions analogous to the OLS contribution rate regressions in Table 5. Allowing for left-censoring at zero and right-censoring if the employee was at any of the relevant limits does not qualitatively change our estimates of the Roth introduction effect on total contribution rates.

IV. Survey experiment

Although we find that 401(k) contributions do not drop when a Roth option is introduced, our data cover only 401(k) contributions, so we do not know the extent to which the increased effective saving inside the 401(k) is offset by decreased saving outside the 401(k). Furthermore, even if we knew that offset is minimal, we cannot tell from our data whether employees increase their effective saving due to confusion about and/or neglect of the tax properties of Roth balances, or due to a rational substitution effect created by the Roth 401(k) increasing the after-tax return on savings.

To gauge how important savings offset and the substitution effect are for preventing a total contribution rate drop in response to Roth introduction, we ran an experiment within the Boston Research Group's online 2014 Defined Contribution Plan Participant survey. The respondents were all current participants in a 401(k), 403(b), 457, or profit-sharing savings plan whose record-keeper was one of 30 major record-keeping companies. Of course, survey responses raise questions of external validity; subjects' responses do not affect their economic outcomes, and neighbors, co-workers, family, the media, and professional advisors influence individuals' financial choices in the field (Beshears et al., 2013b; Brown et al., 2008; Chalmers and Reuter, 2012; Duflo and Saez, 2002 and 2003; Engelberg and Parsons, 2011; Hong, Kubik, and Stein, 2004; Tetlock, 2007). Nonetheless, survey responses shed light on individuals' *intuitions* about optimal choices. Intuitive choices may serve as an initial anchor from which people adjust away, and this adjustment may be only partial (Tversky and Kahneman, 1974).

Respondents were randomly assigned to make a 401(k) contribution rate recommendation for a fictional couple with a relatively high income (and hence a positive current marginal tax rate) who have access to (1) only a before-tax 401(k) account, (2) only a Roth 401(k) account, or (3) both before-tax and Roth 401(k) accounts. Respondents were told that this couple has minimal existing savings and wishes to do all of its saving over the next year in the husband's 401(k), so changes in the husband's 401(k) contribution rate represent the entire change in the couple's savings rate. In addition, their goal is to have a material standard of living that does not change for the rest of their lives; that is, their substitution effect is zero. The husband's 401(k) does not allow withdrawals before age 59½ for any reason, so the fact that early withdrawals from Roth balances face a lesser tax penalty than early withdrawals from before-tax balances should play no role in the contribution rate recommendation. Other details of the vignette were chosen to make the couple's circumstances familiar ones to most respondents.

Respondents in the before-tax-only condition saw the following text:

> Jack and Cindy are married and have two children ages 2 and 4. They are both 30 years old and live in your neighborhood in rental housing. They don't expect to have any more kids.
>
> Jack earns $100,000 per year before taxes working as a computer programmer and expects to retire at age 65. He expects his income to grow at the rate of inflation (that is, the rate at which the cost of living index rises) for the rest of his working life. Cindy is staying at home to raise their children and doesn't expect to return to the workforce.
>
> The only savings Jack and Cindy have right now is $5,000 in a bank savings account. Jack's company offers a 401(k) retirement savings plan that has only a before-tax contribution option (it only accepts before-tax dollars). Jack's company does not make matching contributions to the 401(k). This 401(k) also has a special rule: It does not allow Jack to withdraw money from it for any reason before he is 59.5 years old, even if Jack leaves the firm. (In real life, 401(k) withdrawal rules are not as strict.)

> Jack and Cindy need to decide how much to contribute to the plan and how to invest the contributions. Their financial goal is to have a material standard of living that does not change for the rest of their lives, even in retirement. If they do save anything over the next 12 months, they plan on doing that saving in Jack's 401(k).
>
> Please advise Jack and Cindy by recommending, to the best of your ability, a contribution amount and investment allocation. If you feel you need more information than we gave you, make whatever additional assumptions seem natural to you.

The first question asked of respondents in the before-tax account condition was, “What percent of Jack’s $100,000 income should he contribute as a **before-tax** contribution to his 401(k) plan over the next 12 months? The maximum he is allowed to contribute is 17.5%. If you would like Jack to contribute nothing, the box must have a ‘0’ in it.” The second question asked was, “What percent of Jack’s 401(k) contributions should be invested in stocks? (The rest of the contributions will be invested in bonds.) Enter a number between 0 and 100.”

Respondents in the Roth-only condition saw identical text, except we substituted in the sentence, “Jack’s company offers a 401(k) retirement savings plan that only has a Roth contribution option (it only accepts after-tax dollars),” and asked for a Roth contribution rate. Respondents in the both-accounts condition instead saw the sentence, “Jack’s company offers a 401(k) retirement savings plan that allows both before-tax contributions and Roth (i.e., after-tax dollar) contributions.” Half of subjects in this condition were asked to type in a before-tax contribution rate and a Roth contribution rate on the same screen in which the vignette text appeared. This elicitation mimics the usual way 401(k) contribution rates are elicited from employees. The other half of subjects were asked to first type in the *total* before-tax plus Roth contribution rate, knowing that they would specify on the next screen how this total contribution rate would be split between a before-tax contribution rate and a Roth contribution rate.

After making their contribution rate and asset allocation recommendations, respondents in all arms of the survey were asked two randomly selected questions from a set of four possible questions about 401(k) tax rules. The appendix shows the text of all of the questions asked in the survey. Our sample contains 7,000 respondents, of whom 1,749 were in the before-tax-only condition, 1,750 were in the Roth-only condition, 1,750 were in the both-accounts condition and were asked to enter both the before-tax and Roth contribution rates on the first screen, and 1,751 were in the both-accounts condition and were asked to enter only a total contribution rate on the first screen.

Figure 4 shows the average total 401(k) contribution rate recommendations of respondents in each arm of the survey. Despite the elimination of asset shifting and substitution effects in the survey scenario, respondents recommend only a slightly lower contribution rate in the Roth-only condition than in the before-tax-only condition. The average recommended before-tax contribution rate is 11.2%, and the average recommended Roth contribution rate is 10.7% (p-value of difference = 0.002).[9] Although our survey respondents recommend a lower contribution rate to the Roth than to a before-tax account, the difference in their recommended savings rates is small. Respondents in the Roth-only condition are in fact delivering more retirement consumption and less current consumption to Jack and Cindy in the very likely scenario that their marginal income tax rate currently and in retirement is greater than 4.5%.[10] Since Jack and Cindy want a flat consumption path, moving current and retirement consumption in opposite directions cannot be the optimal solution. Respondents should either deliver weakly more consumption in both periods or strictly less consumption in both periods.

Why doesn't the recommended contribution rate fall more in the Roth-only condition relative to the before-tax-only condition? One possibility is that the recommended asset allocation changes greatly between the before-tax-only and Roth-only conditions. According to the Euler equation, the optimal savings rate for an investor depends on the risk of her portfolio, so a dramatically different asset allocation could rationalize an effective savings rate that is much higher in the Roth-only condition. Figure 5 shows that although respondents do recommend statistically different equity allocations between the two conditions (p-value of difference =

[9] We requested that contribution rate recommendations be entered in units such that "10" would correspond to 10%. A small number of people entered contribution rates between 0 and 1, probably because they misunderstood the units. We multiplied these responses by 100.

[10] This number is derived by solving for τ_1 in the inequality $0.112Y(1 + r)(1 - \tau_1) < 0.107Y(1 + r)$ where the left-hand side is consumption delivered in the future by saving 11.2% of income in a before-tax account, the right-hand side is consumption delivered in the future by saving 10.7% of income in a Roth account, Y is income, r is the rate of return, and τ_1 is the tax rate in retirement. This yields $\tau_1 > 0.045$. Similarly, we solve for τ_0 in the inequality $(1 - 0.112)Y(1 - \tau_0) > Y(1 - \tau_0) - 0.107Y$ where the left-hand side is consumption today with a savings rate of 11.2% of income in a before-tax account, the right-hand side is consumption today when saving 10.7% of income in a Roth account, and τ_0 is the tax rate today. This yields $\tau_0 > 0.045$.

0.025), the gap is economically small: 42% in the before-tax-only group versus 39% in the Roth-only group.[11]

A more likely possibility is that the insensitivity of contributions across conditions is driven by ignorance and/or neglect of the 401(k) tax rules. Table 6 reports the fraction of survey respondents who are able to correctly answer the four questions on the tax treatment of 401(k) contributions and withdrawals. Only 49% of respondents know that making before-tax 401(k) contributions decreases taxable income in the year of the contribution, and only 46% know that making Roth 401(k) contributions does not affect taxable income in the year of the contribution. Because these two questions were multiple-choice questions with three options (corresponding to the contribution increasing taxable income, not affecting taxable income, and decreasing taxable income, plus an "I don't know" option), randomly guessing would have produced the correct answer 33% of the time. Knowledge of how withdrawals are taxed in retirement is also low. In free-response questions, only 33% can correctly identify how much of a $150,000 before-tax withdrawal at age 65 would be taxable income, and only 25% can correctly answer an analogous question about a $150,000 Roth withdrawal at age 65.[12]

Recall that each respondent answered only two randomly selected tax knowledge questions. Forty-five percent answered none of their two questions correctly; 33% answered only one question correctly; and 22% answered both questions correctly. In Figure 6, we categorize respondents by the number of tax knowledge questions answered correctly and show each group's total contribution rate recommendations for each of the four survey arms. We see that the drop in the recommended contribution rate as we move from the before-tax-only condition to the Roth-only condition is 0.38% and insignificant ($p = 0.143$) among those who answered no questions correctly, 0.54% and marginally significant ($p = 0.061$) among those who answered exactly one question correctly, and 0.85% and significant ($p = 0.025$) among those who answered two questions correctly. Although we do not have statistical power to reject the hypotheses that these three contribution rate differences are equal to each other, this pattern suggests that tax ignorance may play an important role in the insensitivity of contribution rates to the tax treatment of 401(k) balances. Even the 0.85% of pay decrease exhibited by the most

[11] As we did for contribution rate recommendations, we multiply the small number of equity allocation responses between 0 and 1 by 100.

[12] We counted the following responses to the before-tax withdrawal question as correct: 150,000; 100 (we assumed the respondent meant percent); 150 (we assumed the respondent was answering in thousands); 1,500,000 and 15,000,000 (we assumed the respondent mistyped extra zeros).

knowledgeable group is a modest one, implying that current consumption falls and retirement consumption rises if the marginal income tax rate in both periods is greater than 6.9%.[13] This result suggests that those who do know the relevant tax rules still may neglect to take them into account when making 401(k) contribution choices.

Because any employer that offers a Roth 401(k) must also offer a before-tax 401(k), the experimental condition where both a before-tax and a Roth account are available most closely corresponds to the situation actually faced by employees hired after a Roth 401(k) introduction. The third bar in Figure 4 shows that when the before-tax and Roth contribution rates are elicited in the usual way—without first asking respondents what the sum of the contribution rates will be—the average recommended total contribution rate is 13.1%, which is substantially *higher* than the recommended contribution rate in the two single-account conditions (*p*-value of difference with respect to either condition = 0.000).[14] This is puzzling because having both accounts available instead of only one weakly increases the after-tax rate of return on saving, so a couple like Jack and Cindy whose intertemporal elasticity of substitution is zero should weakly *decrease* its savings rate when moving from one account to two. Having both the before-tax and Roth accounts also allows one to diversify tax risk by contributing to both accounts. A decrease in investment risk is an additional force that should decrease saving for an agent with an intertemporal elasticity of substitution less than one (Weil, 1990).

A very different portfolio allocation in the both-accounts condition could potentially explain a higher contribution rate. But in Figure 5, the recommended equity allocation of 45% in the both-accounts condition, although statistically different from the 42% allocation in the before-tax-only condition (*p*-value of difference = 0.003) and the 39% allocation in the Roth-only condition (*p*-value of difference = 0.000), is only slightly higher in economic terms. Neither is confusion about taxation a likely explanation: Figure 6 indicates that the disparity between the

[13] This number is derived by solving for τ_1 in the inequality $0.122Y(1 + r)(1 - \tau_1) < 0.114Y(1 + r)$ where the left-hand side is consumption delivered in the future by saving 11.2% of income in a before-tax account, the right-hand side is consumption delivered in the future by saving 10.7% of income in a Roth account, Y is income, r is the rate of return, and τ_1 is the tax rate in retirement. This yields $\tau_1 > 0.069$. Similarly, we solve for τ_0 in the inequality $(1 - 0.122)Y(1 - \tau_0) > Y(1 - \tau_0) - 0.114Y$ where the left-hand side is consumption today with a savings rate of 11.2% of income in a before-tax account, the right-hand side is consumption today when saving 10.7% of income in a Roth account, and τ_0 is the current tax rate. This yields $\tau_0 > 0.069$.

[14] The 13.1% average total contribution rate is comprised of an 8.1% average before-tax contribution rate and a 5.0% average Roth contribution rate.

recommended contribution rate in the both-accounts condition and the single-account conditions is largest among the most tax-knowledgeable respondents.

In a pilot survey we ran before the survey reported on in this paper, we observed that recommended total contributions rose in the both-accounts condition when contribution rates were elicited as above. We hypothesized that this rise was caused by the psychological phenomenon of partition dependence. Fox, Ratner, and Lieb (2005) show that since people have a bias towards allocating an equal amount to every discrete option presented to them, choices are sensitive to how the action space is partitioned.[15] If current consumption is a category that respondents are considering when making their contribution decisions, then a bias towards equal allocation would reduce consumption when the three partitions {current consumption, before-tax contribution, Roth contribution} are considered relative to when only two partitions, {current consumption, before-tax contribution} or {current consumption, Roth contribution}, are considered.

One way Fox, Ratner, and Lieb (2005) demonstrate partition dependence is by running an experiment where participants were asked to divide $2 among one international charity and four local charities. Participants who were asked to first decide how much to allocate internationally versus locally before dividing the local allocation among the four local charities chose to give 52% to the international charity, whereas participants who were not prompted to follow this hierarchical procedure chose to give 21% to the international charity. In the context of savings, a study on very low income day laborers in India by Soman and Cheema (2011) finds that asset accumulation is significantly higher when individuals partition their savings into two "accounts" (envelopes in their experiment) rather than a single account because individuals spend less out of their savings when it is partitioned. The results of these experiments motivated us to ask half of the respondents in our both-accounts condition to recommend a total 401(k) contribution rate before deciding how contributions would be split between before-tax and Roth contributions. We predicted that prompting respondents to think of the partitions {current consumption, total contribution} would elicit a total 401(k) contribution rate that is similar to the 401(k) contribution rate in the single-account conditions and lower than the total contribution rate when

[15] Diversification biases do not necessarily cause people to allocate *exactly* an equal amount to each option, but rather bias their choices *towards* an equal allocation.

respondents face the three partitions {current consumption, before-tax contribution, Roth contribution}.

Indeed, Figure 4 shows that the average total contribution rate recommendation in the both-accounts condition when the total contribution rate was elicited first is 11.4%, which is not significantly different from the before-tax-only recommendation of 11.2% (p = 0.166), although it is significantly different from the Roth-only recommendation of 10.7% (p = 0.000).[16] The 41% equity allocation (Figure 5) in this both-accounts elicitation is not statistically different from the before-tax-only equity allocation of 42% (p = 0.565) or the Roth-only equity allocation of 39% (p = 0.087). Because respondents in the two-stage elicitation could specify any combination of before-tax and Roth contribution rates that respondents in the one-stage elicitation could, we conclude that there is nothing about the economics of the both-accounts condition that makes a total contribution rate that is much higher than in the single-account conditions optimal. Instead, it appears that partition dependence can explain nearly all of the increase in the total contribution rate that occurs when moving from a single-account condition to the both-accounts condition with a one-stage elicitation.

Because the companies in our field data that introduced a Roth probably used a one-stage elicitation for contribution rates, partition dependence may have played a role in preventing the total contribution rate from falling in the post-Roth hire cohort. In fact, total contribution rates rise (albeit not statistically significantly) in the post-Roth cohort, which is not a pattern that tax neglect alone would produce but which is a pattern that partition dependence could explain.

V. Conclusion

Comparing 401(k) contribution rates of employees hired one year prior to Roth introduction to employees hired immediately after Roth introduction, we find no evidence that introducing a Roth 401(k) option decreases total 401(k) contribution rates. This means that the total amount of retirement consumption being purchased via the 401(k) increases after the Roth is made available. Our survey experiment suggests that employee confusion about and neglect of the tax properties of Roth balances along with partition dependence are drivers of our finding that total contribution rates do not change following Roth introduction. These results raise the

[16] The 11.4% average total contribution rate is comprised of a 7.5% average before-tax contribution rate and a 4.0% average Roth contribution rate.

possibility that governments may be able to increase after-tax private savings while holding the present value of taxes collected roughly constant by making savings non-deductible up front but tax exempt in retirement, rather than vice versa.

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Table 1. Company characteristics as of 2010

Company	Industry	Total employees	Average age	Median salary	Average salary	Average tenure	Percent male
A	Pharmaceutical	~ 50,000	43.1	$95,100	$106,089	10.6 years	54%
B	Financial services	~ 10,000	46.4	$77,079	$84,285	11.9 years	42%
C	Financial services	~ 25,000	43.7	$54,687	$73,679	9.6 years	46%
D	Financial services	~ 50,000	35.0	$140,598	$295,206	4.9 years	61%
E	Financial services	~ 25,000	44.0	$80,304	$148,184	8.4 years	60%
F	Financial services	~ 10,000	47.5	N/A	N/A	12.2 years	53%
G	Financial services	~ 25,000	40.7	N/A	N/A	8.9 years	33%
H	Business services	~ 25,000	36.4	$83,900	$109,856	6.6 years	62%
I	Manufacturing	~ 25,000	46.6	$59,218	$74,808	16.0 years	65%
J	Manufacturing	~ 100,000	45.7	$67,694	$77,694	13.4 years	76%
K	Financial services	~ 10,000	42.3	N/A	N/A	8.1 years	35%

Table 2. 401(k) plan characteristics in year of Roth introduction

Company	Participation rate at 11 months after hire	Enrollment default	Employer match structure	Max contribution allowed (% of salary)	Roth 401(k) introduction date
A	93%	3% before-tax contribution rate	75% match on first 6% of income contributed after 1 year of tenure	50%	1/1/2008
B	93%	3% before-tax contribution rate	70% match on first 6% of income contributed	20%	9/1/2006
C	61%	Non-enrollment	133% match on first 3% of income contributed after 1 year of tenure	45%	1/1/2006
D	62%	Non-enrollment	No match	50%	2/1/2006
E	63%	Non-enrollment	100% match on first 6% of income contributed after 1 year of tenure	100%	1/1/2007
F	60%	Non-enrollment	No match	50%	1/1/2006
G	31%	Non-enrollment	115% match on first 6% of income contributed after 1 year of tenure	20%	1/1/2008
H	64%	Non-enrollment	Either 33%, 50%, or 100% match on first 6% of income contributed	50%	1/1/2006
I	90%	6% before-tax contribution rate	Either 70% or 100% match on first 6% of income contributed	35%	1/1/2009
J	91%	2% before-tax contribution rate	100% match on the first 2% of income contributed, 50% match on the next 2% of income contributed, and 25% match on the next 4% of income contributed	75%	1/1/2010
K	37%	Non-enrollment	50% match on the first 6% of income contributed	100%	7/1/2010

Table 3. Comparison of hire cohort characteristics

This table shows the average age as of hire date, average salary, and gender composition at each company among employees who were hired in the twelfth month prior to Roth introduction or in the month after Roth introduction. The change in these variables between the before and after cohorts is also reported, with standard errors in parentheses. Salary is in 2005 dollars, deflated by CPI-W. The last column shows the number of employees in the before and after cohorts combined. Salaries are calculated using fewer employees than in the last column because of missing data.

	Age (years)			Salary			Percent male			
Company	Before Roth	After Roth	Change	Before Roth	After Roth	Change	Before Roth	After Roth	Change	*N*
A	36.4	33.7	-2.75**	$83,192	$65,121	-$18,071**	47.6%	44.7%	2.91%	519
			(0.74)			(3,420)			(4.07)	
B	36.2	38.3	2.15	$62,684	$67,462	4,778	39.0%	50.0%	10.98	120
			(2.11)			(6,981)			(9.73)	
C	35.0	37.3	2.30**	$39,133	$41,183	2,050	58.9%	46.7%	-12.12**	650
			(0.83)			(3,304)			(3.90)	
D	31.2	29.5	-1.68	$184,811	$160,114	-24,697	60.2%	68.4%	8.19	225
			(0.94)			(30,906)			(6.39)	
E	36.0	36.2	0.20	$59,908	$66,787	6,879	58.1%	55.1%	-2.94	441
			(1.06)			(5,953)			(4.76)	
F	38.7	36.5	-2.21	N/A	N/A	N/A	46.9%	48.8%	1.92	285
			(1.40)						(5.98)	
G	33.6	33.1	-0.51	N/A	N/A	N/A	39.1%	42.2%	3.13	775
			(0.77)						(3.55)	
H	34.4	33.2	-1.22	$66,492	$78,773	12,281**	58.3%	58.6%	0.23	890
			(0.74)			(3,401)			(3.47)	
I	35.5	37.7	2.28	$55,814	$74,345	18,531*	64.3%	50.0%	-14.34	150
			(2.36)			(7,240)			(11.19)	
J	36.2	37.8	1.57*	$59,479	$62,280	2,800	71.5%	74.7%	3.14	1,326
			(0.68)			(1,812)			(2.52)	
K	36.0	37.9	1.88	N/A	N/A	N/A	61.9%	41.2%	-20.73*	93
			(2.36)						(10.31)	

* Significant at 5% level. ** Significant at 1% level.

Table 4. Average total contribution rates by hire cohort

This table shows the average total employee contribution rate (before-tax plus Roth plus after-tax) at six or eleven months after hire among employees who were hired in the twelfth month prior to Roth introduction or in the month after Roth introduction. The change in the average total contribution rate between the before and after cohorts is also reported, with standard errors in parentheses. The penultimate row shows the averages pooling all companies together, and the last row shows the averages excluding companies that had one or more significant demographic changes across the before and after hire cohorts in Table 3.

	Total contribution rate 6 months after hire			Total contribution rate 11 months after hire		
Company	Before Roth	After Roth	Difference	Before Roth	After Roth	Difference
A	7.48	6.53	-0.95* (0.46)	8.14	6.89	-1.25* (0.51)
B	5.61	7.50	1.89 (0.97)	5.85	7.09	1.24 (1.01)
C	3.45	3.63	0.18 (0.42)	3.88	4.31	0.43 (0.45)
D	7.26	5.97	-1.28 (1.33)	6.99	7.76	0.77 (1.47)
E	7.33	7.29	-0.04 (1.38)	9.86	9.02	-0.84 (1.89)
F	5.03	4.89	-0.14 (0.97)	5.35	4.92	-0.43 (1.03)
G	2.14	2.07	-0.07 (0.31)	2.94	2.16	-0.78* (0.32)
H	5.45	5.89	0.44 (0.52)	5.84	6.59	0.75 (0.55)
I	7.40	7.86	0.46 (1.39)	7.05	7.86	0.82 (1.30)
J	5.54	6.00	0.46 (0.30)	5.56	6.11	0.55 (0.31)
K	2.19	3.02	0.83 (1.00)	3.36	2.29	-1.06 (1.16)
All	5.23	5.21	-0.02 (0.20)	5.75	5.81	0.06 (0.23)
All with no demographic changes	4.53	4.71	0.18 (0.44)	5.53	5.59	0.06 (0.56)

* Significant at 5% level. ** Significant at 1% level.

Table 5. The impact of Roth introduction on total 401(k) contribution rates

Each row is an OLS regression where the dependent variable is the total employee contribution rate (before-tax plus Roth plus after-tax) at six months after hire (Panel A) or eleven months after hire (Panel B). The sample is employees who were hired in the twelfth month prior to Roth introduction or in the month after Roth introduction at the company indicated in the first column. The penultimate row in each panel includes in its sample all companies that have a complete set of employee characteristic data. The last row in each panel includes all companies that have a complete set of employee characteristic data and did not have a significant demographic change across the before and after hire cohorts in Table 3. The explanatory variables are a constant, a dummy for being in the post-Roth hire cohort, age as of hire date, age squared, a male dummy, and log salary in the year of hire (in 2005 dollars). Standard errors are in parentheses.

Panel A: Contribution rate 6 months after hire						
Company	Roth	Age	Age^2	Male	log(Salary)	*N*
A	-0.109	-0.088	0.003	0.236	2.018**	519
	(0.489)	(0.217)	(0.003)	(0.477)	(0.594)	
B	1.295	-0.380	0.005	-0.271	4.086**	120
	(0.880)	(0.313)	(0.004)	(0.921)	(0.995)	
C	0.398	0.270	-0.003	0.467	1.744**	650
	(0.411)	(0.144)	(0.002)	(0.407)	(0.241)	
D	-1.165	-0.548	0.012	0.491	-0.372	225
	(1.341)	(0.833)	(0.012)	(1.418)	(1.104)	
E	-0.146	0.416	-0.003	-0.443	0.161	441
	(1.384)	(0.436)	(0.005)	(1.475)	(0.878)	
F	0.244	0.333	-0.002	1.212	N/A	285
	(0.949)	(0.277)	(0.003)	(0.938)		
G	-0.045	0.355**	-0.004**	1.016**	N/A	775
	(0.306)	(0.103)	(0.001)	(0.311)		
H	0.094	-0.646**	0.009**	-0.592	4.371**	890
	(0.524)	(0.165)	(0.002)	(0.527)	(0.647)	
I	-0.543	-0.913**	0.013**	-0.761	3.692**	150
	(1.319)	(0.329)	(0.004)	(0.949)	(0.932)	
J	0.252	-0.298**	0.004**	-0.221	3.125**	1,326
	(0.287)	(0.083)	(0.001)	(0.315)	(0.246)	
K	0.657	0.109	-0.001	-0.104	N/A	93
	(1.045)	(0.366)	(0.005)	(1.033)		
All with complete data	0.096 (0.229)	-0.137 (0.074)	0.003** (0.001)	-0.164 (0.235)	2.233** (0.166)	4,321
Complete data, no demographic changes	-0.005 (0.873)	0.230 (0.300)	-0.001 (0.004)	0.232 (0.923)	0.245 (0.527)	786

Panel B: Contribution rate 11 months after hire						
Company	Roth	Age	Age^2	Male	log(Salary)	N
A	-0.536	0.079	0.001	0.786	1.727*	519
	(0.558)	(0.247)	(0.003)	(0.544)	(0.678)	
B	0.903	-0.276	0.004	-0.614	4.396**	120
	(0.925)	(0.328)	(0.004)	(0.980)	(1.062)	
C	0.415	0.258	-0.003	0.173	0.646*	650
	(0.451)	(0.158)	(0.002)	(0.446)	(0.264)	
D	0.988	-1.020	0.019	-0.169	0.299	225
	(1.481)	(0.920)	(0.013)	(1.566)	(1.220)	
E	-0.978	0.672	-0.005	-0.400	0.297	441
	(1.899)	(0.598)	(0.007)	(2.025)	(1.205)	
F	-0.051	0.094	0.001	0.465	N/A	285
	(1.012)	(0.295)	(0.004)	(1.000)		
G	-0.781*	0.213*	-0.002	1.260**	N/A	775
	(0.314)	(0.106)	(0.001)	(0.320)		
H	0.381	-0.569**	0.008**	-0.039	4.332**	890
	(0.550)	(0.173)	(0.002)	(0.554)	(0.680)	
I	0.038	-0.890**	0.013**	-0.168	2.967**	150
	(1.228)	(0.307)	(0.004)	(0.883)	(0.868)	
J	0.359	-0.153	0.002*	-0.607	2.844**	1,326
	(0.295)	(0.085)	(0.001)	(0.324)	(0.253)	
K	-1.382	-0.153	0.003	-0.209	N/A	93
	(1.206)	(0.435)	(0.005)	(1.198)		
All with complete data	0.346 (0.274)	-0.002 (0.089)	0.001 (0.001)	-0.128 (0.281)	1.937** (0.197)	4,321
Complete data, no demographic changes	0.302 (1.180)	0.433 (0.404)	-0.003 (0.005)	0.440 (1.249)	-0.012 (0.717)	786

* Significant at 5% level. ** Significant at 1% level.

Table 6. Knowledge of 401(k) taxation rules

This table shows the percent of survey respondents who correctly answered each question about 401(k) taxation rules.

	Percent correct	*N*
Suppose a person with a $100,000 salary started making **before-tax** 401(k) contributions this calendar year without changing any of her contributions to other retirement savings accounts. What effect would this have on her taxable income this year?	49%	3,690
Suppose a person with a $100,000 salary started making **Roth** 401(k) contributions this calendar year without changing any of her contributions to other retirement savings accounts. What effect would this have on her taxable income this year?	46%	3,499
Suppose you made $100,000 in **before-tax** contributions to a 401(k) over the course of your working life. Your 401(k) investments went up in value, so that at age 65, your before-tax contributions are worth $150,000. You withdraw the entire $150,000 balance from your 401(k) at once **at age 65**. How much of this $150,000 withdrawal is taxable income in the year of the withdrawal?	33%	3,467
Suppose you made $100,000 in **Roth** contributions to a 401(k) over the course of your working life. Your 401(k) investments went up in value, so that at age 65, your Roth contributions are worth $150,000. You withdraw the entire $150,000 balance from your 401(k) at once **at age 65**. How much of this $150,000 withdrawal is taxable income in the year of the withdrawal?	25%	3,425

Figure 1. Average total contribution rate by hire cohort

Figure 2A. Estimated Roth total contribution rate treatment effects against average Roth contribution rates for post-Roth hires, 6 months after hire

The *y*-axis values are the individual company post-Roth hire cohort dummy coefficients from the regressions found in Table 5, Panel A. The *x*-axis values are the average Roth contribution rate of the post-Roth hire cohort at each company at 6 months after hire.

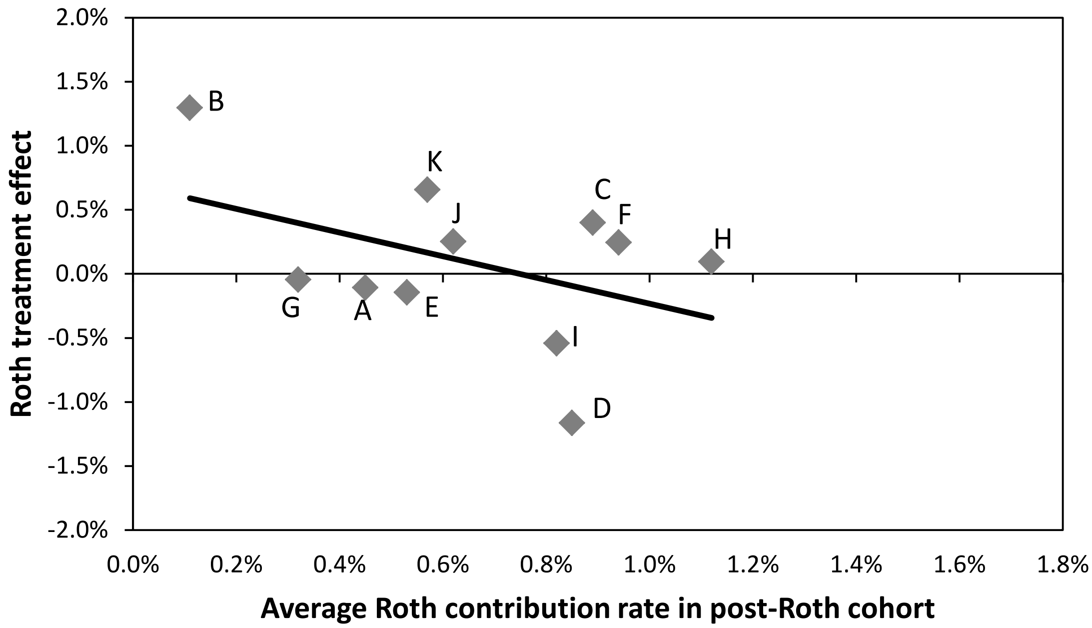


Figure 2B. Estimated Roth total contribution rate treatment effects on against average Roth contribution rates for post-Roth hires, 11 months after hire

The *y*-axis values are the individual company post-Roth hire cohort dummy coefficients from the regressions found in Table 5, Panel B. The *x*-axis values are the average Roth contribution rate of the post-Roth hire cohort at each company at 11 months after hire.

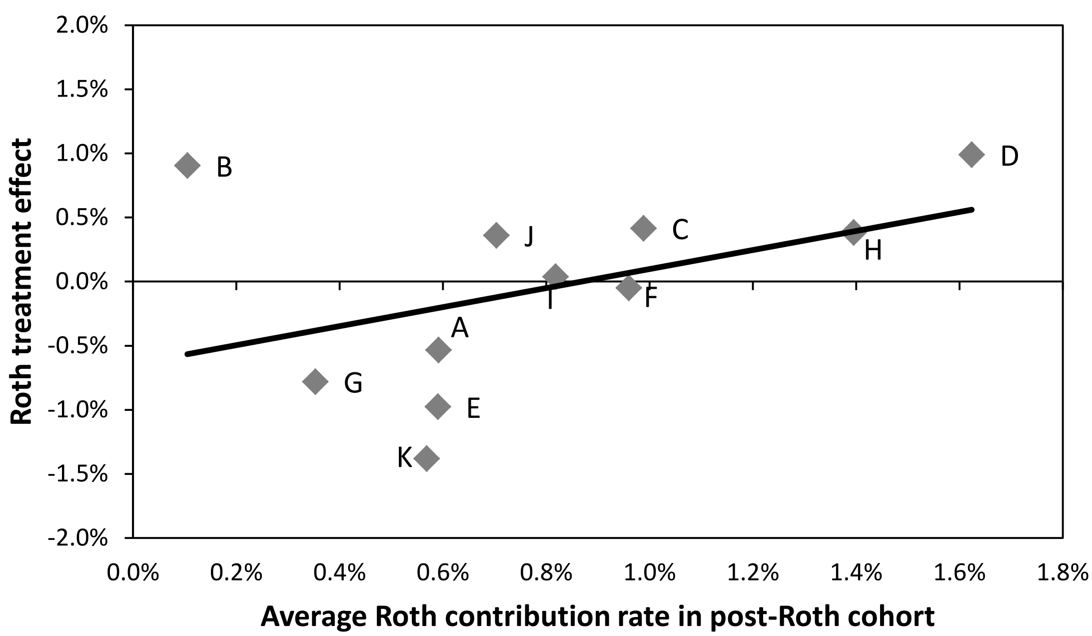


Figure 3A. Estimated Roth total contribution rate treatment effects against fraction of pre-Roth hires contributing at a match threshold, 6 months after hire

The y-axis values are the individual company post-Roth hire cohort dummy coefficients from the regressions in Table 5, Panel A. The x-axis values are the fraction of the pre-Roth hire cohort contributing at a match threshold at each company 6 months after hire.

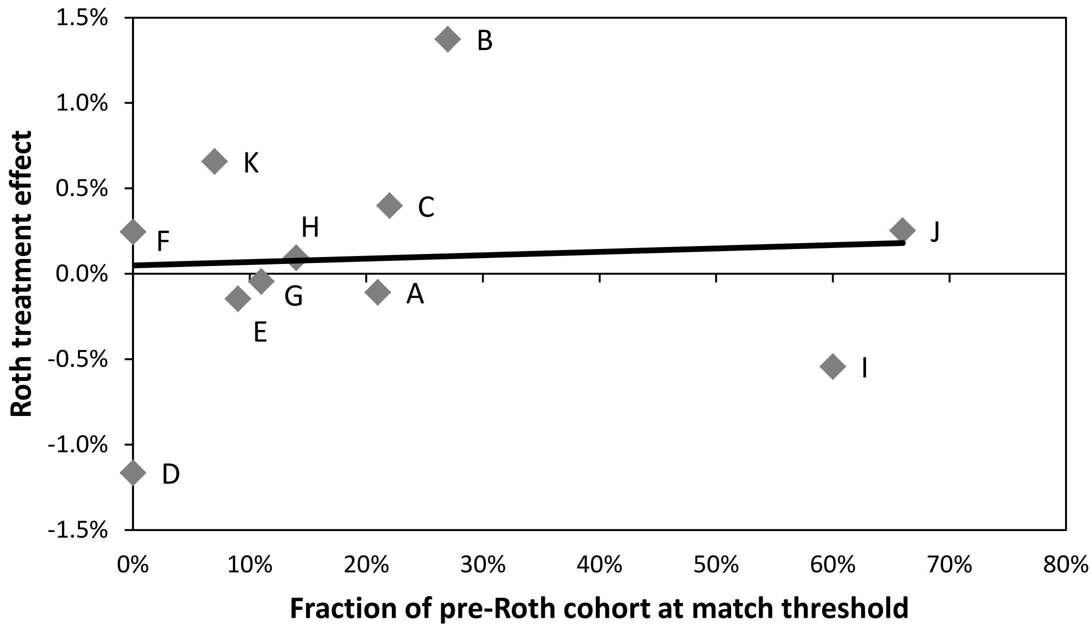


Figure 3B. Estimated Roth total contribution rate treatment effects on against fraction of pre-Roth hires contributing at a match threshold, 11 months after hire

The y-axis values are the individual company post-Roth hire cohort dummy coefficients from the regressions in Table 5, Panel B. The x-axis values are the fraction of the pre-Roth hire cohort contributing at a match threshold at each company 11 months after hire.

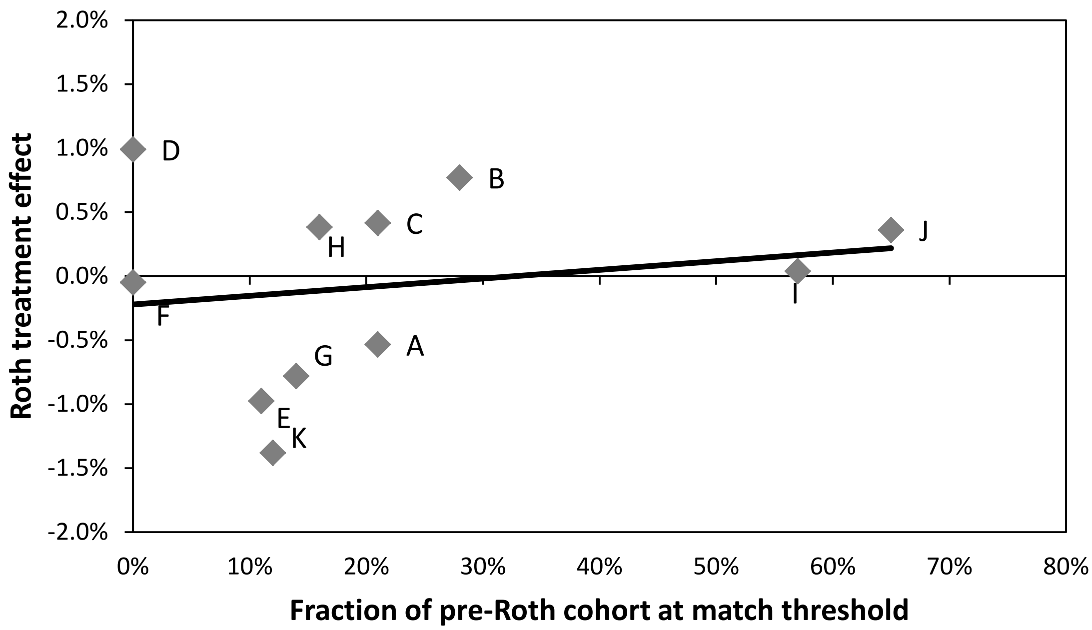


Figure 4. Average total contribution rate recommendations

Error bars show 95% confidence intervals.

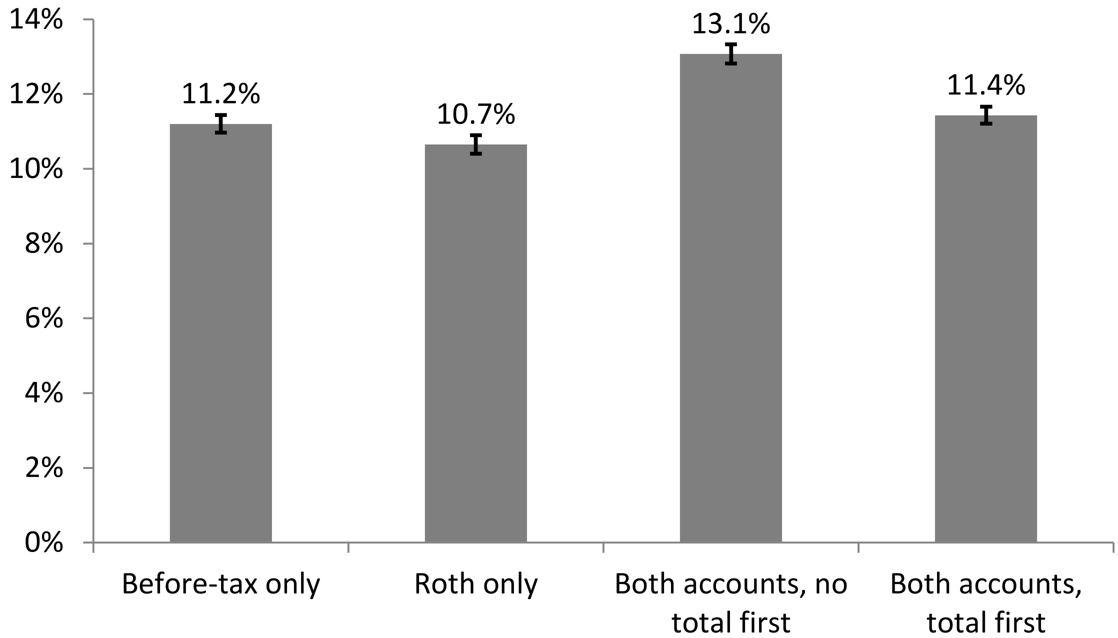


Figure 5. Average equity allocation recommendations

Error bars show 95% confidence intervals.

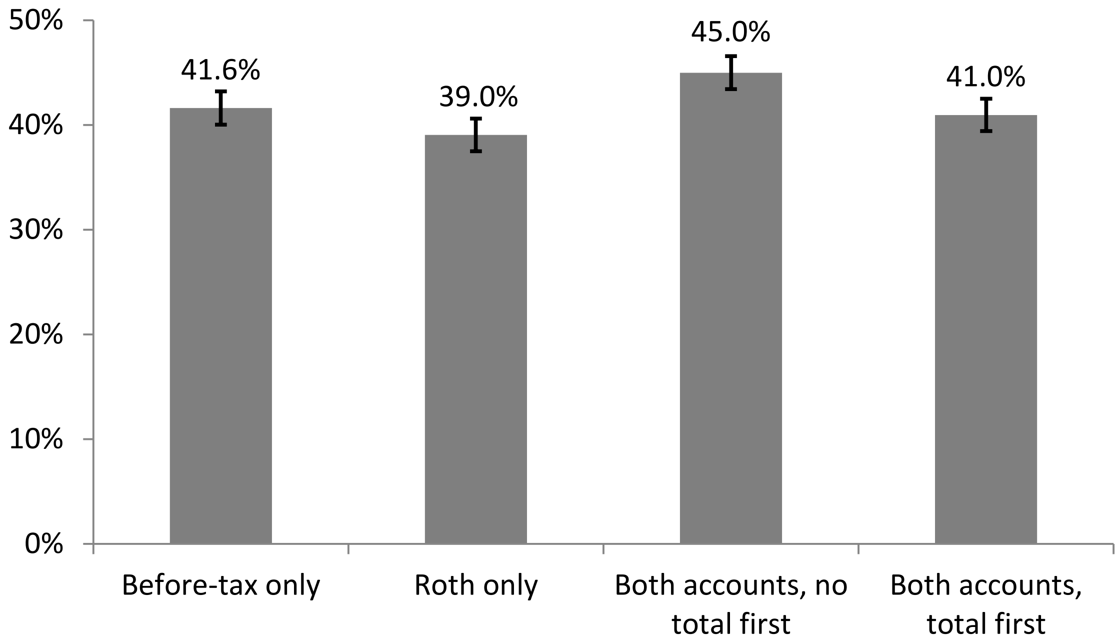
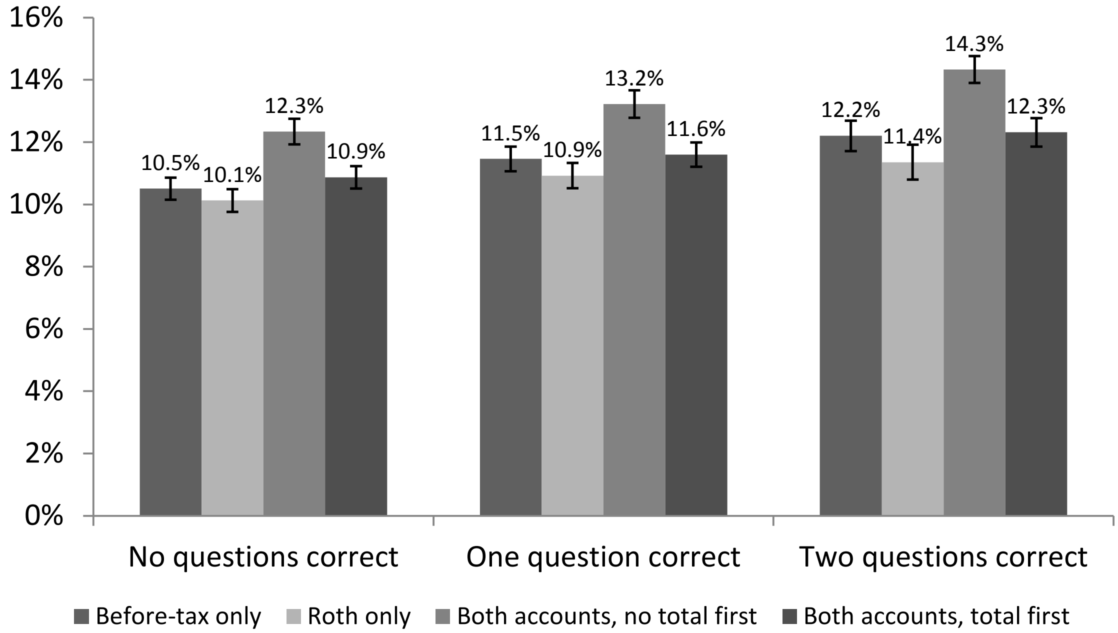


Figure 6. Average total contribution rate recommendations by knowledge of 401(k) tax rules

Error bars show 95% confidence intervals.



Online appendix

Appendix Table 1. Hire cohort average contribution rates by type

This table shows the average before-tax, after-tax, and Roth contribution rates at six or eleven months after hire among employees who were hired in the twelfth month prior to Roth introduction or in the month after Roth introduction. The penultimate row in each panel shows the averages pooling all companies together, and the last row in each panel shows the averages excluding companies that had one or more significant demographic changes across the before and after hire cohorts in Table 3.

Panel A: Contribution rates 6 months after hire

	Hired 12 months prior to Roth			Hired in month after Roth		
Company	Before-tax	After-tax	Roth	Before-tax	After-tax	Roth
A	7.27	0.21	0.00	5.93	0.16	0.45
B	5.23	0.17	0.00	7.32	0.08	0.11
C	3.39	0.06	0.00	2.56	0.18	0.89
D	7.26	0.00	0.00	5.12	0.00	0.85
E	7.11	0.22	0.00	6.71	0.05	0.53
F	5.03	0.00	0.00	3.94	0.00	0.94
G	2.14	0.00	0.00	1.75	0.00	0.32
H	5.45	0.00	0.00	4.77	0.00	1.12
I	7.11	0.29	0.00	7.05	0.00	0.82
J	5.35	0.19	0.00	5.25	0.14	0.62
K	2.19	0.00	0.00	2.16	0.06	0.57
All	5.11	0.15	0.00	4.49	0.10	0.67
All with no demographic changes	4.51	0.18	0.00	4.31	0.08	0.55

Panel B: Contribution rates 11 months after hire

	Hired 12 months prior to Roth			Hired in month after Roth		
Company	Before-tax	After-tax	Roth	Before-tax	After-tax	Roth
A	7.86	0.28	0.00	6.16	0.13	0.59
B	5.12	0.09	0.00	6.34	0.08	0.11
C	3.75	0.12	0.00	3.19	0.13	0.99
D	6.99	0.00	0.00	6.14	0.00	1.62
E	9.64	0.22	0.00	8.38	0.05	0.59
F	5.35	0.00	0.00	3.96	0.00	0.96
G	2.94	0.00	0.00	1.80	0.00	0.35
H	5.84	0.00	0.00	5.19	0.00	1.40
I	6.71	0.33	0.00	6.95	0.09	0.82
J	5.45	0.11	0.00	5.28	0.12	0.70
K	2.24	0.00	0.00	1.22	0.06	0.57
All	5.56	0.10	0.00	4.81	0.07	0.81
All with no demographic changes	5.33	0.16	0.00	4.85	0.07	0.68

Appendix Table 2. The impact of Roth introduction on total 401(k) contribution rates (tobit regressions)

Each row is a tobit regression where the dependent variable is the total employee contribution rate (before-tax plus Roth plus after-tax) at six months after hire (Panel A) or eleven months after hire (Panel B). Observations are left-censored at zero and right-censored if the employee is at a contribution rate or contribution amount maximum. The sample is employees who were hired in the twelfth month prior to Roth introduction or in the month after Roth introduction at the company indicated in the first column. The penultimate row in each panel includes in its sample all companies that have a complete set of employee characteristic data. The last row in each panel includes all companies that have a complete set of employee characteristic data and did not have a significant demographic change across the before and after hire cohorts in Table 3. The explanatory variables are a constant, a dummy for being in the post-Roth hire cohort, age as of hire date, age squared, a male dummy, and log salary in the year of hire (in 2005 dollars). Standard errors are in parentheses.

Panel A: Contribution rate 6 months after hire						
Company	Roth	Age	Age^2	Male	log(Salary)	*N*
A	-0.083	0.029	0.002	0.321	2.607**	519
	(0.552)	(0.246)	(0.003)	(0.538)	(0.677)	
B	1.407	-0.423	0.006	-0.418	4.237**	120
	(0.922)	(0.328)	(0.004)	(0.966)	(1.041)	
C	0.332	0.410	-0.005	-0.132	5.337**	650
	(0.799)	(0.291)	(0.004)	(0.796)	(0.612)	
D	-2.641	-0.888	0.018	-0.196	2.977	225
	(2.659)	(1.656)	(0.024)	(2.787)	(2.276)	
E	0.507	0.853	-0.006	-3.548	6.057**	441
	(3.137)	(0.996)	(0.012)	(3.382)	(2.254)	
F	0.549	1.521**	-0.015*	2.050	N/A	285
	(1.549)	(0.494)	(0.006)	(1.527)		
G	-0.496	1.330**	-0.015**	3.798**	N/A	775
	(1.053)	(0.369)	(0.005)	(1.065)		
H	-0.306	-1.190**	0.016**	-1.000	9.875**	890
	(0.907)	(0.285)	(0.004)	(0.912)	(1.187)	
I	-0.751	-0.920*	0.014**	-0.951	4.034**	150
	(1.436)	(0.356)	(0.005)	(1.024)	(1.005)	
J	0.180	-0.303**	0.004**	-0.179	3.376**	1,326
	(0.312)	(0.090)	(0.001)	(0.342)	(0.270)	
K	0.651	0.799	-0.008	-1.182	N/A	93
	(2.557)	(0.932)	(0.012)	(2.523)		
All with complete data	-0.282	-0.179	0.003**	-0.203	4.201**	4,321
	(0.314)	(0.102)	(0.001)	(0.322)	(0.253)	
Complete data, no demographic changes	-0.751	0.551	-0.003	-1.999	3.115**	786
	(1.499)	(0.519)	(0.007)	(1.593)	(0.982)	

Panel B: Contribution rate 11 months after hire						
Company	Roth	Age	Age^2	Male	log(Salary)	N
A	-0.562 (0.618)	0.124 (0.274)	0.001 (0.004)	0.974 (0.603)	2.501** (0.761)	519
B	0.901 (1.060)	-0.124 (0.372)	0.002 (0.005)	-1.089 (1.099)	4.573** (1.179)	120
C	0.806 (0.767)	0.504 (0.272)	-0.006 (0.003)	-0.128 (0.755)	0.767 (0.442)	650
D	0.620 (2.625)	-1.715 (1.621)	0.031 (0.023)	-1.442 (2.753)	3.388 (2.235)	225
E	0.739 (3.147)	0.845 (0.998)	-0.006 (0.012)	-3.681 (3.388)	6.125** (2.261)	441
F	-0.069 (1.565)	0.973* (0.476)	-0.008 (0.006)	1.304 (1.545)	N/A	285
G	-2.273** (0.830)	0.682* (0.281)	-0.007* (0.004)	3.631** (0.832)	N/A	775
H	0.031 (0.861)	-0.966** (0.272)	0.013** (0.003)	-0.159 (0.867)	9.119** (1.127)	890
I	-0.102 (1.308)	-0.861** (0.326)	0.013** (0.004)	-0.437 (0.942)	3.373** (0.922)	150
J	0.272 (0.319)	-0.160 (0.092)	0.002* (0.001)	-0.540 (0.349)	3.155** (0.277)	1,326
K	-1.754 (2.827)	0.063 (1.014)	0.001 (0.013)	-0.657 (2.798)	N/A	93
All with complete data	0.174 (0.338)	0.012 (0.115)	0.001 (0.001)	0.012 (0.364)	3.302** (0.257)	4,321
Complete data, no demographic changes	0.400 (1.810)	0.599 (0.621)	-0.003 (0.008)	-1.757 (1.922)	3.191** (1.185)	786

* Significant at 5% level. ** Significant at 1% level.

Appendix. Survey experiment questions

[Each respondent was randomly assigned to be asked only one of questions 1-4]

1. Jack and Cindy are married and have two children ages 2 and 4. They are both 30 years old and live in your neighborhood in rental housing. They don't expect to have any more kids.

   Jack earns $100,000 per year before taxes working as a computer programmer and expects to retire at age 65. He expects his income to grow at the rate of inflation (that is, the rate at which the cost of living index rises) for the rest of his working life. Cindy is staying at home to raise their children and doesn't expect to return to the workforce.

   The only savings Jack and Cindy have right now is $5,000 in a bank savings account. Jack's company offers a 401(k) retirement savings plan that has only a before-tax contribution option (it only accepts before-tax dollars). Jack's company does not make matching contributions to the 401(k). This 401(k) also has a special rule: It does not allow Jack to withdraw money from it for any reason before he is 59.5 years old, even if Jack leaves the firm. (In real life, 401(k) withdrawal rules are not as strict.)

   Jack and Cindy need to decide how much to contribute to the plan and how to invest the contributions. Their financial goal is to have a material standard of living that does not change for the rest of their lives, even in retirement. If they do save anything over the next 12 months, they plan on doing that saving in Jack's 401(k).

   Please advise Jack and Cindy by recommending, to the best of your ability, a contribution amount and investment allocation. If you feel you need more information than we gave you, make whatever additional assumptions seem natural to you.

   What percent of Jack's $100,000 income should he contribute as a **before-tax** contribution to his 401(k) plan over the next 12 months? The maximum he is allowed to contribute is 17.5%. If you would like Jack to contribute nothing, the box must have a "0" in it.

   _________%

2. Jack and Cindy are married and have two children ages 2 and 4. They are both 30 years old and live in your neighborhood in rental housing. They don't expect to have any more kids.

   Jack earns $100,000 per year before taxes working as a computer programmer and expects to retire at age 65. He expects his income to grow at the rate of inflation (that is, the rate at which the cost of living index rises) for the rest of his working life.

Cindy is staying at home to raise their children and doesn't expect to return to the workforce.

The only savings Jack and Cindy have right now is $5,000 in a bank savings account. Jack's company offers a 401(k) retirement savings plan that has only a Roth contribution option (it only accepts after-tax dollars). Jack's company does not make matching contributions to the 401(k). This 401(k) also has a special rule: It does not allow Jack to withdraw money from it for any reason before he is 59.5 years old, even if Jack leaves the firm. (In real life, 401(k) withdrawal rules are not as strict.)

Jack and Cindy need to decide how much to contribute to the plan and how to invest the contributions. Their financial goal is to have a material standard of living that does not change for the rest of their lives, even in retirement. If they do save anything over the next 12 months, they plan on doing that saving in Jack's 401(k).

Please advise Jack and Cindy by recommending, to the best of your ability, a contribution amount and investment allocation. If you feel you need more information than we gave you, make whatever additional assumptions seem natural to you.

What percent of Jack's $100,000 income should he contribute as a **Roth** contribution to his 401(k) plan over the next 12 months? The maximum he is allowed to contribute is 17.5%. If you would like Jack to contribute nothing, the box must have a "0" in it.

_________%

3. Jack and Cindy are married and have two children ages 2 and 4. They are both 30 years old and live in your neighborhood in rental housing. They don't expect to have any more kids.

   Jack earns $100,000 per year before taxes working as a computer programmer and expects to retire at age 65. He expects his income to grow at the rate of inflation (that is, the rate at which the cost of living index rises) for the rest of his working life. Cindy is staying at home to raise their children and doesn't expect to return to the workforce.

   The only savings Jack and Cindy have right now is $5,000 in a bank savings account. Jack's company offers a 401(k) retirement savings plan that allows both before-tax contributions and Roth (i.e., after-tax dollar) contributions. Jack's company does not make matching contributions to the 401(k). This 401(k) also has a special rule: It does not allow Jack to withdraw money from it for any reason before he is 59.5 years old, even if Jack leaves the firm. (In real life, 401(k) withdrawal rules are not as strict.)

   Jack and Cindy need to decide how much to contribute to the plan and how to invest the contributions. Their financial goal is to have a material standard of living that does not change for the rest of their lives, even in retirement. If they do save anything over the next 12 months, they plan on doing that saving in Jack's 401(k).

Please advise Jack and Cindy by recommending, to the best of your ability, a contribution amount and investment allocation. We will ask you for two contribution rates -- one for the before-tax contribution and one for the Roth contribution. If you feel you need more information than we gave you, make whatever additional assumptions seem natural to you.

What percent of Jack's $100,000 income should he contribute as a **before-tax** contribution to his 401(k) plan over the next 12 months?

What percent of Jack's $100,000 income should he contribute as a **Roth** contribution to his 401(k) plan over the next 12 months?

The maximum combined amount he is allowed to contribute is 17.5%. If you would like Jack to contribute nothing, both boxes must have a "0" in them.

Before-tax contribution percentage ________%

Roth contribution percentage ________%

4. Jack and Cindy are married and have two children ages 2 and 4. They are both 30 years old and live in your neighborhood in rental housing. They don't expect to have any more kids.

   Jack earns $100,000 per year before taxes working as a computer programmer and expects to retire at age 65. He expects his income to grow at the rate of inflation (that is, the rate at which the cost of living index rises) for the rest of his working life. Cindy is staying at home to raise their children and doesn't expect to return to the workforce.

   The only savings Jack and Cindy have right now is $5,000 in a bank savings account. Jack's company offers a 401(k) retirement savings plan that allows both before-tax contributions and Roth (i.e., after-tax dollar) contributions. Jack's company does not make matching contributions to the 401(k). This 401(k) also has a special rule: It does not allow Jack to withdraw money from it for any reason before he is 59.5 years old, even if Jack leaves the firm. (In real life, 401(k) withdrawal rules are not as strict.)

   Jack and Cindy need to decide how much to contribute to the plan and how to invest the contributions. Their financial goal is to have a material standard of living that does not change for the rest of their lives, even in retirement. If they do save anything over the next 12 months, they plan on doing that saving in Jack's 401(k).

Please advise Jack and Cindy by recommending, to the best of your ability, a contribution amount and investment allocation. If you feel you need more information than we gave you, make whatever additional assumptions seem natural to you.

What percent of Jack's $100,000 income should he contribute **in total** to his 401(k) plan over the next 12 months? The maximum he is allowed to contribute is 17.5%. If you would like Jack to contribute nothing, the box must have a "0" in it. On the next screen, we will ask you how Jack should split his contributions between before-tax and Roth contributions.

________%

5. What percent of Jack's 401(k) contributions should be invested in stocks? (The rest of the contributions will be invested in bonds.) Enter a number between 0 and 100.

____

[*Question 6 was asked only of respondents who were assigned to answer question 4. It appeared on a separate screen from question 4.*]

6. You recommended that Jack contribute [*fill in response from question 4*]% of his income in total to the 401(k). What percent of Jack's income should he contribute as a before-tax contribution versus a Roth contribution? The numbers you type in the two boxes below must add up to *[fill in response from question 4]*.

   Before-tax contribution percentage ________%

   Roth contribution percentage ________%

7. Suppose you made $100,000 in **before-tax** contributions to a 401(k) over the course of your working life. Your 401(k) investments went up in value, so that at age 65, your before-tax contributions are worth $150,000. You withdraw the entire $150,000 balance from your 401(k) at once **at age 65**. How much of this $150,000 withdrawal is taxable income in the year of the withdrawal?

   ☐I know the answer (Please type the dollar amount below)

   ____

   ☐I don't know

8. Suppose a person with a $100,000 salary started making **before-tax** 401(k) contributions this calendar year without changing any of her contributions to other retirement savings accounts. What effect would this have on her taxable income this year?

   ☐It would **increase** her taxable income this year

   ☐It would have **no effect** on her taxable income this year

   ☐It would **decrease** her taxable income this year

   ☐I don't know

9. Suppose you made $100,000 in **Roth** contributions to a 401(k) over the course of your working life. Your 401(k) investments went up in value, so that at age 65, your Roth contributions are worth $150,000. You withdraw the entire $150,000 balance from your 401(k) at once **at age 65**. How much of this $150,000 withdrawal is taxable income in the year of the withdrawal?

   ☐I know the answer (Please type the dollar amount below)

   ____

   ☐I don't know

10. Suppose a person with a $100,000 salary started making **Roth** 401(k) contributions this calendar year without changing any of her contributions to other retirement savings accounts. What effect would this have on her taxable income this year?

   ☐It would **increase** her taxable income this year

   ☐It would have **no effect** on her taxable income this year

   ☐It would **decrease** her taxable income this year

   ☐I don't know