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Potential vs. realized savings under automatic enrollment

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Abstract

Employer adoption of automatic enrollment can dramatically increase retirement savings plan participation. However, many savings plan participants withdraw some, or even all, of their accumulated balances prior to reaching retirement. The extent to which individuals' preretirement withdrawal decisions, sometimes months or even years after they have been automatically enrolled, offset the increased savings induced by automatic enrollment is an open question. We explore this issue by studying the evolution of retirement savings outcomes over time for the employees at a large firm that introduced automatic enrollment in 2005. Comparing employees hired in the 12 months after the introduction of automatic enrollment to those hired in the 12 months prior, we find that automatic enrollment increases total potential retirement system balances by 7% of starting pay eight years after hire; at the same time, leakage in the form of outstanding loans and withdrawals that are not rolled over into another qualified savings plan also increase by 3% of starting pay, offsetting approximately 40% of the potential increase in savings from automatic enrollment. The net effect is that automatic enrollment increases retirement system balances by 4-5% of first year pay eight years after hire. These results mask substantial differences across those who remain employed at the firm versus those who separate. Among those who remain employed, leakage offsets relatively little of the incremental savings generated by automatic enrollment at low levels of tenure. As tenure increases, so does the extent to which leakage offsets the savings increases from automatic enrollment, and eight years after hire, leakage, primarily in the form of plan loans, offsets 9-27% of the potential

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increased savings. In contrast, for employees who separate, leakage, primarily in the form of non-rollover withdrawals, offsets more than half of the potential incremental savings from automatic enrollment at low levels of tenure. Although this rate of offset declines with time since hire for separated employees, at eight years it still exceeds 40%. Overall, while automatic enrollment results in a net increase in retirement system balances, preretirement leakage significantly limits its potential impact.

Previous research has documented the powerful impact that automatic enrollment has on retirement savings outcomes. When a savings plan's default—the option that is implemented on behalf of employees that do not actively elect an alternative option—is changed from not participating in the plan to contributing a positive fraction of pay to the plan, the proportion of employees contributing to the plan increases dramatically, and many employees who would otherwise have not participated begin to accumulate plan balances (Madrian and Shea, 2001; Choi, et al., 2002 and 2004; Beshears, et al., 2008). Even though automatic enrollment increases plan contributions for many employees, the ultimate impact on the accumulation of plan balances is unclear. Argento, Bryant and Sabelhaus (2015) have documented that many households make substantial withdrawals from their defined contribution accounts well before reaching retirement age, a phenomenon known as "leakage" (because balances are "leaking" out of accounts). They find that among households under the age of 55, each dollar contributed to a 401(k) plan or similar tax-advantaged retirement account is offset by approximately $0.40 in pre-retirement taxable withdrawals. This high rate of leakage raises the possibility that the positive effect of automatic enrollment on savings plan contributions may be offset in whole or in part by subsequent pre-retirement withdrawals, leaving a reduced long-term net impact (or no net impact) of automatic enrollment on retirement assets.

We studied the effect of automatic enrollment on savings plan loans and withdrawals and their implications for the evolution of retirement plan balances over time by examining the experience of a large Fortune 500 company in the financial services sector that introduced automatic enrollment at a 2% default contribution rate for all employees hired on or after July 1, 2005. Our empirical strategy compares savings plan outcomes for employees hired in the 12 months after the introduction of automatic enrollment to those for employees hired in the 12 months prior. We restrict our analysis to those employees in both cohorts who remained at the firm for at least one year and then follow these two cohorts for up to eight years after they joined the firm. We first examine outcomes directly observable in administrative data: savings plan participation, contributions, balances, outstanding loans, and whether plan withdrawals are rolled over into another qualified savings plan or not. We then project the potential impact that automatic enrollment could have on retirement savings accumulations if there were no plan leakage and decompose that amount into several component parts— retirement plan balances, outstanding loan balances, rollovers into other qualified plans, and non-rollover withdrawals—to quantify the extent to which leakage reduces retirement asset accumulation overall, and the incremental asset accumulation induced by automatic enrollment in particular.

Consistent with previous research, we find that savings plan participation at the firm we study is significantly higher for the post-automatic enrollment cohort in the first few years after being hired, as is the average fraction of pay contributed to the plan; conditional on plan participation, however, the average contribution rate is lower for the post-automatic enrollment cohort because a sizeable fraction of participants persist at the (low) default contribution rate of 2% (Madrian and Shea, 2001; Choi, et al., 2002 and 2004; Beshears, et al., 2008). Automatic enrollment increases total potential retirement system balances by 7% of starting pay eight years after hire; at the same time, leakage in the form of outstanding loans and withdrawals that are not rolled over into another qualified savings plan also increase by 3% of starting pay, offsetting approximately 40% of the potential increase in savings from automatic enrollment. The net effect is that automatic enrollment increases retirement system balances by 4-5% of first year pay eight years after hire. These results mask substantial

differences across those who remain employed at the firm versus those who separate. Among those who remain employed, leakage offsets relatively little of the incremental savings generated by automatic enrollment at low levels of tenure. As tenure increases, so does the extent to which leakage offsets the savings increases from automatic enrollment, and eight years after hire, leakage, primarily in the form of plan loans, offsets 9-27% of the potential increased savings. In contrast, for employees who separate, leakage, primarily in the form non-rollover withdrawals, offsets more than half of the potential incremental savings from automatic enrollment at low levels of tenure. Although this rate of offset declines with time since hire for separated employees, at eight years it still exceeds 40%. Overall, while automatic enrollment results in a net increase in retirement system balances, preretirement leakage significantly limits its potential impact.

The paper proceeds as follows. In Section I, we explain the features of the retirement savings plan at the firm studied. Section II then describes the data used in our analysis. We begin our empirical analysis in Section III by documenting the impact of automatic enrollment on several different observable plan outcomes. We then turn in Section IV to assessing the impact of automatic enrollment on asset accumulation, accounting for plan leakage and differences across cohorts in plan eligibility rules and the time path of asset returns. Section V concludes.

I. Features of the retirement savings plan studied

As noted earlier, the firm that we studied is a large U.S. Fortune 500 company in the financial services sector. Table 1 summarizes the relevant features of the retirement savings plan at this firm. The company adopted automatic enrollment for newly hired employees starting July 1, 2005. Prior to that date, eligible employees had to opt-in to participation in order to contribute to the plan. After the adoption of automatic enrollment, all newly hired employees were automatically enrolled in the plan at a default contribution rate of 2% directed into a pretax account and invested in a balanced

mutual fund unless they opted out of plan participation or chose a different contribution rate and/or asset allocation during a five-day opt-out period.

This firm also made a concurrent change in eligibility for plan participation on July 1, 2005. Prior to that date, employees had to accrue three months of continuous service and be scheduled to work at least 20 hours per week in order to participate in the plan. After that date, all newly hired employees were immediately eligible to participate in the plan and subject to automatic enrollment as described above; existing employees not already eligible to participate became eligible to participate on that date, but were not subject to automatic enrollment. This concurrent change in eligibility means that a simple comparison of savings outcomes for employees hired before versus after automatic enrollment will confound the effects of automatic enrollment and earlier eligibility. The eligibility effect is likely to be small for longer-term outcomes as the modal employee hired before automatic enrollment became eligible in his fourth month of tenure (see Appendix Figure 1). Nonetheless, in the analysis that follows in Section IV, we will adjust for the eligibility differences across these two cohorts so that we can measure the impact of automatic enrollment alone on savings outcomes.

While there were no other changes to the savings plan concurrent with the adoption of automatic enrollment, there were some additional changes to the plan that were implemented subsequent to the adoption of automatic enrollment and within the several year time period that we studied. Before January 1, 2006, employees could contribute up to 50% of their pre-tax compensation to the savings plan, subject to IRS dollar contribution limits. After January 1, 2006, the company increased its contribution limit so that employees could contribute up to 75% of their pre-tax compensation, also subject to IRS dollar contribution limits. Employees aged 50 and older could make additional "catch-up" contributions, subject to an IRS catch-up contribution limit, although they were subject to the same firm-imposed limits on the fraction of pay that could be contributed as younger employees. None of these contribution limits—the firm-specific limit

on the fraction of pay that could be contributed to the plan and neither the IRS regular contribution limit or the IRS catch-up contribution limit—are particularly relevant. Only 1% of the person-year observations for the hire cohorts that are the subject of our analysis have annual employee contributions at the IRS dollar contribution limits, and less than 0.2% have a contribution rate of 50% or higher. The firm also added a contribution escalation option on August 1, 2006. With this feature, employees could elect in advance to have a contribution rate increase take effect on January 1 of each calendar year. Employees had to actively opt-in to benefit from contribution escalation, as enrollment in this option was not automatic. Finally, the plan changed its investment lineup in December 2010. Existing balances invested in certain lifecycle and other mutual funds, including the automatic enrollment default investment fund, were mapped to one of 12 lifecycle funds according to the participant age unless participants actively chose a different allocation for their investments.

In addition to the employee's own contributions to the plan, the firm provided an employer match of 100% of the employees' contributions up to 4% of pay for participants who attained at least one full year of tenure and logged at least 1,000 hours of work. These matching contributions were invested in the firm's Employee Stock Ownership Plan (ESOP), with dividends reinvested in the ESOP unless the employee actively opted out of dividend reinvestment. Employer matching contributions vested immediately throughout the time period that we studied. Note that the automatic enrollment default contribution rate of 2% is below the 4% maximum contribution rate for which employees are eligible to receive an employer match.

Participants who were actively employed at the firm could tap into their plan balances by taking out a plan loan subject to a maximum limit of two outstanding loans at any time. The minimum amount that an employee could borrow was $1,000, and the maximum amount that an employee could borrow was the lesser of 50% of a participant's account balance and $50,000 minus any outstanding loan balance. Loans for a primary residence

could have a maturity of up to 180 months, while the maturity for all other loans was capped at 60 months. The loan interest rate was fixed over the duration of the loan at 1% above the prime interest rate as reported in the *Wall Street Journal* on the first business day of the month in which the loan application was made.

Depending on their circumstances, participants could potentially also tap into their plan balances through an in-service withdrawal, a hardship withdrawal, a cash distribution, or a rollover distribution. Participants still actively employed and age 59½ or older could take an in-service withdrawal in any amount up to their plan balance for any reason with no penalties. Actively employed participants younger than age 59½ could take a hardship withdrawal to cover expenses related to a primary residence, post-secondary education, outstanding medical bills, or funeral costs. Such a withdrawal could be no less than $500 and no greater than the sum of the stated hardship need plus withholding taxes upon withdrawal. Before taking a hardship withdrawal, however, participants had to first take advantage of the plan loan option and exhaust any after-tax or rollover balances in the plan, which they could access for any reason. Participants who took a hardship withdrawal were not allowed to make additional contributions to the plan for six months following the withdrawal.

Employees who separated from the company could take their balances out of the plan as a cash distribution at any time subsequent to their separation and for any reason, or roll their balances into another qualified plan or IRA.[1] Additionally, separated employees whose balances exceeded $5,000 had the option of retaining their balances in the plan. Separated employees with a balance of less than $1,000 were subject to a mandatory cash distribution unless they opted to roll over the balance into an IRA or another qualified plan. Separated employees with a balance greater than $1,000 but less than $5,000 had their balance automatically rolled over into an IRA unless they elected to roll over the balance into another qualified plan or to receive a cash distribution.

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[1]   We refer to a termination of employment for any reason (voluntary or involuntary) as a separation.

Per IRS regulations, 20% of the taxable amount of any cash withdrawal was automatically withheld for federal tax purposes. Additionally, actively employed participants and separated employees under the age of 59½ were subject to a 10% early withdrawal penalty on the cash amount withdrawn from before-tax accounts. This 10% penalty did not apply to ESOP dividends that participants elected to receive as cash distributions, withdrawals used to pay tax-deductible medical expenses, or in certain other limited circumstances. This 10% penalty also did not apply to funds withdrawn by separated participants at least 55 years of age.

II. Data

To examine the extent to which retirement plan leakage offsets the increased savings that results from automatic enrollment, we analyzed employee-level data on a single client firm of a large U.S. benefits administrator. The data consist of a series of year-end cross sections containing demographic and employment-related information such as birth date, hire date, gender, and compensation, as well as savings plan information such as initial plan eligibility and participation dates, current participation status, and year-end measures for total balances, outstanding loans amounts, and asset allocation. We also have a monthly contribution rate history, as well as annual measures of contributions, withdrawals and loan payments. The data span calendar years 2005 through 2013.

Our analysis focuses on comparing savings outcomes for two cohorts of newly hired employees at the firm studied. The pre-automatic enrollment (pre-AE) cohort consists of employees hired in the year preceding the introduction of automatic enrollment—that is, from July 1, 2004, to June 30, 2005. The post-automatic enrollment (post-AE) cohort consists of employees hired in the year following the introduction of automatic enrollment—that is, from July 1, 2005, to June 30, 2006. Because most of our data come from cross-sectional year-end snapshots, individuals in the pre-AE cohort have tenures ranging from 6-17 months at year-end 2005, as do the post-AE cohort at year-end 2006. In our analysis, we will, for the sake of parsimony, label both of these cohorts as having tenure of one year at these respective points in time,

although in fact each cohort will have individuals with tenures ranging from 6-17 months (one year on average). We follow a similar convention for subsequent levels of tenure up through eight years. The final observation for the pre-AE cohort in our analysis comes from year-end 2012, when this cohort has 90-101 months of tenure, while for the post-AE cohort, that comes from year-end 2013, when these employees are at a similar level of tenure (see Appendix Table 1 for the precise tenure levels of both cohorts at each year-end spanned by our data).

Our primary outcome variable of interest is the ratio of savings plan balances to starting pay. However, our year-end snapshots only contain salary information for individuals who are employed on the snapshot date. Because of this, we exclude from our sample employees who were hired during the relevant date ranges for our two hire cohorts, but who were not still employed at the firm on the snapshot date corresponding to tenure of one year as defined above and in Appendix Table 1 (12/31/2005 for the pre-AE cohort and 12/31/2006 for the post-AE cohort). Because turnover rates at this company are quite high, this selection criterion excludes 45% of the pre-AE cohort and 44% of the post-AE cohort. We additionally exclude any individuals employed at the tenure year one snapshot date whose salary information is missing for some reason other than non-employment; this restriction reduces our sample by an additional 3%. Finally, we also exclude employees who rolled balances into the plan because, in our data, we cannot easily identify whether withdrawals from the plan come out of rolled-in balances or from contributions made to plan. The possibility of taking withdrawals from rolled-in balances has the potential to generate extreme outliers in our measures of leakage, which, like plan balances, we normalized by starting pay. This further reduces our sample by an additional 3% for both cohorts. Our final sample includes 14,883 employees, 7,347 in the pre-AE cohort and 7,536 in the post-AE cohort.

In our analysis, when we refer to "all hires," we mean everyone meeting the sample selection criteria as described above. This sample is fixed over time. We will at times also examine different subgroups that deserve mention. One is the subgroup of employees

who have been continuously employed at the firm through a given observation date. Because of employee turnover, the composition of this sample changes and the sample size falls over time. We refer to this subgroup as the "continuously employed." Another subgroup is employees who have separated from the firm. As with the continuously employed, the composition of this sample changes and in this case the sample size increases over time. For some outcomes, our analysis will also be restricted to savings plan participants.

Because we will follow both hire cohorts over time, Figure 1 shows the fraction of each cohort still employed at the firm by tenure (as defined in Appendix Table 1), conditional on being observed at the one year of tenure snapshot date for each cohort. Note that the retention rates are fairly similar over time for both cohorts, with approximately 15% of both cohorts still employed at the firm approximately eight years after hire. Appendix Figure 2 disaggregates cohort retention rates by starting salary quartile (see Appendix Table 2 for the average salary within each quartile for the pre- and post-AE cohorts). Within each quartile, the pre- and post-AE cohorts have similar retention rates over time; the retention rates for both hire cohorts, however, increase with starting salary quartile.

Slightly less than one-fifth of the employees who separate are subsequently rehired by this firm during the eight-year period that we study; this fraction is similar for both cohorts. In the parts of our analysis that restrict the sample to those continuously employed through a given level of tenure, we exclude any years of employment corresponding to a rehire following separation; that is, we treat a separation as terminal when it happens. This maintains comparability between the employees who separated and were subsequently hired at other firms (where we do not observe what happens), and employees who separate and were subsequently rehired at the firm studied (where we do observe what happens). For this latter group, we ignore the information we have following their rehire and treat them as if the rehire did not happen (alternatively, we treat them as if they had been hired at a different firm).

Table 2 reports summary statistics for the pre- and post-AE cohorts for a number of different variables, as well as p-values from tests comparing those means. Both groups of employees are very similar in terms of gender, age at hire, and average starting salary, with no statistically significant differences for any of these variables. Approximately two-thirds of each cohort is female, both cohorts have an average age at hire of approximately 31, and the average annualized starting salary is around $28,000 (deflated to 2004 dollars using growth in seasonally adjusted average weekly earnings for private sector workers from the Current Employment Statistics survey). The distribution of salaries within cohorts is also similar. Table 2 shows the average annualized salary, by salary quartile, for both cohorts at their first year of tenure. Within quartile, the deflated salaries are very similar for both cohorts. Appendix Figure 3 shows the full distribution of annualized starting salaries for the pre- and post-AE cohorts. Once again, the full distribution of salaries appears similar across cohorts.

One potential concern with our empirical approach of comparing two different year-long hire cohorts at fixed points in time is that if hiring patterns over the course of the year are not similar for both cohorts, comparisons across cohorts could be biased. Appendix Figure 4 shows the cumulative distribution of the fraction of employees hired across months-of-the-year for the pre-AE and post-AE hire cohorts. These distributions are very similar, reducing concerns that our timing conventions for measuring outcomes bias our comparisons across cohorts. A second concern is that the impact of automatic enrollment on savings outcomes may be confounded by calendar time effects as there is an almost two-year difference in the hire dates of the first members of the pre-AE cohort and the last members of the post-AE cohort. In particular, the stock market crash of 2008 and subsequent recovery impact members of both the pre- and post-AE cohorts, but at different levels in their respective tenures. To account for these calendar time effects, in Section IV of the paper, we apply the same time-path of asset returns to the contributions made by both cohorts to infer what balances would be had the cohorts faced the same asset return trajectories over time, a process that we describe in greater detail later in the paper.

III. The effect of automatic enrollment on savings outcomes

We begin our analysis by documenting the differences in savings plan outcomes that can be directly observed in our data for the pre- and post-AE cohorts.

Savings plan eligibility. As noted above in Section I, savings plan eligibility changed concurrently with the adoption of automatic enrollment on July 1, 2005. Prior to that time, employees had to accrue three months of continuous service and be scheduled to work at least 20 hours per week in order to participate in the plan. After that date, all newly hired employees were immediately eligible to participate in the plan; existing employees not already eligible to participate also became eligible on that date, but were not subject to automatic enrollment (Table 1). Consistent with this eligibility change, the pre-AE cohort becomes eligible for the plan 3.5 months after hire on average, while the post-AE cohorts becomes eligible for the plan almost immediately (see Table 2). Appendix Figure 1 shows the full distribution of time until eligibility for both cohorts. As expected, the vast majority of the post-AE cohort becomes eligible within one month of being hired. In contrast, the majority of the pre-AE cohort becomes eligible in their fourth month after being hired. The pre-AE cohort employees hired in April, May and June of 2005 all became eligible to participate July 1, 2005, and account for the mass of the pre-AE cohort that become eligible within three months of being hired. In Section IV, we will account for the differences in plan eligibility between the pre- and post-AE cohorts.

Savings plan participation. Consistent with previous research (Madrian and Shea, 2001; Choi, et al., 2002 and 2004; Beshears, et al., 2008; Clark, Utkus and Young, 2015), automatic enrollment substantially increases savings plan participation: 62.2% of the pre-AE cohort ever contributed to the savings plan during their tenure at the firm, while 98.3% of the post-AE cohort did. Of those in each cohort who ever contributed, the median member of the pre-AE cohort began participating 8 months after hire, while the median member of the post-AE cohort began participating immediately. At one year (eight years) of tenure, the pre-AE cohort

participation rate was 36.2% (86.6%), and the post-AE cohort participation rate was 96.0% (96.0%). Figure 2 shows the fraction of employees making a savings plan contribution in the previous calendar year by tenure for employees who have been continuously employed through the indicated level of tenure and who are eligible to participate in the savings plan. Using this metric of participation, we see that savings plan participation for the pre-AE cohort starts out low but increases steadily over the subsequent years. In contrast, the post-AE cohort has a relatively high and constant participation rate that hovers around 95% over the entire observation period. Although the participation rates of the two cohorts converge with tenure, the post-AE cohort participation rate exceeds that of the pre-AE cohort at all levels of tenure shown. The difference in the participation rates between the two cohorts is largest over the first three years of tenure.

Figure 2 also shows the relationship between tenure and savings plan participation for the pre- and post-AE cohorts stratified by starting salary quartile. The participation rate under automatic enrollment is high at all levels of tenure for all salary quartiles. In contrast, the participation rate for the pre-AE cohort at lower levels of tenure increases quite noticeably with salary quartile; the rate of increase in savings plan participation with respect to tenure in the first three years is also larger for the lower salary quartiles than for the higher salary quartiles. The net effect of these patterns is that the difference in the saving plan participation rate for the pre- versus post-AE cohorts at any level of tenure is typically largest for the lowest salary quartile and smallest for the highest salary quartile.

Savings plan contributions. Figure 3 shows the average employee contribution rate to the savings plan by tenure for employees who have been continuously employed through the indicated level of tenure and who are eligible to participate in the savings plan. This measure of contributions **is not** conditional on participation in the plan (that is, employees not contributing to the plan are counted in the average as having a contribution rate of 0). The average savings plan contribution rate is higher under automatic enrollment initially, an effect driven

by the substantially higher savings plan participation rate under automatic enrollment, but the pre-AE cohort average contribution rate converges to that of the post-AE cohort by around three years of tenure, after which the difference in the average contribution rates of the two cohorts is neither economically nor statistically significant. That the average contribution rate for the pre- and post-AE cohorts is virtually identical after three years of tenure while the savings plan participation rate is higher for the post-AE cohort at all levels of tenure implies that the average contribution rate conditional on participation is lower for the post-AE cohort than it is for the pre-AE cohort, a finding documented in the previous literature and that, at this firm, can be ascribed to employee persistence at the low automatic enrollment default contribution rate of 2% for the post-AE cohort.

As in Figure 2, Figure 3 also stratifies the relationship between tenure and the average savings plan contribution rate for the pre- and post-AE cohorts by starting salary quartiles. The highest starting salary quartile has a much higher average contribution rate at all levels of tenure and for both cohorts than the other three starting salary quartiles. For the top three salary quartiles, we see a similar convergence pattern in the average contribution rates of the pre- and post-AE cohorts over time. For the lowest salary quartile, however, the average employee contribution rate for the post-AE cohort exceeds that of the pre-AE cohort throughout. Appendix Figures 5 and 6 show the full distribution of contribution rates at selected levels of tenure (Appendix Figure 5) and by salary quartile (Appendix Figure 6). The primary difference between cohorts is the fraction of employees at the default contribution rate: 0% of salary for the pre-AE cohort and 2% of salary for the post-AE cohort. Automatic enrollment increases average contribution rates by increasing the contributions of employees who would not have participated in the plan in the absence of automatic enrollment; for these employees, the contribution rate increases from 0 (not participating in the plan) to 2% of pay (the automatic enrollment default). This effect is most pronounced at lower levels of tenure, when the gap in savings plan participation between the two cohorts is largest (Figure 2).

Savings plan balances. The measure of balances that we consider is the sum of before-tax, after-tax, Roth and employer match balances. Balances that were rolled into the plan from another employer's plan are excluded de facto by our sample exclusion criteria (see Section II). To be conservative, we also exclude outstanding loan amounts from our measure of plan balances. Because the distribution of balances is extremely skewed, we normalize balances by annualized starting salary (deflated to 2004 dollars). As shown in Figure 4, plan balances are higher by an amount equal to 7% of starting pay eight years after hire for the entire (all hires) post-AE cohort compared to the pre-AE cohort. Not surprisingly, this difference is even larger among the subset of employees who are continuously employed at the firm studied: about 17% of pay (Appendix Figure 7 stratifies these results by starting salary quartile). It is fairly easy to see in Figure 4 how differences in the tenure timing of asset market returns differentially impact the pre- and post-AE cohorts. The slopes of growth in plan balances from one tenure year to the next appear similar, but with a one tenure year lead for the pre-AE cohort relative to the post-AE cohort. In Section IV, we will account for the impact of the differential timing of asset returns on balances for these two cohorts, as well as for the effects of different forms of leakage.

Savings plan loans. The results discussed so far corroborate findings documented elsewhere in the literature. We turn now to the mechanisms by which participants can access plan balances before retirement (which have received much less attention), namely loans, which are made with the intent of being repaid over time, and various forms of "early" withdrawals (e.g., hardship withdrawals, cash distributions). We will examine each of these margins in turn, but begin with plan loans. Figures 5-8 compare different measures of loan utilization for the pre- and post-AE cohorts. As shown in Figure 5, the fraction of plan participants with an outstanding loan balance is initially low for both cohorts but increases with tenure in-line with loan utilization rates reported elsewhere (e.g., Beshears, et al., 2012, and Lu, et al., 2017). This increase in the loan utilization rate with respect to tenure makes sense: participants must first accrue balances in the plan before they can borrow

against them. At low levels of tenure, loan utilization rates are both low, and similar, for the pre- and post-AE cohorts. At higher levels of tenure (4+ years), however, loan utilization rates of the pre- and post-AE cohorts start to diverge, and the fraction of participants with a loan is higher for the post-AE cohort than for the pre-AE cohort. This suggests that the post-AE participants who are induced to save because of automatic enrollment may have a higher propensity to take out a savings plan loan than the participants who would have elected to save in the absence of automatic enrollment.[2]

An alternative measure of loan utilization is the fraction of employees who are participating in the savings plan but have no outstanding loan balance, a measure we call the non-loan participation rate. As shown in Figure 6, the non-loan participation rate is increasing for the pre-AE cohort through the fourth year of tenure (after which it levels out): more employees are joining the plan each year than are taking out a plan loan. In contrast, it is decreasing for the post-AE cohort: an increasing number of employees have a savings plan loan, while savings plan participation is essentially constant (Figure 2). Convergence in the non-loan participation rate (Figure 6) is much more rapid than convergence in the participation rate (Figure 2). Nonetheless, the non-loan participation rate is higher for the post-AE than for the pre-AE cohort at all levels of tenure.

Conditional on having a plan loan, the average outstanding loan amount as a fraction of total plan balances on both a participant-weighted and on a dollar-weighted basis is slightly higher (and statistically different) for the post-AE cohort than for the pre-AE cohort during the first three years of tenure (Figure 7), when very few members of either cohort have a loan (Figure 5), but is of a similar magnitude (and not statistically different) for both cohorts at higher levels of

tenure (see Appendix Figure 8 for the average number of loans outstanding conditional on having a loan). The ratio of loan balances to total plan balances for both cohorts is slightly higher than that reported elsewhere for other populations (e.g., Beshears, et al., 2012).

Because most savings plan participants do not have a loan outstanding at a given point in time (Figure 5), the outstanding loan amount as a fraction of total plan balances across *all* participants, both those with a loan and those without, is substantially lower (Figure 8) than when the sample is conditioned on having a loan as in Figure 7, and is generally increasing until plateauing at around six years of tenure, at which point loans represent around 4% of total plan balances on a dollar-weighted basis. In contrast to Figure 7, the outstanding loan amount averaged across all participants is similar for both the pre- and post-AE cohorts at all levels of tenure. The dollar-weighted measure of outstanding loan amounts as a fraction of total plan balances is somewhat lower than the person-weighted measure: individuals who borrow more relative to their total balances also tend to have lower balances.[3]

Savings plan withdrawals. Although loans are an important mechanism used by a sizeable fraction of plan participants to access their plan assets before retirement, the balances borrowed by plan participants are largely repaid over time; leakage through this channel largely occurs when a participant with an outstanding loan balance experiences a job termination (either voluntarily or involuntarily) and cannot repay the loan in full. As shown in Appendix Figure 9, the fraction of balances on which participants default never exceeds 12% (on a dollar-weighted basis) of the cumulative amount of plan loans ever taken and is similar for both cohorts.

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[2]   If post-AE participants who save because of automatic enrollment are more likely to take loans than post-AE participants who would have saved in the absence of automatic enrollment, one might expect post-AE participants who contribute at the default rate to have a higher loan utilization rate than post-AE participants who contribute at a non-default rate. However, at more than four years of tenure, the opposite is true. This difference is driven by the post-AE participants who contribute at a rate higher than the default, as contribution rates are positively associated with loan utilization rates. This finding does not contradict the claim because a contribution rate equal to the default rate does not necessarily imply that the employee is saving only because of automatic enrollment.

[3]   Part of this difference between the person-weighted and dollar-weighted measures could be mechanical. There is both a minimum loan amount, which is more likely to be binding for those with lower balances, and a maximum loan amount, which is more likely to be binding for those with higher balances.

The greater source of leakage from defined contribution retirement savings plans is through hardship withdrawals and pre-retirement cash distributions (GAO 2009). To examine the impact of automatic enrollment on savings plan withdrawals, we start by characterizing three different types of withdrawals. The first is *rollover withdrawals* (RWs), which occur when a participant directly transfers assets to another tax qualified savings plan (e.g., an IRA or another employer's defined contribution savings plan). Assets rolled over into another qualified plan do not trigger any tax liability for the plan participant and are not subject to the 10% tax penalty levied on some other types of withdrawals. More importantly, these assets stay within the retirement savings system. Assets can also be taken out of the plan in the form of a cash distribution that is not rolled over into another tax qualified savings plan. We categorize these as either *penalized non-rollover withdrawals* (P-NRWs) or *non-penalized non-rollover withdrawals* (NP-NRWs), depending on whether they are subject to the 10% early withdrawal tax penalty.[4]

In contrast to plan loans, which can only be taken by plan participants actively employed at the firm, withdrawals are primarily initiated by participants no longer employed at the firm, although there are some limited circumstances in which active employees may also make withdrawals from the plan (refer back to Section I). Figure 9a shows the fraction of each employee cohort (both actively employed and terminated employees) that participated in the savings plan and had a rollover, penalized non-rollover, or non-penalized non-rollover withdrawal in a given year of tenure. The fraction of participants with non-penalized non-rollover withdrawals (NP-NRWs) is low (<5%) at all levels of tenure, and similar for both the pre- and post-AE cohorts. In contrast, the fraction with penalized non-rollover withdrawals (P-NRWs) is much higher in all but the first year of tenure, ranging

from 10-20% of participants each year, and is much higher for the post-AE cohort than for the pre-AE cohort in tenure years 2-4. The fraction of participants with rollover withdrawals (RWs) lies between the other two withdrawal rates and is similar for both cohorts.

The likelihood of both penalized non-rollover withdrawals (P-NRWs) and rollover withdrawals (RWs) in Figure 9a follows a hump-shaped pattern over time, first increasing with tenure, then decreasing. This pattern is related to the timing of employee turnover at the firm and to the balances that departing employees have when they leave the firm. Rollover withdrawals occur when participating employees leave the firm and decide to move their balances to an IRA or another employer's savings plan. Because most employee turnover happens in the first few years of employment, the fraction of each employee cohort leaving employment and at risk of making a rollover withdrawal declines over time. Penalized non-rollover withdrawals largely happen when employees separate from employment and receive their balances as a cash distribution. When balances are low (<$1,000) at the time of separation, the firm can compel a (penalized) cash distribution; even when balances exceed $1,000 at separation, employees are more likely to take a (penalized) cash distribution when balances are low than when balances are high (Choi, et al., 2002). These facts help explain why the rate of penalized non-rollover withdrawals is so much higher for the post-AE cohort than for the pre-AE cohort at lower levels of tenure: the participants in the post-AE cohort have a lower average contribution rate (Figure 3), and thus tend to have lower average balances at separation (Figure 17, which we describe later). These lower balances at separation then generate a higher rate of penalized non-rollover withdrawals. Eventually, the balances of the post-AE cohort reach a high enough level that the rate of penalized non-rollover withdrawals is similar to that of the pre-AE cohort.

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[4]   Penalized non-rollover withdrawals (P-NRW) include penalized total distributions, loan settlements (e.g., loan balances that were not repaid), hardship withdrawals, and non-hardship, non-age-based withdrawals. Non-penalized non-rollover withdrawals (NP-NRW) include non-penalized total distributions, age-based withdrawals, refunds and ESOP dividends. For a list of the circumstances in which withdrawals are and are not subject to the 10% early withdrawal tax penalty, see the U.S. Internal Revenue Service web page "Retirement Topics–Exceptions to Tax on Early Distributions" https://www.irs.gov/retirement-plans/plan-participant-employee/retirement-topics-tax-on-early-distributions (accessed 01/11/2017).

Appendix Figure 10 replicates Figure 9a, stratified by starting salary quartile. The fraction of participants with penalized non-rollover withdrawals declines quite substantially with salary quartile, but the general patterns in Figure 9a hold for the first three salary quartiles. The highest salary quartile, however, is either more likely to have a rollover withdrawal than a penalized non-rollover withdrawal (at lower levels of tenure) or about equally likely (at higher levels of tenure).

The importance of employee separation as a driver of savings plan withdrawals can be seen by comparing Figures 9a (Appendix Figure 10) and 10a (Appendix Figure 12). In Figure 9a, the sample is all participating employees with plan activity in the previous calendar year, including those who have left the firm. In Figure 10a, we restrict the sample to participating employees with plan activity in the previous calendar year who are still actively employed at the firm at the end of the relevant observation period and who have been continuously employed until that time (Appendix Figure 12 stratifies Figure 10a by starting salary quartile). As can be seen, the rates of all three types of leakage are very low for this group of continuously employed individuals (overall, and for each salary quartile), and similar for both the pre- and post-AE cohorts.

Figures 9b and 10b provide a different way of calibrating the role of withdrawals for the pre- and post-AE cohorts by plotting the cumulative fraction of employees (whether or not they have participated in the savings plan) who have ever had each of the three different types of withdrawals (Appendix Figures 11 and 13 stratify Figures 9b and 10b by starting salary quartile). The cumulative fraction of each employee cohort with non-penalized non-rollover withdrawals (NP-NRWs) is fairly low and similar for both cohorts. The cumulative fraction of employees with rollover-withdrawals increases over time, and is higher for the post-AE cohort (by a relatively constant 6-7 percentage points after tenure year 3). The cumulative fraction of employees with penalized non-rollover withdrawals (P-NRWs) is even higher, and substantially higher for the post-AE cohort than for the pre-AE cohort, eventually reaching 55% in tenure year 8. The sizeable discrepancy in the fraction of individuals who have ever had a penalized non-rollover withdrawal for the pre- and

post-AE cohorts is driven in large part by the fact that the post-AE cohort has a much higher participation rate, and thus has more balances that can be withdrawn. However, the fact that such a high fraction of this cohort has ever had a withdrawal could certainly be viewed as problematic if the goal of automatic enrollment is to increase long-term retirement savings.

Figures 9 and 10 show the fraction of individuals who have had different types of plan withdrawals. To give a sense of the fraction of plan balances that are actually withdrawn by each cohort over time, in Figure 11 we divide the annual amount of each type of withdrawal by the sum of year-end plan balances and current year withdrawals (we use this measure to scale withdrawals because our data do not include a measure of mid-year balances at the time that mid-year plan withdrawals are made). We saw in Figure 9a that the most frequent type of withdrawal for both cohorts and at all levels of tenure is a penalized non-rollover withdrawal; averaged across all individuals, penalized non-rollover withdrawals are also the distribution type that represents the highest fraction of balances when averaged across individual participants (Figure 11a). On an aggregate, dollar-weighted basis, however, (non-penalized) rollover withdrawals represent the highest fraction of the assets being taken out of the plan (Figure 11b). In short, on a person-weighted basis, most withdrawals are penalized, while on a dollar-weighted basis, most are rollovers. This is consistent with the argument made earlier that individuals are more likely to take a penalized non-rollover withdrawal when balances are low and a (non-penalized) rollover withdrawal when balances are high. Although the rate of penalized non-rollover withdrawals is much lower on a dollar-weighted basis than it is on a person-weighted basis, it is still substantially higher for the post-AE cohort than for the pre-AE cohort at low levels of tenure. In Figure 12, we restrict the sample to those participants who have been continuously employed (as in Figure 10). Given the low fraction of continuously employed participants with withdrawals shown in Figure 10, it is not surprising that the fraction of balances taken out as withdrawals, on either a participant-weighted or dollar-weighted basis, is negligible for this group, well below 2% of balances in any given year for all measures of withdrawals.

Appendix Figures 14 and 15 stratify Figures 11a and 11b by starting salary quartile. Within a given starting salary quartile, the person-weighted fraction of participants with different types of withdrawals (Appendix Figure 10) and the person-weighted fraction of balances accounted for by different types of withdrawals (Appendix Figure 14) are very similar, although the dollar-weighted fraction of balances accounted for by withdrawals is much lower (Appendix Figure 15), once again consistent with the idea that individuals taking withdrawals tends to have lower plan balances. In general, withdrawals taken by participants with lower starting salaries tend to be penalized, while withdrawals taken by participants with higher starting salaries tend to be rollovers. Appendix Figures 16 and 17 stratify Figures 12a and 12b (those who are continuously employees) by starting salary quartile. As with Figures 12a and 12b, the person-weighted and dollar-weighted fraction of plan balances taken as withdrawals for those who are continually employed is extremely small for all withdrawal types and for all salary quartiles.

Appendix Figures 18-21 disaggregate the withdrawals as a fraction of plan balances shown in Figures 11 and 12 into more granular withdrawal categories. When looking at all hires (Appendix Figures 18 and 19), the largest category of withdrawals is penalized withdrawals that occur when individuals take a total distribution of balances at separation; consistent with evidence presented already, the rate of penalized total distributions is much higher for the post-AE cohort than for the pre-AE cohort. The second largest category of withdrawals is (non-penalized) rollover withdrawals, which occur at similar rates for the pre- and post-AE cohorts. Several other types of withdrawals each contribute a small amount to the remaining fraction of overall withdrawals. For the subsample of those who are continuously employed (Appendix Figures 20 and 21) for which overall withdrawal rates are much lower, the composition of withdrawals is very different. The two largest withdrawal categories for this subgroup are hardship withdrawals and age-based withdrawals (in-

service withdrawals taken by employees older than age 59½). In some years, we also see refunds that result from the plan failing IRS non-discriminations tests. These refunds, made to highly compensated employees (HCEs), are made to bring the plan into compliance so that employee contributions for the plan as a whole receive favorable tax treatment.[5]

IV. Measuring the impact of leakage on retirement wealth using contribution-inferred balances

We have thus far documented the impact of automatic enrollment on the savings plan outcomes directly observable in the data for the plan that we studied. We turn now to our primary question of interest: assessing the impact of automatic enrollment on retirement system balances over time accounting for both leakage out of the retirement system and for the fact that balances rolled into another employer's plan or an IRA remain in the system. To do so, there are several complications that we need to address:

1. At the firm studied, a change in plan eligibility was implemented concurrent with the adoption of automatic enrollment

2. Asset market returns varied widely over time during our observation period, and impacted the pre- and post-AE cohorts at different points in their employment tenure

3. We do not observe the disposition of plan balances after a withdrawal

We address these issues by using contributions to the plan and flows out of the plan to construct projected measures of 401(k) and retirement system balances under a single set of assumptions about eligibility and asset returns over tenure time. We refer to the outcomes that we calculate using this approach as *contribution-inferred balances*.

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[5]   Because the plan failed IRS non-discrimination tests in 2007 and 2008, refunds of some contributions were given to highly compensated employees to bring the plan into compliance. As a result, we see an increase in non-penalized withdrawals in the third and fourth years of tenure for the pre-AE cohort, and the second and third years of tenure in the post-AE cohort. It is likely that the adoption of automatic enrollment decreased the need to make non-discrimination testing refunds by increasing the participation of non-highly compensated employees.

One benefit of this approach is that we can account for the change in plan eligibility rules by excluding contributions made by members of the post-AE cohort at a point in their tenure when a member of the pre-AE cohort hired one year earlier was not eligible to participate. We begin by using each employee's monthly contribution rate history as the basis for building our measure of contribution-inferred balances. As noted earlier, prior to July 1, 2005, when automatic enrollment was adopted, employees scheduled to work at least 20 hours per week became eligible to contribute to the plan on the first of the month following three full months of continuous service. As of July 1, 2005, all employees were immediately eligible to contribute to the plan. To separate the impact of automatic enrollment on savings plan balances from the impact of differential eligibility, we "equalize" eligibility by setting the contribution rate of employees in both cohorts to 0 until employees have reached tenure month 4 if hired in the first 9 months of their cohort (July through March), or by setting the contribution rate in the months before July of the year of hire equal to 0 for employees hired in April through June.

We apply this eligibility-adjusted history of monthly contribution rates to the calendar-year salary observed for each employee to derive a monthly employee contribution amount, multiplying annual salary by each monthly contribution rate and then dividing by 12. For employees who separate, we do not observe salary during the year of termination; for these employees, we use the previous calendar year's salary to calculate contribution amounts during the year of separation. We impute employer match contributions by applying the match formula of 100% on the first 4% of the employee's own contributions. Per the plan's rules, employees do not begin accruing the employer match in either cohort until they have been employed for twelve full calendar months.

We then grow the employer and employee contributions over the entire duration of our observation period at a return that is fixed across cohorts. While both cohorts have experienced the sharp drop and recovery in asset prices associated with the global financial crisis by later years of tenure, a given contribution made during the market peak will have a smaller impact on future balances than the same contribution made during the market's trough. To equalize the impact of asset returns on both cohorts, we apply a constant time series of monthly returns for the pre-AE cohort to the contributions of both the pre-AE and post-AE cohorts.[6] We use the returns on an age-appropriate lifecycle fund for employee contributions and the firm's stock return for employer contributions as the match was made in the form of employer stock. For example, we assume pre-AE cohort employee contributions made in January 2007 and post-AE cohort employee contributions made in January 2008 both grow at the rate of the January 2007 returns of an age-appropriate lifecycle fund. This gives us a measure of *contribution-inferred potential plan balances* at each level of tenure that is calculated on an equivalent basis for both the pre- and post-AE cohorts. It tells us what plan balances would have been for the pre- and post-AE cohorts if they had faced the same eligibility criteria, the same time series of asset returns, and if there had been no loans or withdrawals from the plan.

Accounting for the impact of leakage relative to our measure of contribution-inferred potential plan balances is somewhat more complicated. While we observe the value of withdrawals when they occur, these withdrawal amounts will be confounded by the differences in the timing of asset returns across cohorts discussed above. The observed value of a withdrawal made at a particular point in time will also not reflect its impact on retirement system balances at future points in tenure time as our measure of contribution-inferred balances changes over time with asset returns, while the observed values of withdrawals are static, point-in-time measures.

Our approach to accounting for leakage is to construct an employee-specific leakage rate that we can then apply to our measure of contribution-inferred potential plan balances. Because balances can leave the plan different ways which differentially impact the resources available at retirement, we consider three different measures of leakage, which we denote L1, L2 and L3.

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[6]   Differences between the two cohorts are larger by eight years after hire if we use the time series of returns for the post-AE cohort.

Included in leakage measure			
Measure of leakage	Rollover withdrawals	Outstanding loan balances	Non-rollover withdrawals (penalized and non-penalized)
L1	Yes	Yes	Yes
L2	No	Yes	Yes
L3	No	No	Yes

Non-rollover withdrawals (both penalized and non-penalized) are classified as leakage under all three measures. These are withdrawals that are primarily used for consumption and thus represent a reduction in the assets available for retirement. L2 additionally includes outstanding loan balances as leakage. The extent to which loans represent a reduction in the assets available for retirement depends on whether or not the loans are eventually repaid. In our data, employees who take out a plan loan default on less than 12% of loan balances during the time period over which we observe them; stated differently, more than 88% of loan balances are repaid (Appendix Figure 9). The true measure of the proportionate reduction in assets available for retirement due to non-rollover withdrawals and loans is likely somewhere between the L2 and L3 leakage rates; we present both measures to provide an upper and lower bound. The most expansive definition of leakage, L1, also includes rollover withdrawals. Rollover withdrawals remain in the retirement system, and thus do not represent a reduction in assets available for retirement, but they do reflect a reduction in the asset within the plan.

To calculate these three leakage rates, we first construct a projected future value of withdrawn balances by growing withdrawals at the rate of an age-appropriate lifecycle fund from the date each withdrawal was taken through all relevant future tenure year observation dates.[7] We then add up the projected future value of all withdrawals to calculate the *cumulative projected value of withdrawals* over time. This measure will be the numerator in our rollover and non-rollover leakage rates. Figures 13a and 13c show the cumulative projected

value of rollover and non-rollover withdrawals as a fraction of starting pay, respectively, for all hires, and for the subset of those continuously employed through each observation date, for both the pre- and post-AE cohorts. For the sake of completeness, Figure 13b shows outstanding loan balances relative to starting pay for the continuously employed. As expected, rollover withdrawals are negligible as a fraction of starting pay for the continuously employed subsample. They matter much more when we consider all hires, accounting for 4.5% of starting pay after 8 years for the pre-AE cohort and 6.8% of starting pay after 8 years for the post-AE cohort. Non-rollover withdrawals matter more than rollover withdrawals for the subsample of the continuously employed, although their impact is still small, accounting for 1% of starting pay for the pre-AE cohort and 1.8% of starting pay for the post-AE cohort. When we look at all hires, non-rollover withdrawals are larger than rollover withdrawals for the post-AE cohort, at 7.8% of starting pay, while they are smaller than rollover withdrawals for the pre-AE cohort, at 3.7% of starting pay. Outstanding loan balances are low relative to average starting pay at lower levels of tenure for those continuously employed, when the likelihood of having an outstanding loan is small (Figure 5), and similar for both the pre- and post-AE cohorts. As tenure increases beyond three years, loan balances relative to pay also increase, at an increasing rate, more so for the post-AE cohort than for the pre-AE cohort. By tenure year 8, outstanding loan balances as a fraction of starting pay are 1.5 percentage points (35%) higher for the post-AE cohort than for the pre-AE cohort.

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[7]   We assign participants to one of the five lifecycle funds whose inception dates preceded the pre-AE cohort among the set of twelve lifecycle funds to which balances in the default investment option were mapped in December 2010. Because we know the date on which balances are withdrawn from the plan, we use daily returns after this date to impute the future value of withdrawn balances. All returns are adjusted for dividends.

As the denominator for our rollover, non-rollover and loan leakage rates, we use a measure of *withdrawal-adjusted balances*, which we define as the sum of actual plan balances, actual outstanding loan balances, and the cumulative projected value of rollover and non-rollover withdrawals at each level of tenure. The rollover and non-rollover leakage rates are then calculated by dividing our measures of the cumulative projected value of rollover and non-rollover withdrawals by our measure of withdrawal-adjusted balances, while the loan leakage rate is computed as actual outstanding loan balances at each level of tenure divided by withdrawal-adjusted balances. Using these cumulative rollover, non-rollover, and loan leakage rates, we then calculate the three aggregated leakage rates defined earlier as follows:

L1: cumulative rollover + cumulative non-rollover + loan leakage rates

L2: cumulative non-rollover + loan leakage rates

L3: cumulative non-rollover leakage rate.

Note that these leakage rates are undefined for those employees who are never observed with any 401(k) balances.

Figures 14a and 14b plot the person-weighted L1, L2 and L3 leakage rates for all hires and for the continuously employed subsample, respectively, for the pre- and post-AE cohorts. When we look at all hires, all three of the L1, L2 and L3 leakage rates are high (exceeding one-third at eight years of tenure) for both the pre- and post-AE cohorts. There are also significant differences across the pre- and post-AE cohorts, and across the three different measures of leakage. The L2 and L3 measures of leakage are similar for both the pre- and post-AE cohorts (the difference between the two is around 2% of withdrawal-adjusted balances for both cohorts), reflecting the fact that loans, which constitute the difference between L2 and L3, are not relevant for the large fraction of all hires that have separated from the firm. There is, however, a sizeable difference between the L1 and L2 measures of leakage for both the pre- and post-AE cohorts, on the order of one-quarter of withdrawal-adjusted balances (slightly larger for the pre-AE cohort and slightly smaller for the post-AE cohort),

reflecting the importance of rollover withdrawals, the difference between the L1 and L2 measures of leakage. The difference in the L1, L2 and L3 leakage rates across the pre- and post-AE cohorts at eight years of tenure is 9.0%, 12.8%, and 13.3% of withdrawal-adjusted balances, respectively. Appendix Figure 22 shows the cumulative L1, L2 and L3 leakage rates stratified by starting salary quartile for all hires. All three of these leakage rates decline quite substantially with starting salary, as do their differences across the pre- and post-AE cohorts. In contrast, the differences between L1 and L2 increase significantly with starting salary, while the differences between L2 and L3 are small for all salary quartiles.

Because there are many low-tenure employees who take total distributions of small balances upon separation, we also show these leakage rates on a dollar-weighted basis in Figure 15 (and Appendix Figure 24). The dollar-weighted leakage rates for all hires are much lower than the person-weighted rates, never exceeding 33% of withdrawal-adjusted balances. The difference in L1 between the pre- and post-AE cohorts is also substantially smaller, with a difference of only 3% of dollar-weighted withdrawal-adjusted balances at eight years of tenure, relative to the 9% person-weighted difference.

When we look at the subsample of those continuously employed in Figures 14b and 15b (Appendix Figures 23 and 25), we see first that the leakage rates are much lower than for all hires, never exceeding 10% of withdrawal-adjusted balances on a person-weighted basis, or 7% on a dollar-weighted basis. We also see that there is little difference between the L1 and L2 measures of leakage on either a person- or dollar-weighted basis, reflecting the fact that rollover withdrawals, the difference between L1 and L2, are precluded for most of those who are employed (the exception is for older individuals eligible to make age-based withdrawals). In contrast, there is a large difference between the L2 and L3 leakage rates, reflecting the fact that loans, the difference between L2 and L3, matter much more for those who are employed than for the full sample of all hires, which includes many separated employees, especially at higher levels of

tenure. At eight years of tenure, the difference between L2 and L3 is 6% of withdrawal-adjusted balances for the pre-AE cohort and 7% for the post-AE cohort. L1 and L2 leakage rates are 2% higher for the post-AE cohort than for the pre-AE cohort at eight years of tenure, while L3 leakage rates are 1% higher. When we look at dollar-weighted differences in Figure 15b, these differences between the pre- and post-AE cohorts almost completely disappear, suggesting that the differences across-cohorts in Figure 14b are driven by differences in the distribution of leakage rates across the pre- and post-AE cohorts.

Part of the differences between the L1 and L2 leakage rates for the pre- and post-AE all hire cohorts (Figures 14a and 15a) are mediated by the plan's rules governing distributions at separation (see Section I). While our data do not include a measure of balances at the time of separation (if a separation occurs), we can impute balances at separation using actual balances from the year-end prior to separation and contribution flows that occur in the year of separation. First, we assume that balances measured at the year-end prior to separation grow at the rate of an age-appropriate lifecycle fund through the date of separation. To this measure of balances, we add a measure of contribution-inferred balances that reflects the value at the time of separation of employee and employer matching contributions made during the year of separation (following the approach described earlier for our calculation of contribution-inferred balances). From this amount, we then subtract the cumulative projected value at separation of any rollover and non-rollover withdrawals taken in the year of separation prior to the date of separation (following the approach described earlier for our calculation of the cumulative projected value of withdrawals). This gives us an imputed measure of balances at separation.

In Figure 16, we bucket separating employees into four categories relevant to asset preservation on the basis of their imputed balances at separation: those with balances of $0; those with balances greater than $0 but less than $1,000 (for whom the default treatment of

balances at separation is a cash distribution); those with balances greater than $1,000 but less than $5,000 (for whom the default treatment of balances at separation is an IRA rollover); and those with balances greater than $5,000 (for whom balances will remain in the plan by default). At lower levels of tenure at separation, automatic enrollment shifts employees from having no balances at separation to having positive balances less than $1,000, and from having positive balances less than $1,000 at separation to having balances greater than $1,000 but less than $5,000. These differences persist for separations that occur well after hire. At higher levels of tenure at separation, we see a shift away from employees having positive balances at separation of less than $5,000 under automatic enrollment and toward having balances at separation of more than $5,000.

To see how the default distribution rules differentially impact the pre- and post-AE cohorts, we classify separating participants as either preserving assets after separation or not. If separating participants continue to have assets in the plan at the end of the calendar year after the year in which a separation occurred, or if they have taken a rollover withdrawal between their separation and the year-end subsequent to their year of separation, we categorize them as having preserved assets post-separation.[8] In Figure 17a, we categorize separating participants by the imputed size of their balances at separation. The pre-AE cohort is more likely to preserve assets post-separation for all three categories of balances at separation. The largest difference in asset preservation—7 percentage points—is among employees with positive balances at separation of less than $1,000, where the default option is a compelled cash distribution (which is not asset preserving).

Figure 17b shows the fraction of separating employees who preserve assets specifically by keeping their balances in the plan. Comparing Figures 17a and 17b shows that one-half of the asset preservation among separated participants who have the option to keep balances in the plan (those with imputed balances at

separation of at least $5,000) comes from doing just that—keeping balances in the plan (which is the default for these separated participants). For participants with a lower level of imputed balances at separation, the primary form of asset preservation upon separation is through rollovers, as participants are not allowed to keep their balances in the plan following separation if the balances are less than $5,000. (We attribute the small faction of separating participants in Figure 18b with imputed balances of less than $5000 who keep their balances in the plan to measurement error in our estimate of imputed balances at separation.)

Taken together, the narrative suggested by Figures 14-17 is that leakage rates are higher for the post-AE cohort than for the pre-AE cohort (Figure 14), and that the vast majority of plan leakage among both cohorts can be attributed to separating employees. Conditional on imputed balances at separation, employees in the pre- and post-AE cohorts are equally likely to keep balances in the plan post separation, but those in the pre-AE cohort are more likely to roll balances over into another plan and are thus more likely to preserve assets post-separation. However, those in the post-AE cohort have higher balances at separation, and asset preservation increases substantially with the size of imputed balances at separation (Figure 17). Automatic enrollment thus has two opposing effects on the preservation of retirement assets following separation: conditional on balances at separation, leakage rates are higher post-AE, which works to reduce retirement system balances, but automatic enrollment also increases the balances that employees have at separation, which tends to reduce leakage.

To gauge the total impact of automatic enrollment retirement savings, we need to account for both the higher balances accrued under automatic enrollment and the higher rate of leakage. To do this, we compare four different measures of imputed balances for the pre- and post-AE cohorts:

- *Contribution-inferred potential plan balances*: As described earlier, this is the projected value of plan balances under a common set of assumptions regarding plan eligibility and asset returns over time

for both cohorts and assuming there are no loans or withdrawals from the plan.

- *Contribution-inferred retirement system balances (including loans)*: This measure adds to contribution-inferred plan balances the cumulative projected value of rollover withdrawals plus the imputed value of outstanding loans (calculated as contribution-inferred potential plan balances multiplied by (1-L3)). Outstanding loan balances are treated as if they will be repaid and remain in the retirement savings system.

- *Contribution-inferred retirement system balances (excluding loans)*: This measure adds to contribution-inferred plan balances the cumulative projected value of rollover withdrawals (calculated as contribution-inferred potential plan balances multiplied by (1-L2)). Outstanding loan balances are treated in the same way as non-rollover withdrawals.

- *Contribution-inferred plan balances*: Contribution-inferred potential plan balances net of the cumulative projected value of rollover and non-rollover withdrawals and loans (calculated as contribution-inferred potential plan balances multiplied by (1-L1)).

Figure 18 shows the evolution of these different balance measures over time for the pre- and post-AE cohorts of all hires and for the subsample of the continuously employed. Table 3 shows the value of these measures at selected levels of tenure. In both Figure 18 and Table 3, we normalize these measures of contribution-inferred balances by starting pay.

One way to assess the impact of our approach to calculating contribution-inferred balances is to compare the contribution-inferred measure of plan balances relative to starting pay in Figure 18d with ratio of actual plan balances to starting pay in Figure 4. One clear difference is that our measures of contribution-inferred plan balances for the pre- and post-AE cohorts have very similar slopes between any two tenure years, whereas the measures of actual plan balances relative to pay have slopes between any two tenure years that are out of synch because calendar time asset returns are

experienced by the pre- and post-AE cohorts at different points in tenure time. This difference is by design as our contribution-inferred methodology fixes asset returns experienced by each cohort at any given tenure time. Another difference is that the gap in balances as a fraction of pay between the pre- and post-AE cohorts is much less variable over time for the contribution-inferred measure of plan balances relative to pay than for actual plan balances relative to pay. Finally, the differences in balances relative to pay between the pre- and post-AE cohorts at higher levels of tenure is much smaller for our contribution-inferred measure of plan balances to pay than for actual plan balances to pay. At eight years of tenure, actual plan balances for the post-AE cohort of the continuously employed are higher by an amount equal to 17% starting pay; in contrast, contribution-inferred plan balances for the post-AE, continually employed cohort are higher by only 4% of starting pay. This smaller difference reflects two factors. First, the eligibility changes that we account for in constructing our measure of contribution-inferred balances excludes up to four months of contributions for the post-AE cohorts, reducing their accumulation relative to the pre-AE cohort. Second, the post-AE cohort experiences the financial crisis at a lower level of tenure than does the pre-AE cohort. Our approach to constructing contribution-inferred balances applies the same pre-AE time sequence of asset returns to both cohorts, delaying in tenure time the contributions made by the post-AE cohort that experience high market returns as the economy recovers from the stock market crash of 2008, and compressing the differences in asset accumulation across cohorts.

Comparing our different measures of contribution-inferred balances in Figure 18, we see that all of the measures of contribution-inferred balances are higher for the post-AE cohort than for the pre-AE cohort. As one might expect, the largest differences are for potential plan balances (which do not account for leakage), which are higher for the post-AE cohort of all hires by 7.3% of starting pay at eight years of tenure. The difference in contribution-inferred plan balances between the pre- and post-AE cohorts is much smaller, at 3.4% of starting pay for all hires at eight years of tenure, reflecting the fact that loans and withdrawals drive a wedge between

potential balances and what actually remains in the plan, and that this wedge is larger for the post-AE cohort. But some plan withdrawals do not reflect leakage from the retirement system as a whole, just leakage from the plan. So if our interest is in retirement system balances rather than just plan balances, a better metric would be our measures of contribution-inferred retirement system balances, which includes the cumulative projected value of rollover withdrawals. If we include loans in our measure of retirement system balances, they are higher by 4.6% of starting pay for the post-AE cohort of all hires; if we exclude loans from our measure of retirement system balances, they are higher by a slightly smaller 4.2% of starting pay.

Table 4 shows the proportionate change in contribution-inferred retirement system and plan balances relative to our measure of contribution-inferred potential plan balances. The *Pre-* and *Post-AE* rows in Table 4 use the numbers in Table 3 to calculate the fraction of potential plan balances that are "lost" to either the retirement system or to the plan due to loans and withdrawals (e.g., the 5.7% in the first cell in Table 4 is calculated as (5.3-4.99)/4.99 taken from the pre-AE *Potential Plan Balances* and *Retirement System Balances (incl. loans)* rows in Table 3). The *Difference* rows measure the extent to which loans and withdrawals offset the potential increases in savings generated by automatic enrollment. A value of 0 indicates that all of the increases in contribution-inferred potential plan balances generated by automatic enrollment are retained as increased saving (this does not imply that there is no leakage, just that there is no incremental leakage from the increased balances induced by automatic enrollment), whereas a value of 1 indicates that all of increased savings generated by automatic enrollment are offset by an increase in leakage. Numbers between 0 and 1 measure the share of the automatic-enrollment induced increase in contribution-inferred potential plan balances that are offset by increased leakage for the post-AE cohort.

Relative to the level of contribution-inferred potential plan balances, non-rollover withdrawals decrease contribution-inferred retirement system balances by 13.0% for the pre-AE cohort of all hires at eight years of tenure (first

row of Table 4), and by a somewhat larger 17.8% for the post-AE cohort (second row of Table 4). The higher rate of non-rollover withdrawals for the post-AE cohort reduces the potential savings gains of automatic enrollment at eight years of tenure by 36.0% (third row of Table 4). If we exclude loans from our measure of retirement system balances, all of these numbers increase: non-rollover withdrawals decrease potential balances by 16.9% for the pre-AE cohort and by a higher 22.1% for the post-AE cohort, reducing the potential savings gains of automatic enrollment by 41.6%.

If we look at our continuously employed subsample in the bottom of panel of Table 4, non-rollover withdrawals offset 9.1% of the potential savings gains of automatic enrollment at eight years of tenure (relative to the 36% offset for the all hires sample), while the combination of non-rollover withdrawals and loans offset 27.4% of the potential savings gains of automatic enrollment. Which of these very different offset measures is a more accurate reflection of the extent to which incremental leakage for the post-AE cohort offsets some of the savings gains of automatic enrollment depends on the extent to which loans are repaid. As noted earlier, the data from this firm suggests that almost 90% of loan balances are eventually repaid (Appendix Figure 9), so the smaller number is probably closer to the truth, although with a downward bias.

Another way of seeing the impact of leakage is with a stacked bar graph (Figure 19) showing the component parts of our contribution-inferred balance measures: contribution-inferred savings plan balances at year-end, the contribution-inferred cumulative projected value of rollover and non-rollover withdrawals, and imputed outstanding loan balances. The height of each section gives the size of each of these components relative to starting pay at each tenure year, and the total height of each bar shows what retirement balances as a fraction of starting pay would be if there were no leakage. Contribution-inferred balances are higher for the post-AE cohort than for the pre-AE cohort at all levels of tenure for both all hires and for the continuously employed subsample. For all hires, the cumulative projected value

of rollover and non-rollover balances is higher for the post-AE cohort, and their magnitude relative to the size of contribution-inferred plan balances is clearly evident. In contrast, for the continuously employed, outstanding loan balances are quantitatively important for both cohorts and higher for the post-AE cohort, while rollover and non-rollover withdrawals are relatively minor for both cohorts.

The analysis thus far shows the impact of automatic enrollment on population average outcomes, either for the population of all hires, or for the continuously employed subgroup. These means differences mask considerable heterogeneity in the impact of automatic enrollment. In Figure 20, we plot contribution-inferred potential plan balances at different points in the savings plan distribution for the all hires population. At eight years of tenure, the average impact of automatic enrollment on contribution-inferred potential plan balances is an increase of 7.2% of starting pay. The impacts at eight years of tenure at the 10th, 25th, 50th, 75th and 90th percentiles of the potential plan balance distribution are 1.9%, 4.6%, 8.4%, 10.9% and 6.4%, respectively. As we have documented, much of this increase in potential plan balances is never realized, so we look in Figure 21 at the distribution of contribution-inferred plan balances (as opposed to potential plan balances). The average impact of automatic enrollment on contribution-inferred plan balances at eight years of tenure for all hires is an increase of 3.4% of starting pay; the impacts at the 10th, 25th, 50th, 75th and 90th percentiles are 0%, 0%, 0%, 27.5% and 6.7%. Because turnover at this firm is high, the lower end of the savings distribution is primarily composed of employees who have separated, while the upper end of the savings distribution is primarily composed of those who have been continuously employed. The complete lack of an impact at the 10th, 25th, and 50th percentiles results from the level of contribution-inferred plan balances to starting pay being 0 for both the pre- and post-AE cohorts. Essentially, the individuals at these points in the distribution have separated from the firm and taken all of their balances out of the plan. We don't see a sustained positive impact of automatic enrollment on plan balances until the 75th percentile of the distribution. Although the

measure of contribution-inferred balances in Figure 21 excludes rollovers, it illustrates the significant impact that withdrawals have on both the pre- and post-AE cohorts.

Figures 22 and 23 show the same outcomes as Figures 20 and 21 for the subsample of the continuously employed. The levels of contribution-inferred potential plan balances are much higher for both the pre- and post-AE cohorts compared to the levels for the sample of all hires. The distributional effects of automatic enrollment are largest at the 10th and 25th percentiles, and there is very little effect at higher percentiles in the savings distribution.

In Figures 24 and 25, we examine the distributional outcomes for the subsample of employees who have separated from the firm. Instead of showing how savings evolves with tenure, the outcomes in these figures are all measured eight years after hire, but employees are stratified by their tenure at the time of separation (the x-axes). In Figure 24, we measure the difference in contribution-inferred potential plan balances for the pre- and post-AE cohorts (the y-axes plot the post minus the pre-AE outcomes). Automatic enrollment increases contribution-inferred potential plan balances at the 10th and 25th percentiles of the savings distribution, more so for individuals who separate with longer tenures. The effects at the higher percentiles of the distribution are much smaller and not statistically different from 0 for employees who separate with higher levels of tenure (the sample sizes of employees separating with higher levels of tenure are relatively small).

In Figure 25, we measure how much of the increase in potential plan balances shown in Figure 24 is realized by plotting the difference in contribution-inferred retirement system balances (excluding loans) for the pre- and post-AE cohorts (the y-axes plot the post minus the pre-AE outcomes). There is no difference at the 10th percentile of the distribution; all of the balances of both cohorts are withdrawn and leave the retirement system after separation. There is also no difference at the 25th percentile except for a small effect among employees who separate with seven years of tenure. The place in the distribution where we see an effect

of automatic enrollment is at the median. The effect on retirement system balances increases with tenure at time of separation through five years of tenure and then declines. This pattern is consistent with the data presented in Figure 17 on asset preservation. The separated participant at the median of the savings distribution has accumulated some balances in the plan, and automatic enrollment has the effect of increasing balances at separation enough to move some of these participants across the balances-at-separation categories in Figure 17 in a way that preserves assets, reducing the fraction of participants who are subject to a compelled cash distribution (balances at separation <$1,000) and increasing the fraction for whom the default is an IRA rollover or the fraction who can keep their balances in the plan. The effect at the median likely decreases with tenure at separation at higher levels of tenure because as tenure increases, balances in the plan also increase and are more likely to stay in the retirement system after separation for both the pre- and post-AE cohorts. Consistent with this, at the 75th and 90th percentile, the differences in retirement system balances across and pre- and post-AE cohorts are very small and/ or not statistically different from 0. These individuals are the motivated savers and likely to preserve assets regardless of balances at the time of separation.

V. Conclusion

Our analysis highlights the potential magnitude that pre-retirement withdrawals and loans have on retirement system balances in general, and in attenuating the potential impact of automatic enrollment on asset accumulation in particular. We find that automatic enrollment increases total potential retirement system balances by 7% of starting pay eight years after hire; at the same time, leakage in the form of outstanding loans and withdrawals that are not rolled over into another qualified savings plan also increase by 3% of starting pay, offsetting approximately 40% of the potential increase in savings from automatic enrollment. The net effect is that automatic enrollment increases retirement system balances by 4-5% of first year pay eight years after hire. These results mask substantial differences across those who remain employed at the firm versus those who separate. Among those who remain employed,

leakage offsets relatively little of the incremental savings generated by automatic enrollment at low levels of tenure. As tenure increases, so does the extent to which leakage offsets the savings increases from automatic enrollment, and eight years after hire, leakage, primarily in the form of plan loans, offsets 9-27% of the potential increased savings. In contrast, for employees who separate, leakage, primarily in the form of non-rollover withdrawals, offsets more than half of the potential incremental savings from automatic enrollment at low levels of tenure. Although this rate of offset declines with time since hire for separated employees, at eight years it still exceeds 40%. Overall, while automatic enrollment results in a net increase in retirement system balances, pre-retirement leakage significantly limits its potential impact.

We do not know the extent to which the results at the firm studied would generalize to other populations. The firm we study has a high employee turnover rate which, as we have documented in our analysis, is a key mediating factor contributing to retirement system leakage. It also has a low default automatic enrollment contribution rate, and no employee match during the first year of employment when turnover is high, additional factors that also likely contribute to a relatively high rate of leakage.

The approach used to assess the impact of pre-retirement leakage on retirement wealth accumulation can be adapted to examine outcomes at other companies that have adopted automatic enrollment. Future research should evaluate the factors that impact when leakage rates are high versus low, and when leakage is more versus less likely to crowd-out the potential savings that could result from automatic enrollment. These factors include demographic factors such as age and salary, firm factors such as turnover, and plan factors such as the default contribution rate, the generosity of the employer match, and the default treatment of savings plan balances following termination.

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Brigitte Madrian is the Aetna Professor of Public Policy and Corporate Management at the Harvard Kennedy School. Before coming to Harvard in 2006, she was on the faculty at the University of Pennsylvania Wharton School (2003-2006), the University of Chicago Graduate School of Business (1995-2003) and the Harvard University Economics Department (1993-1995). She also is a research associate and co-director of the Household Finance working group at the National Bureau of Economic Research.

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Table 1. Retirement savings plan features

Eligibility		
Employee contributions	Before 7/1/2005: First day of the month following three full months of continuous service for employees scheduled to work 20+ hours per week On or after 7/1/2005: Immediately upon hire for all employees	
Employer contributions	First day of the month following one year of service in which the employee worked 1,000+ hours and if employed at the end of the year	
Automatic Enrollment	Employees hired on or after July 1, 2005, are automatically enrolled in the plan at a 2% contribution rate invested in a balanced mutual fund unless they opt-out within five business days	
Automatic Escalation	Available as an opt-in feature starting August 1, 2006, with contribution escalation occurring on January 1 of each subsequent calendar year	
Contributions		
Employee	Before 1/1/2006: up to 50% of pay On or after 1/1/2006: up to 75% of pay	
Employer	100% match on employee contributions up to 4% of pay, allocated to employer stock	
Vesting	Immediate	
Loans		
Total loan limit	At most two loans outstanding at a time	
Loan minimum	$1,000	
Loan maximum	The lesser of 50% of the participant's account balance or $50,000 minus the participant's highest outstanding loan balance during the past 12 months	
Distributions following separation	Balances <$1,000 are subject to an automatic cash distribution if not rolled into another qualified plan within 60 days. Balances of $1,000 to <$5,000 are automatically rolled into an IRA if not rolled into another qualified plan or taken as a cash distribution. Balances >$5,000 can be retained in the plan after separation, rolled into another qualified plan, or taken as a cash distribution. Distributions taken before age 55 and not rolled into another qualified account are subject to 10% tax penalty.	
In-service withdrawals		
Non-Hardship	Permitted from all accounts after age 59½ without penalty and from after-tax and certain rollover accounts before age 59½ with a 10% penalty	
Hardship	Permitted from all accounts for college, funeral, outstanding medical, and some primary residence expenses without penalty; $500 minimum	

Source: Plan documents.

Table 2. Demographic characteristics and savings plan outcomes

	Pre-AE cohort	Post-AE cohort	*p*-value of difference
Demographic characteristics			
Fraction female	64.5%	65.7%	0.119
Age at hire	31.1	31.1	0.938
Avg. starting salary ($2004)[a]	$28,551	$28,285	0.450
Months to eligibility from hire	3.5	0.1	0.000
Ever contributed to savings plan	62.2%	98.3%	0.000
Median months to participation from eligibility | ever contributed	5	0	0.000
Participation rate in first month of eligibility	20.4%	77.1%	0.000
Continuously employed as of eight years after hire	14.8%	14.8%	0.895
Savings plan outcomes (at one year after hire)			
Participation rate | still employed	36.2%	96.0%	0.000
Avg. contribution rate | still employed	1.7%	3.0%	0.000
Avg. contribution rate | contributing and still employed	5.8%	3.3%	0.000
Balance/starting salary | still employed	1.4%	3.2%	0.000
Savings plan outcomes (at eight years after hire)			
Participation rate | still employed	86.6%	96.0%	0.000
Avg. contribution rate | still employed	5.8%	6.0%	0.581
Avg. contribution rate | contributing and still employed	7.1%	6.4%	0.046
Balance/starting salary | still employed	18.7%	25.4%	0.000
Fraction with outstanding loan | still employed and participating	26.3%	31.5%	0.008
Number of loans | loans and still employed	1.63	1.61	0.673
Loan balance/starting salary | loan and still employed	19.1%	19.1%	0.999
Ever taken rollover withdrawal | ever contributed	28.8%	25.3%	0.000
Ever taken non-rollover withdrawal | ever contributed	43.2%	58.6%	0.000
Sample size	N=7,347	N=7,536	

Source: Authors' calculations. The sample is all hires continuously employed through eligible for the plan at tenure year one as defined in Appendix Table 1.

[a] Growth in seasonally adjusted average weekly earnings for private sector workers from the Current Employment Statistics survey is used to deflate employee salaries to 2004 dollars.

Table 3. Contribution-inferred balances relative to starting pay

A. All Hires

	Tenure (years)			
	2	4	6	8
Potential Plan Balances				
Pre-AE	5.30%	9.02%	18.55%	27.39%
Post-AE	8.65%	12.51%	24.02%	34.63%
Difference (Post-Pre)	3.36%	3.49%	5.47%	7.24%
Retirement System Balances (incl. loans)				
Pre-AE	4.99%	8.15%	16.45%	23.83%
Post-AE	7.78%	10.65%	20.06%	28.46%
Difference (Post-Pre)	2.78%	2.50%	3.61%	4.64%
Retirement System Balances (excl. loans)				
Pre-AE	4.95%	7.90%	15.78%	22.75%
Post-AE	7.70%	10.29%	19.11%	26.98%
Difference (Post-Pre)	2.75%	2.39%	3.33%	4.23%
Plan Balances				
Pre-AE	4.60%	6.75%	13.46%	18.48%
Post-AE	7.17%	8.87%	16.10%	21.88%
Difference (Post-Pre)	2.57%	2.11%	2.64%	3.39%

B. Continuously Employed

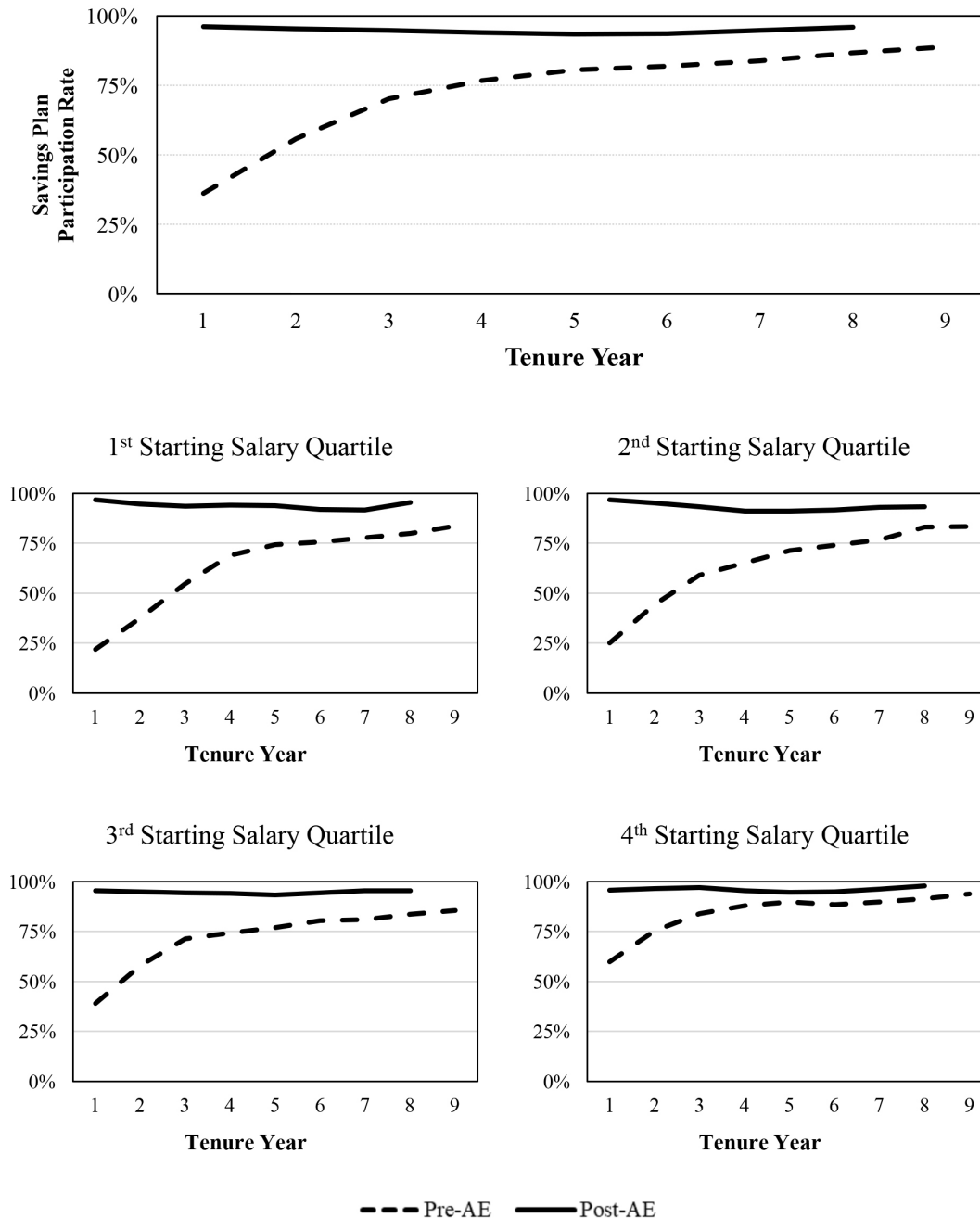|	Tenure (years)			
	2	4	6	8
Potential Plan Balances				
Pre-AE	7.21%	18.93%	48.19%	82.45%
Post-AE	11.05%	22.34%	52.85%	88.16%
Difference (Post-Pre)	3.84%	3.41%	4.66%	5.71%
Retirement System Balances (incl. loans)				
Pre-AE	7.19%	18.77%	47.66%	81.44%
Post-AE	10.97%	22.08%	51.85%	86.63%
Difference (Post-Pre)	3.78%	3.31%	4.19%	5.19%
Retirement System Balances (excl. loans)				
Pre-AE	7.11%	18.10%	45.49%	77.32%
Post-AE	10.84%	21.22%	48.83%	81.46%
Difference (Post-Pre)	3.73%	3.13%	3.34%	4.14%
Plan Balances				
Pre-AE	7.11%	18.10%	45.49%	77.03%
Post-AE	10.84%	21.22%	48.71%	81.36%
Difference (Post-Pre)	3.74%	3.12%	3.22%	4.33%

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The continuously empl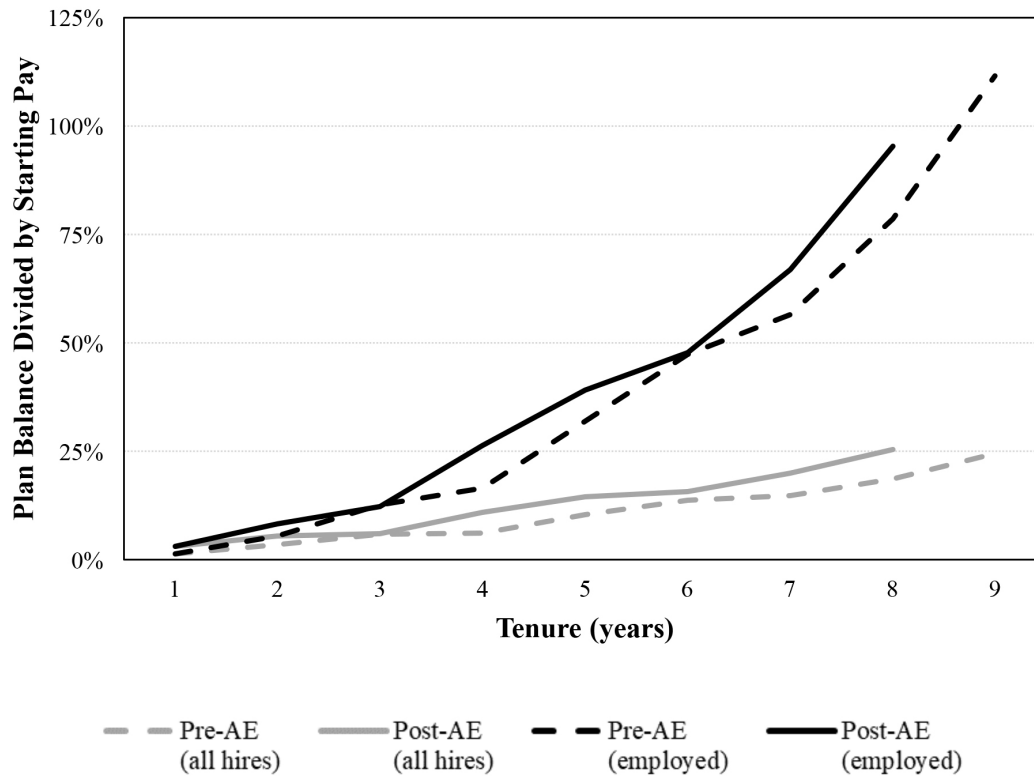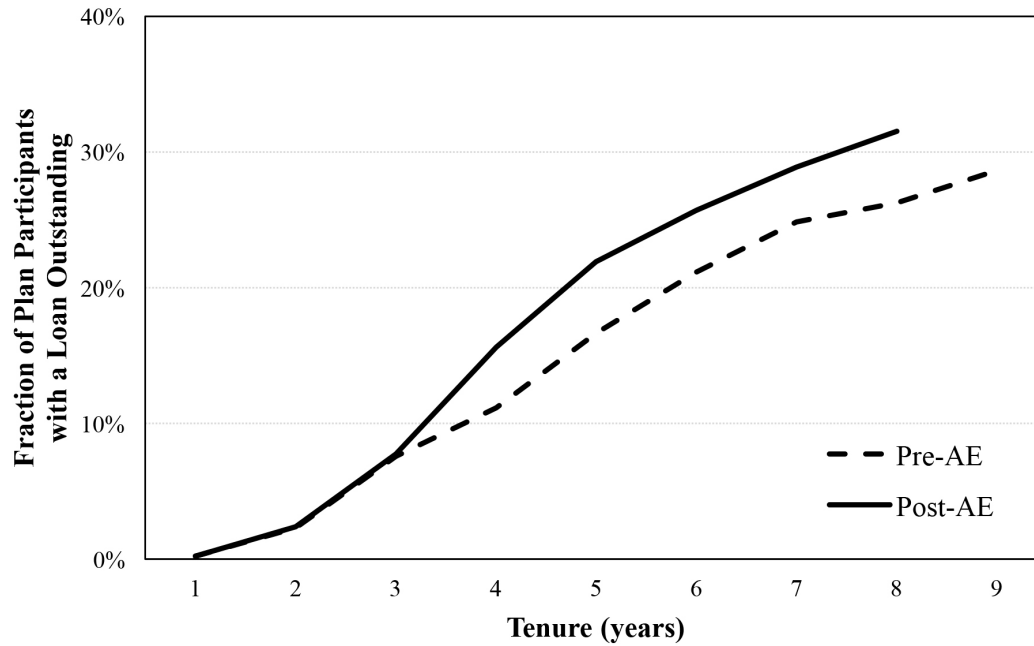oyed subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (panel B). The different measures of contribution-inferred balances are calculated as described in Section IV of the paper.

Table 4. Reduction in balances relative to contribution-inferred potential plan balances

A. All Hires

	Tenure (years)			
	2	4	6	8
Contribution-Inferred Retirement System Balances (incl. loans)				
Pre-AE	-5.7%	-9.6%	-11.3%	-13.0%
Post-AE	-10.1%	-14.8%	-16.5%	-17.8%
Differential Impact (Post-Pre)	17.1%	28.3%	34.0%	36.0%
Contribution-Inferred Retirement System Balances (excl. loans)				
Pre-AE	-6.6%	-12.4%	-14.9%	-16.9%
Post-AE	-11.0%	-17.8%	-20.4%	-22.1%
Differential Impact (Post-Pre)	18.0%	31.6%	39.1%	41.6%
Contribution-Inferred Plan Balances				
Pre-AE	-13.2%	-25.1%	-27.4%	-32.5%
Post-AE	-17.2%	-29.1%	-33.0%	-36.8%
Differential Impact (Post-Pre)	23.4%	39.4%	51.7%	53.2%

B. Continuously Employed

	Tenure (years)			
	2	4	6	8
Contribution-Inferred Retirement System Balances (incl. loans)				
Pre-AE	-0.3%	-0.9%	-1.1%	-1.2%
Post-AE	-0.7%	-1.2%	-1.9%	-1.7%
Difference (Post-Pre)	1.6%	2.9%	10.1%	9.1%
Contribution-Inferred Retirement System Balances (excl. loans)				
Pre-AE	-1.4%	-4.4%	-5.6%	-6.2%
Post-AE	-1.9%	-5.0%	-7.6%	-7.6%
Difference (Post-Pre)	2.9%	8.3%	28.3%	27.4%
Contribution-Inferred Plan Balances				
Pre-AE	-1.4%	-4.4%	-5.6%	-6.6%
Post-AE	-1.9%	-5.0%	-7.8%	-7.7%
Difference (Post-Pre)	2.8%	8.4%	30.8%	24.2%

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The continuously employed subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (panel B). The different measures of contribution-inferred balances are calculated as described in Section IV of the paper.

Figure 1. Employee retention rate by tenure
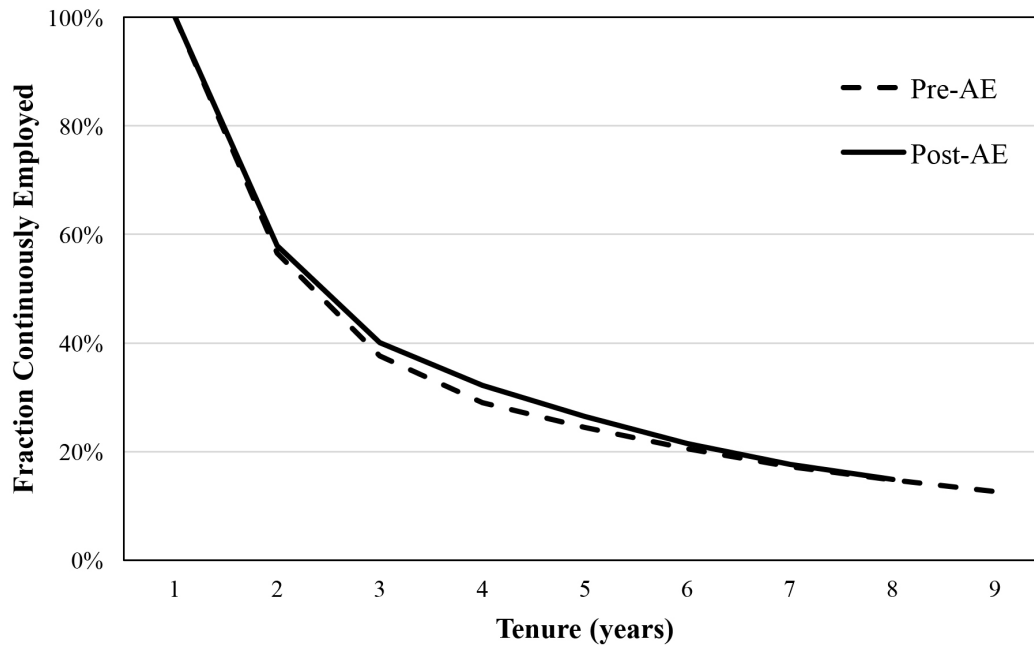
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one. The employee retention rate is defined as the fraction of these employees continuously employed through the indicated level of tenure as defined in Appendix Table 1.

Figure 2. Savings plan participation rate (continuously employed)

1st Starting Salary Quartile

2nd Starting Salary Quartile

3rd Starting Salary Quartile

4th Starting Salary Quartile
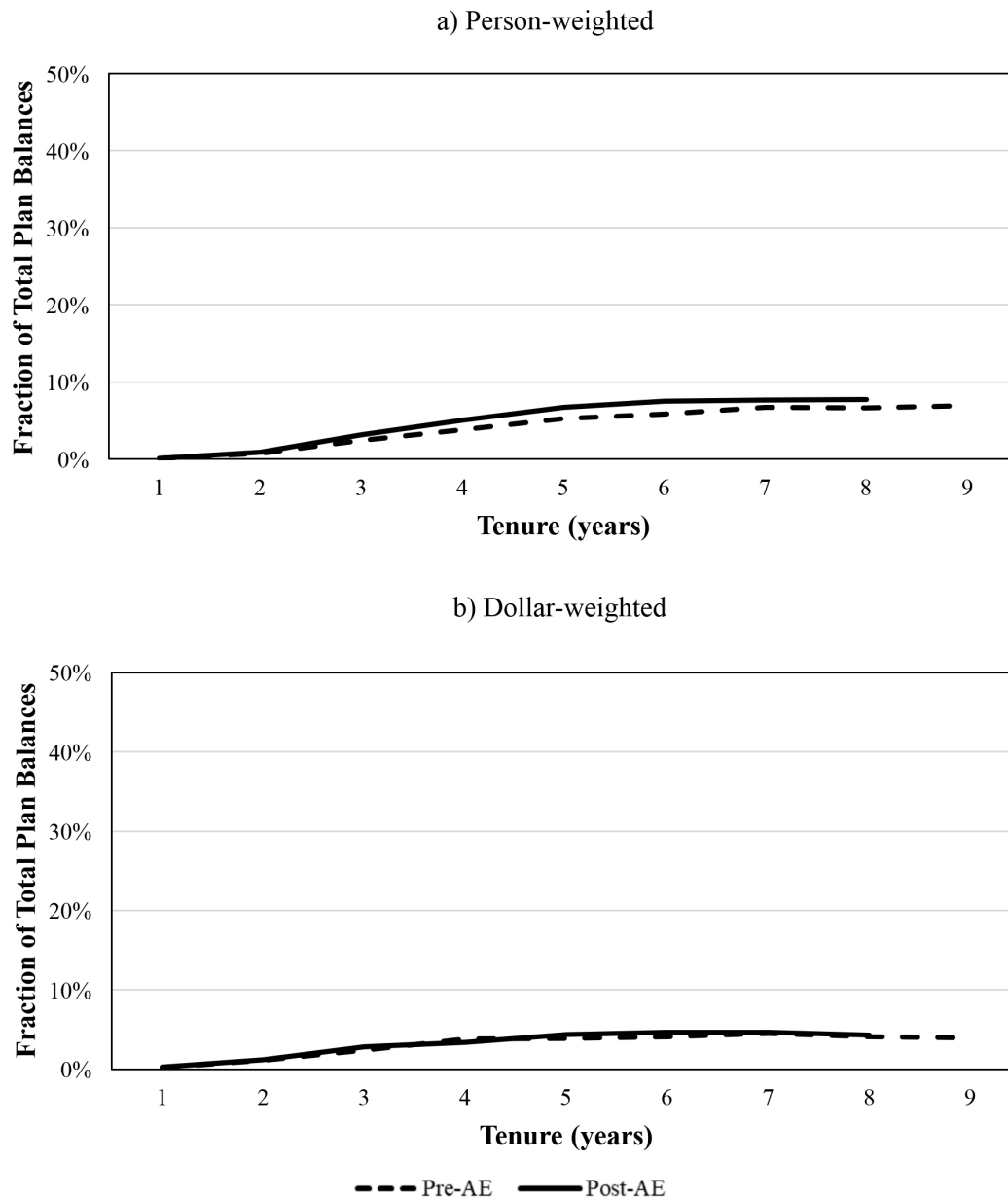

- - - Pre-AE   ——— Post-AE

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. The savings plan participation rate is defined as the fraction of employees making a positive contribution to the savings plan in a given year.

Figure 3. Average savings plan contribution rate (continuously employed)
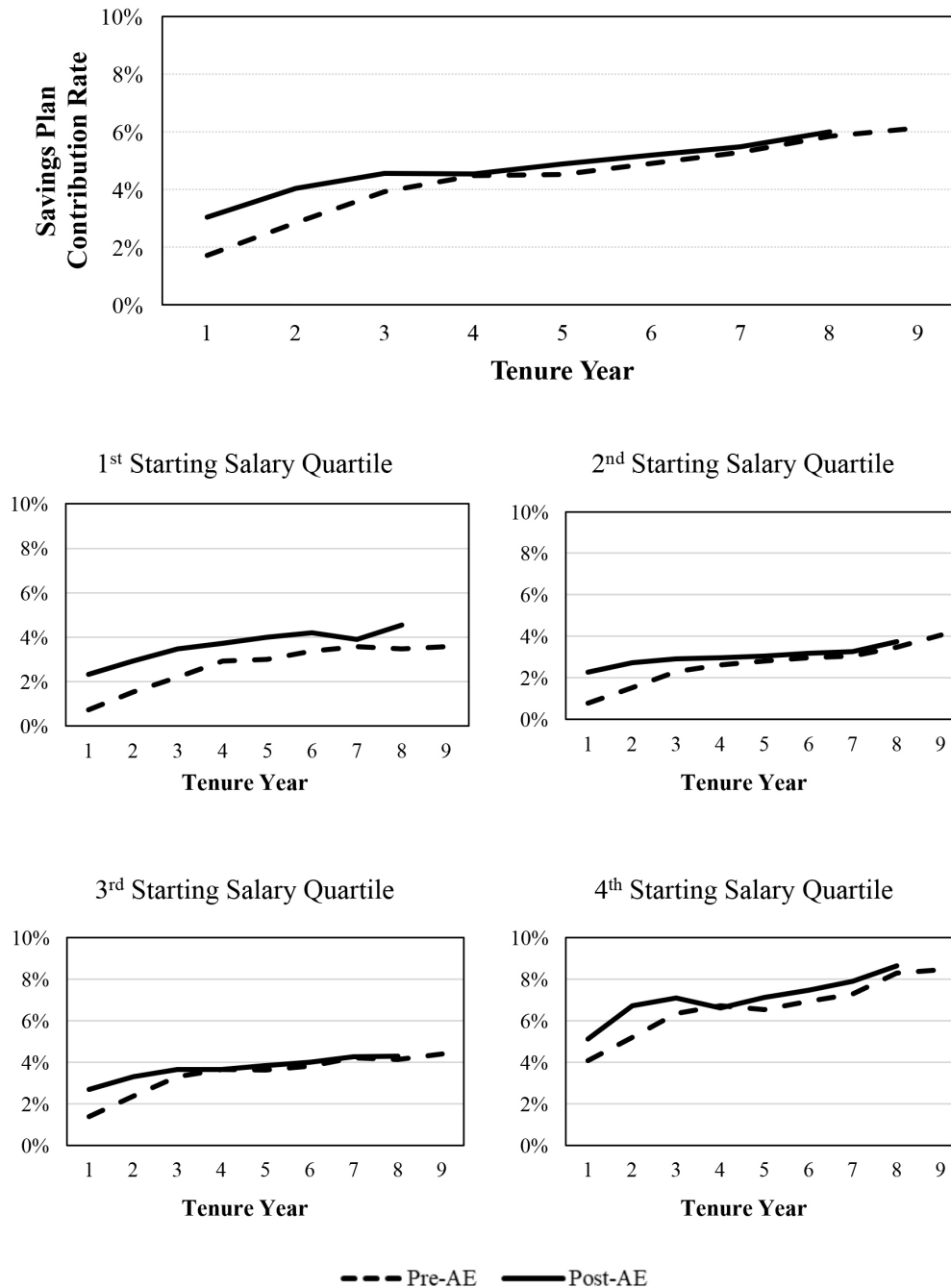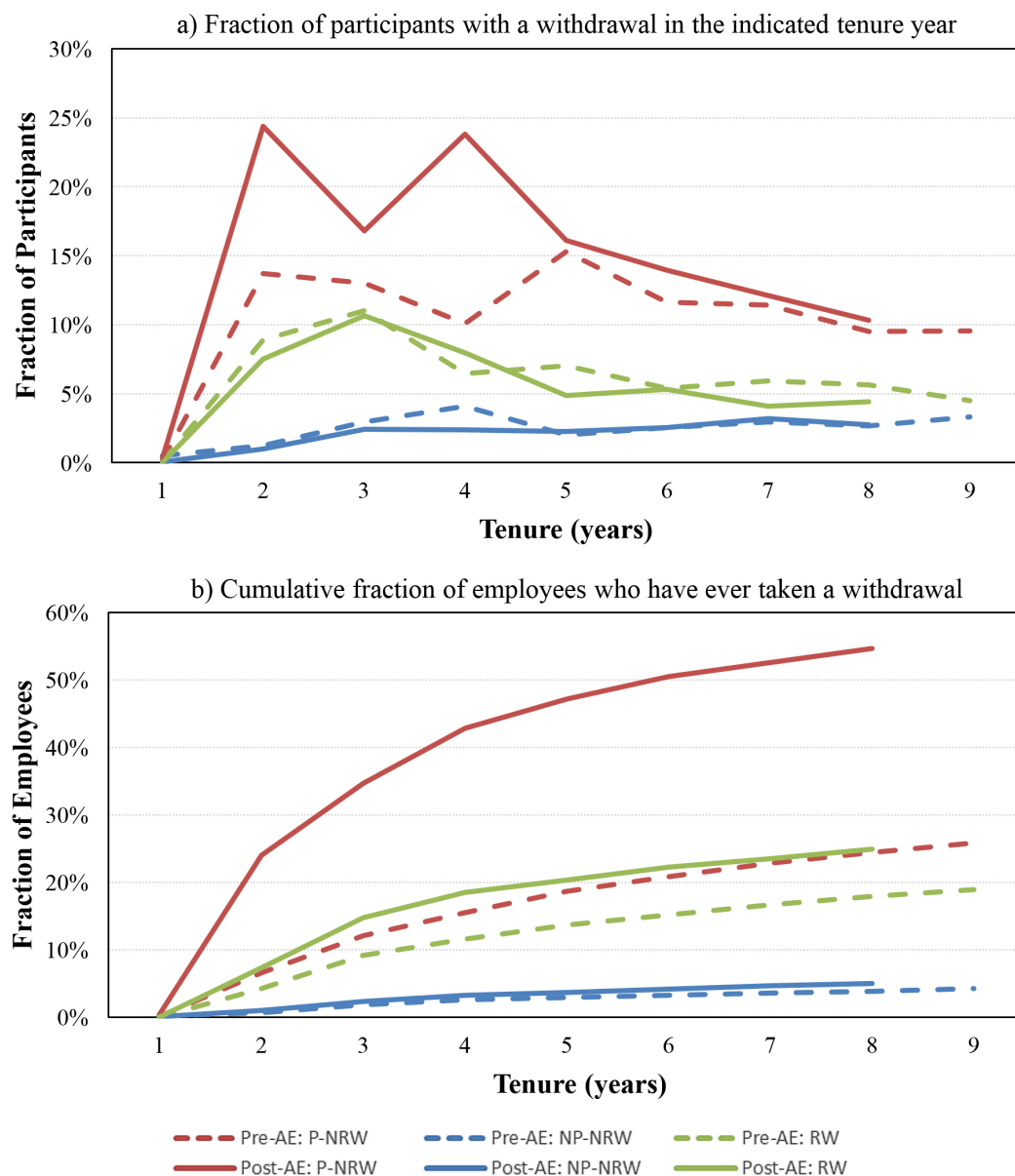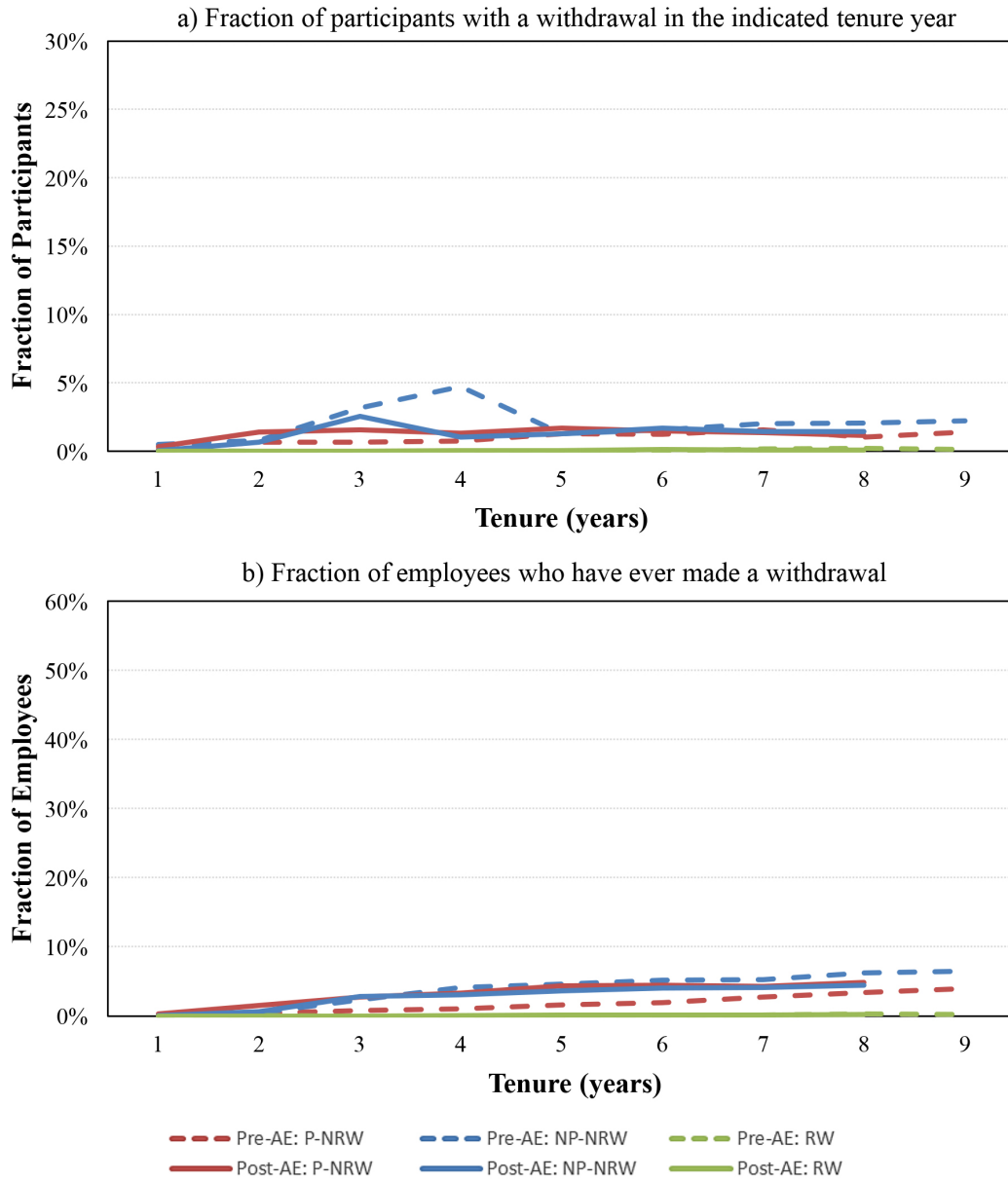

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. The contribution rate is the sum of employee before-tax, after-tax, and Roth contribution rates as a percentage of pay. The figure plots person-weighted means.

Figure 4. Savings plan balances relative to starting pay

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. Plan balances include before-tax, after-tax, Roth and employer match balances. Outstanding 401(k) loan amounts are excluded. Starting pay is the annualized salary during the calendar year corresponding to tenure year one. Person-weighted ratio.

Figure 5. Loan utilization rate (continuously employed savings plan participants)

Source: Authors' calculations. The sample is restricted to those continuously employed at a given level of tenure conditional on being employed at one year of tenure as defined in Appendix Table 1. The sample is further restricted to those participating in the savings plan (defined as having a positive plan or loan balance). Loan utilization is defined as having a positive loan balance at the indicated tenure.

Figure 6. Non-loan savings plan participation rate (continuously employed)
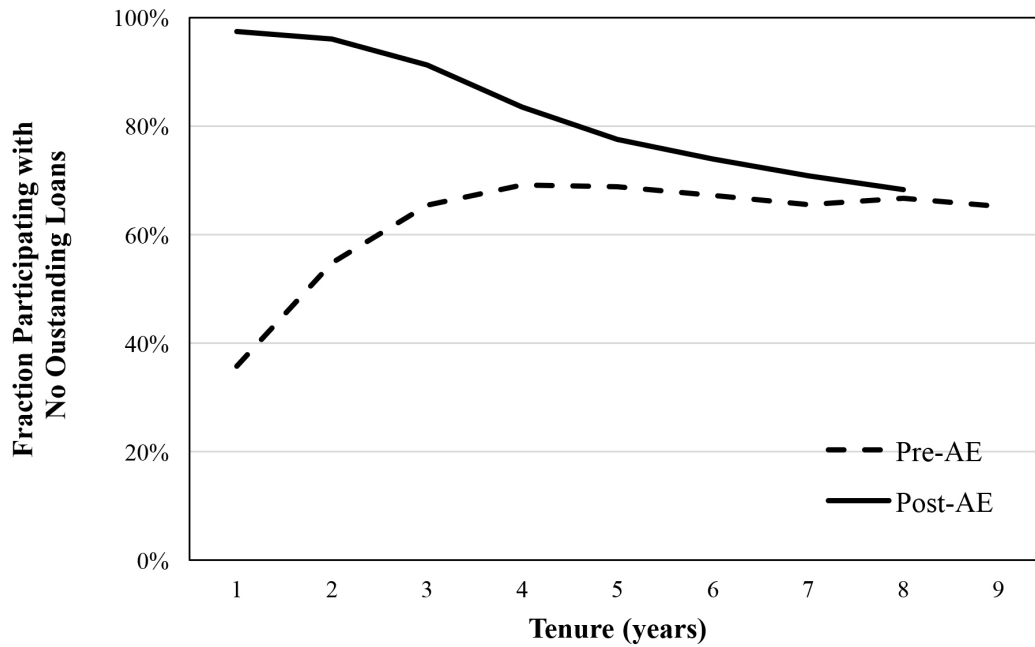
Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. Participation is defined as having either a positive balance at the indicated level of tenure or having had activity in the plan during the previous calendar year. Non-loan participation is defined as having a positive plan balance at the indicated tenure while having no outstanding loan balances.

Figure 7. Outstanding loan balances as a fraction of total plan balances (continuously employed plan participants with a loan)

a) Person-weighted

b) Dollar-weighted

- - - Pre-AE ——— Post-AE

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for and participating in the plan with a non-zero outstanding loan balance at the indicated level of tenure as defined in Appendix Table 1. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure shows the ratio of total outstanding loan balances to total plan balances (including outstanding loan balances).

Figure 8. Outstanding loan balances as a fraction of total plan balances (continuously employed plan participants)

a) Person-weighted

b) Dollar-weighted

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for and participating in the plan at the indicated level of tenure as defined in Appendix Table 1. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure shows the ratio of total outstanding loan balances to total plan balances (including outstanding loan balances).

Figure 9. Fraction of individuals with a withdrawal (all hires)

a) Fraction of participants with a withdrawal in the indicated tenure year

b) Cumulative fraction of employees who have ever taken a withdrawal

Legend:
- Pre-AE: P-NRW
- Pre-AE: NP-NRW
- Pre-AE: RW
- Post-AE: P-NRW
- Post-AE: NP-NRW
- Post-AE: RW

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one as defined in Appendix Table 1. The sample in (a) is further restricted to plan participants defined as those having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. (a) plots the fraction of participants with a penalized non-rollover withdrawal, a non-penalized non-rollover withdrawal, or a (non-penalized) rollover withdrawal during the indicated tenure year. (b) plots the cumulative fraction of all hires (regardless of plan participation) who have ever taken one of these withdrawals through the indicated tenure year.

Figure 10. Fraction of individuals with a withdrawal (continuously employed)

a) Fraction of participants with a withdrawal in the indicated tenure year

b) Fraction of employees who have ever made a withdrawal

Legend:
- Pre-AE: P-NRW
- Pre-AE: NP-NRW
- Pre-AE: RW
- Post-AE: P-NRW
- Post-AE: NP-NRW
- Post-AE: RW

Source: Authors' calculations. The sample is restricted to those continuously employed through the indicated tenure year as defined in Appendix Table 1. The sample in (a) is further restricted to plan participants defined as those having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. (a) plots the fraction of participants with a penalized non-rollover withdrawal, a non-penalized non-rollover withdrawal, or a (non-penalized) rollover withdrawal during the indicated tenure year. (b) plots the cumulative fraction of employees (regardless of plan participation) who have ever taken one of these withdrawals through the indicated tenure year.

Figure 11. Yearly withdrawals as a fraction of plan balances (all hires)
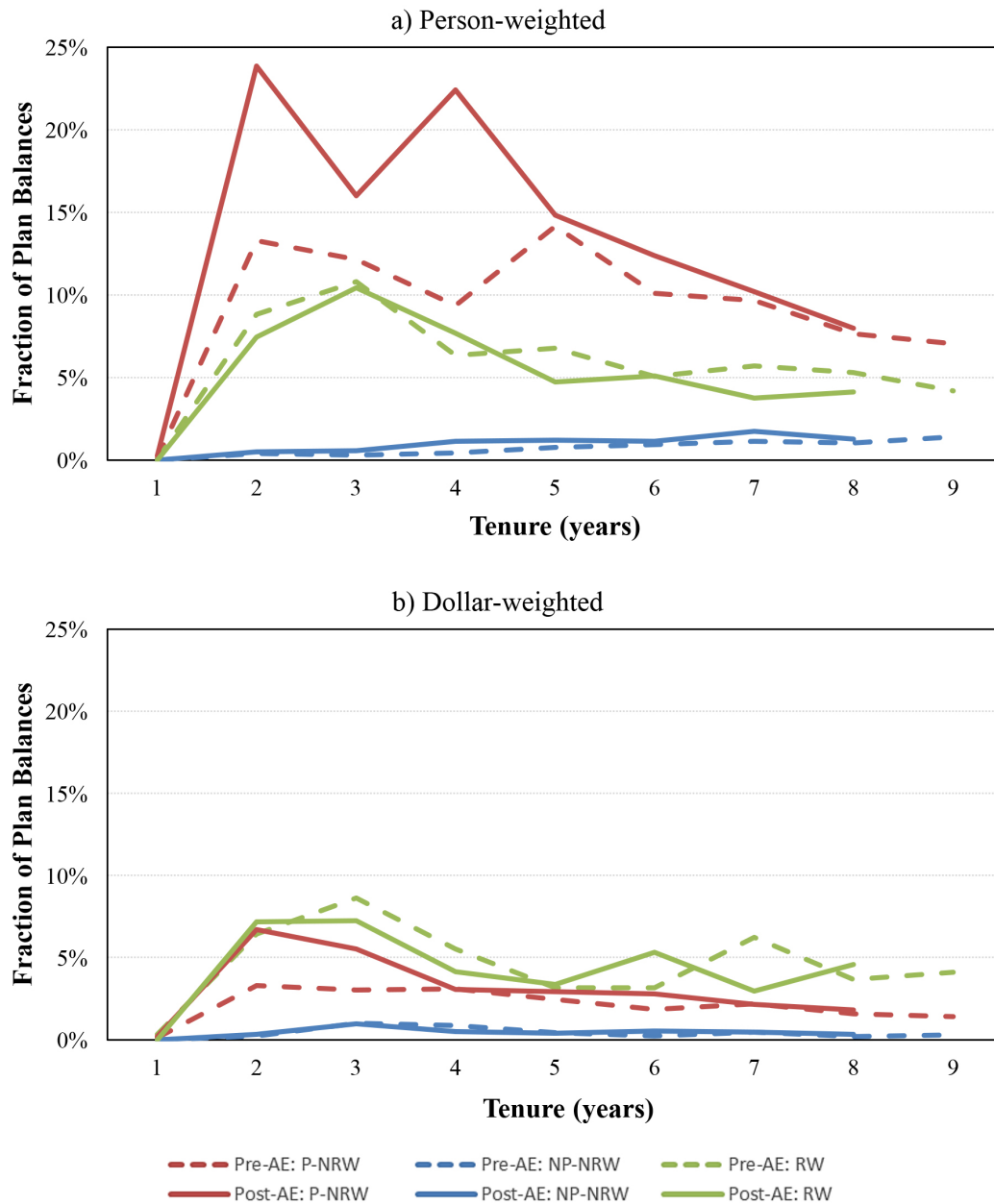
a) Person-weighted

b) Dollar-weighted

Legend:
- Pre-AE: P-NRW (red dashed)
- Pre-AE: NP-NRW (blue dashed)
- Pre-AE: RW (green dashed)
- Post-AE: P-NRW (red solid)
- Post-AE: NP-NRW (blue solid)
- Post-AE: RW (green solid)

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one and participating in the plan at the indicated level of tenure. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure plots the person- and dollar-weighted value of calendar year penalized non-rollover withdrawals, non-penalized non-rollover withdrawals, and (non-penalized) rollover withdrawals, as a fraction of the sum of year-end plan balances and calendar-year withdrawals.

Figure 12. Yearly withdrawals as a fraction of plan balances (continuously employed)
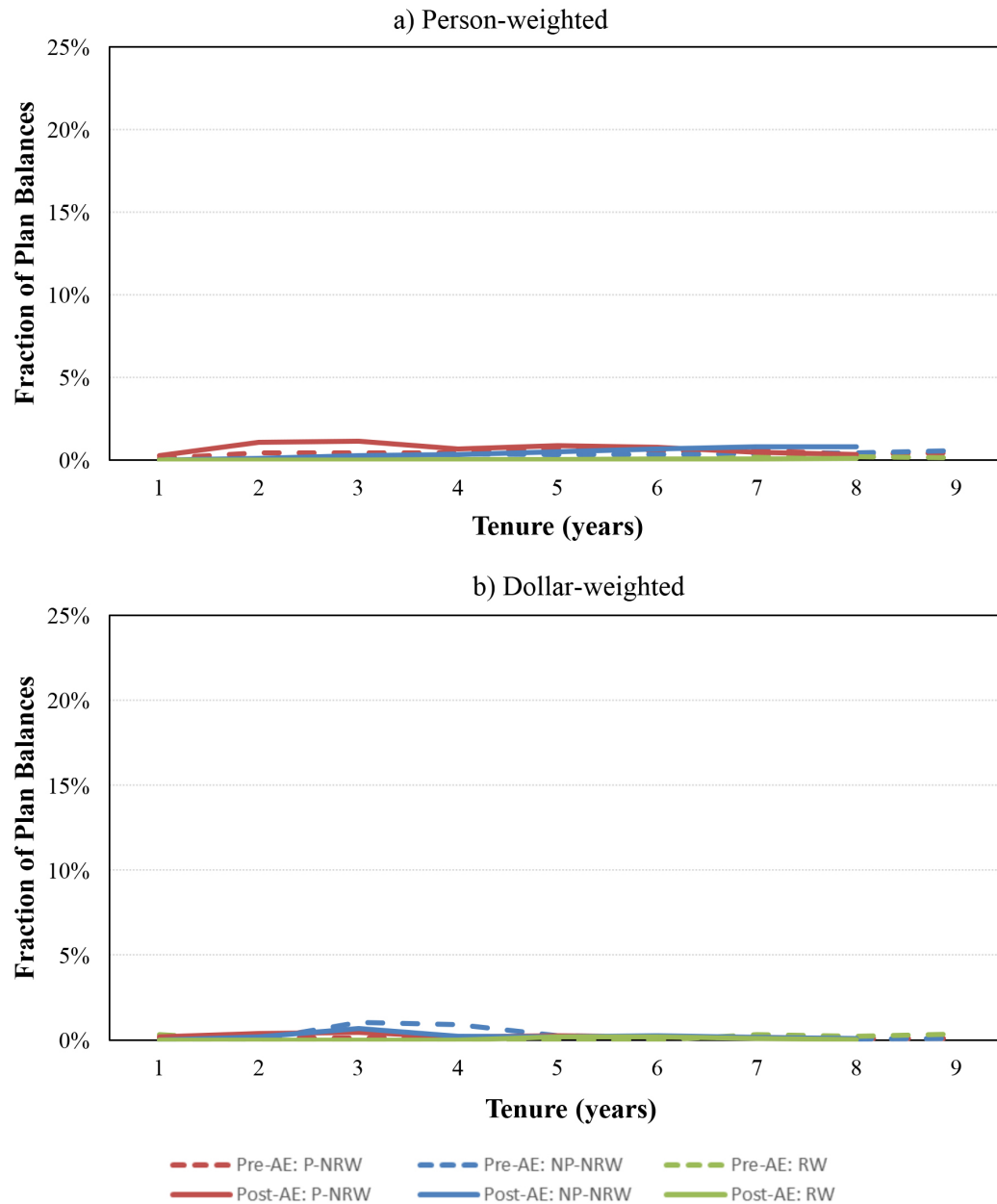
a) Person-weighted

b) Dollar-weighted

Legend:
- Pre-AE: P-NRW
- Pre-AE: NP-NRW
- Pre-AE: RW
- Post-AE: P-NRW
- Post-AE: NP-NRW
- Post-AE: RW

Source: Authors' calculations. The sample is restricted to those continuously employed through and participating in the plan at the indicated level of tenure. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure plots the person- and dollar-weighted value of calendar year penalized non-rollover withdrawals, non-penalized non-rollover withdrawals, and (non-penalized) rollover withdrawals, as a fraction of the sum of year-end plan balances and calendar-year withdrawals.

Figure 13. Cumulative value of withdrawals and loans relative to starting pay
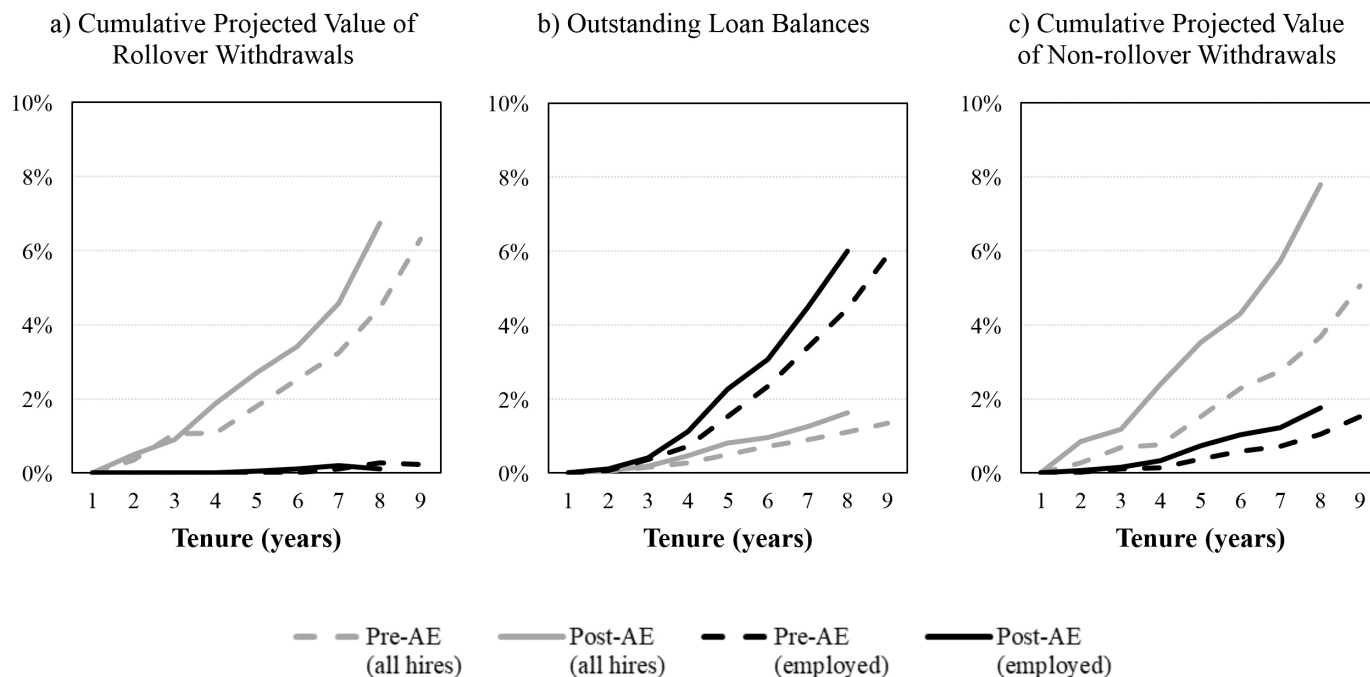
a) Cumulative Projected Value of Rollover Withdrawals

b) Outstanding Loan Balances

c) Cumulative Projected Value of Non-rollover Withdrawals

Legend:
- – – Pre-AE (all hires)
- —— Post-AE (all hires)
- – – Pre-AE (employed)
- —— Post-AE (employed)

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. Cumulative rollover (a) and non-rollover (b) withdrawals are calculated as described in Section IV of the paper. Rollover withdrawals include balances rolled over to an IRA other qualified plan. Starting pay is the annualized salary during the calendar year corresponding to tenure year one.

Figure 14. Cumulative L1, L2 and L3 leakage rates (person-weighted)

a) All Hires

b) Continually Employed

Legend:
- Pre-AE: L1 Leakage
- Pre-AE: L2 Leakage
- Pre-AE: L3 Leakage
- Post-AE: L1 Leakage
- Post-AE: L2 Leakage
- Post-AE: L3 Leakage

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances, and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.

Figure 15. Cumulative L1, L2 and L3 leakage rates (dollar-weighted)

a) All Hires

b) Continually Employed

Legend:
- – – Pre-AE: L1 Leakage
- – – Pre-AE: L2 Leakage
- – – Pre-AE: L3 Leakage
- —— Post-AE: L1 Leakage
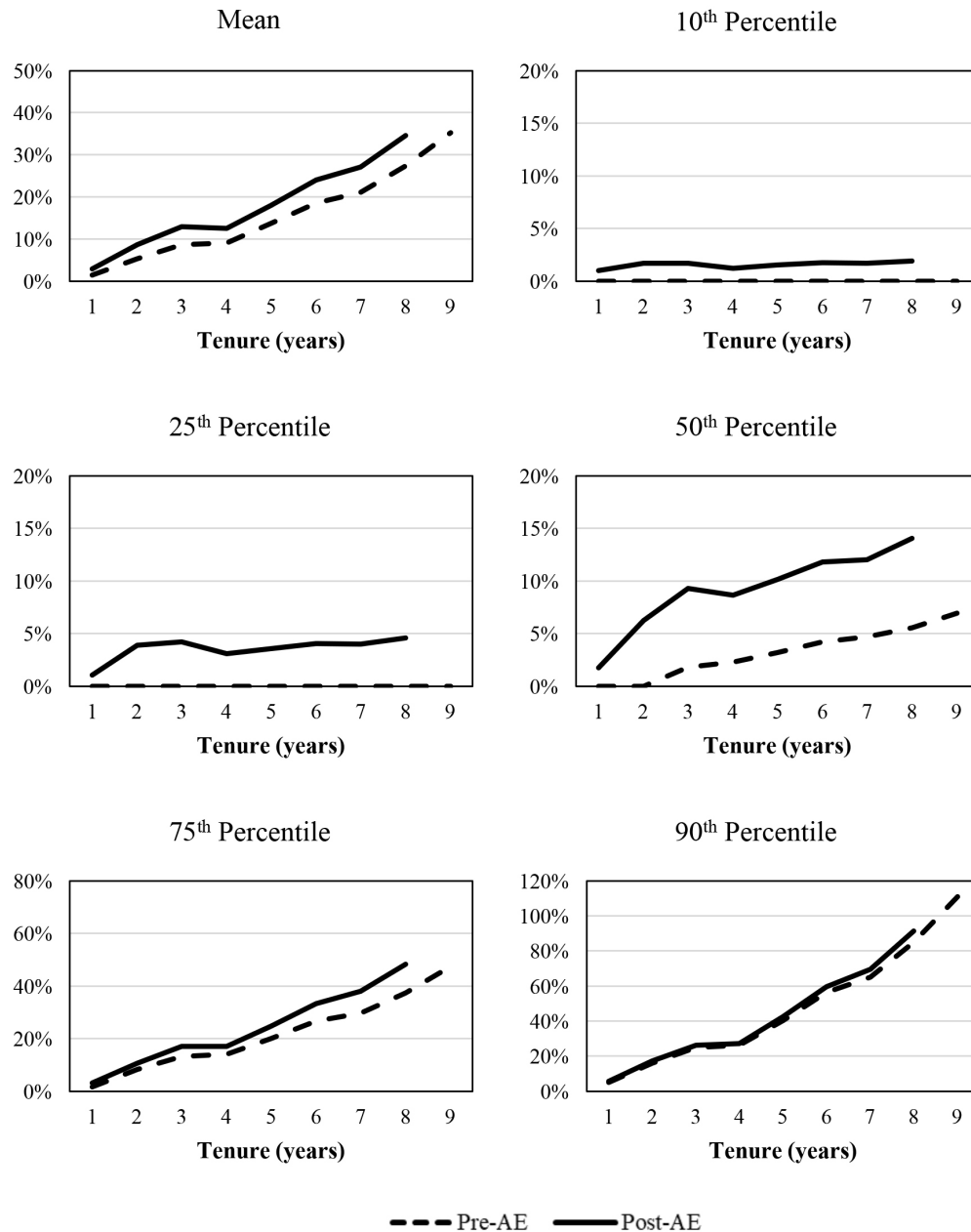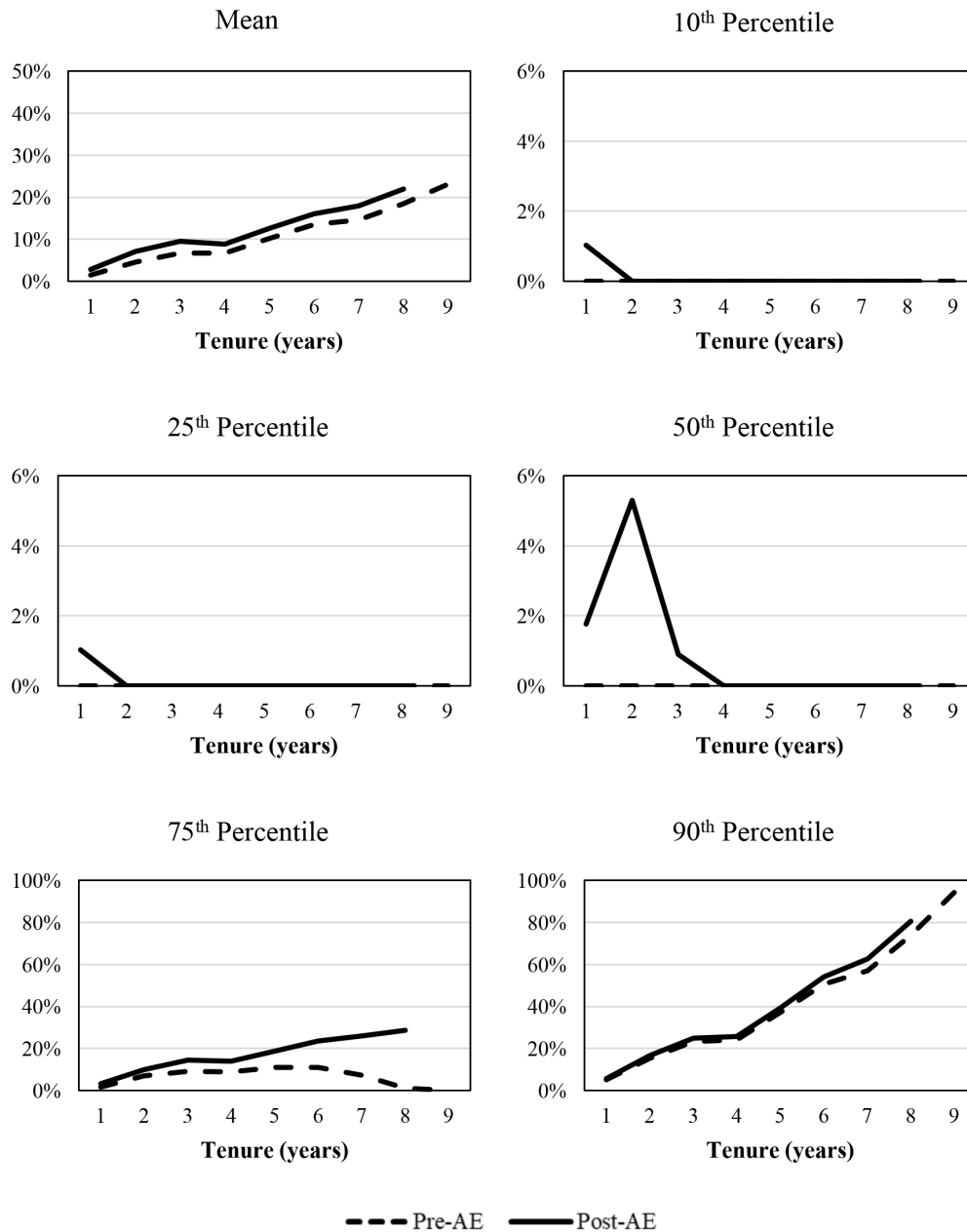- —— Post-AE: L2 Leakage
- —— Post-AE: L3 Leakage

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances, and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.

Figure 16. Imputed plan balances at separation by tenure at separation
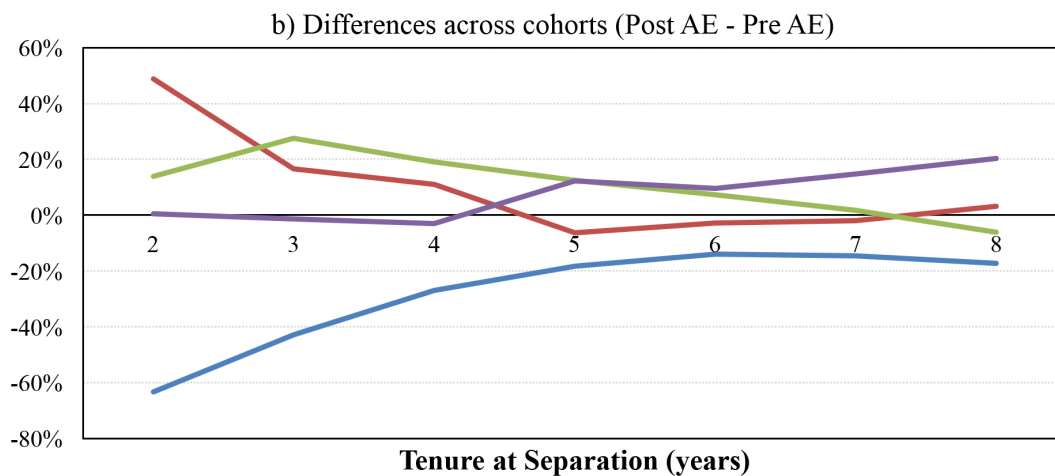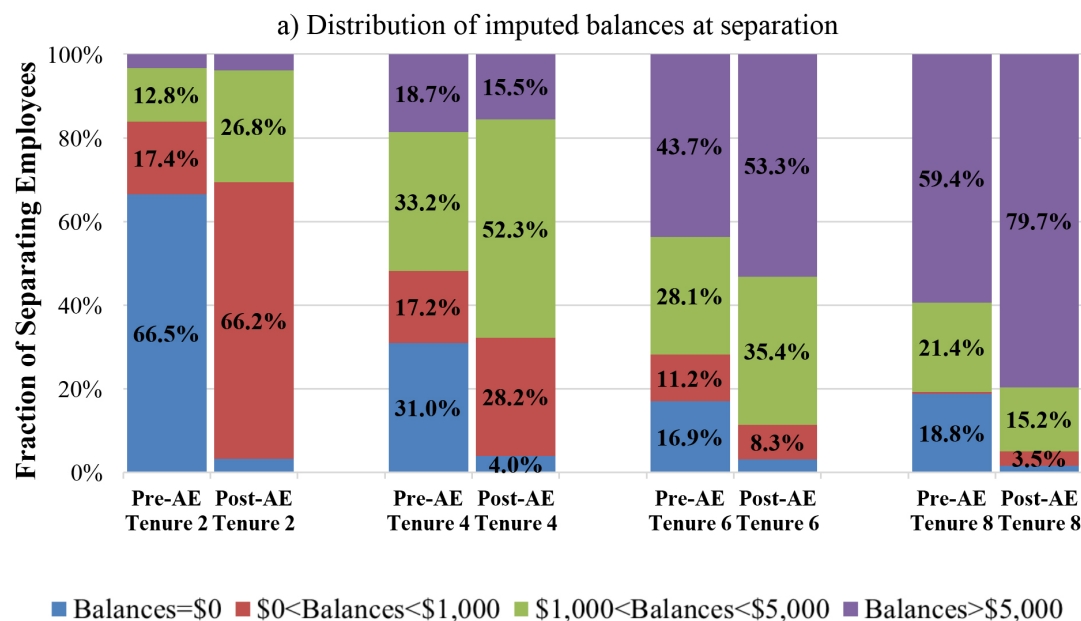
a) Distribution of imputed balances at separation

■ Balances=$0 ■ $0<Balances<$1,000 ■ $1,000<Balances<$5,000 ■ Balances>$5,000

b) Differences across cohorts (Post AE - Pre AE)

Tenure at Separation (years)

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm. Imputed balances at separation are calculated as described in Section IV of the paper.

Figure 17. Asset preservation following separation by imputed balances at separation

### a) Fraction Keeping Assets in the Retirement System
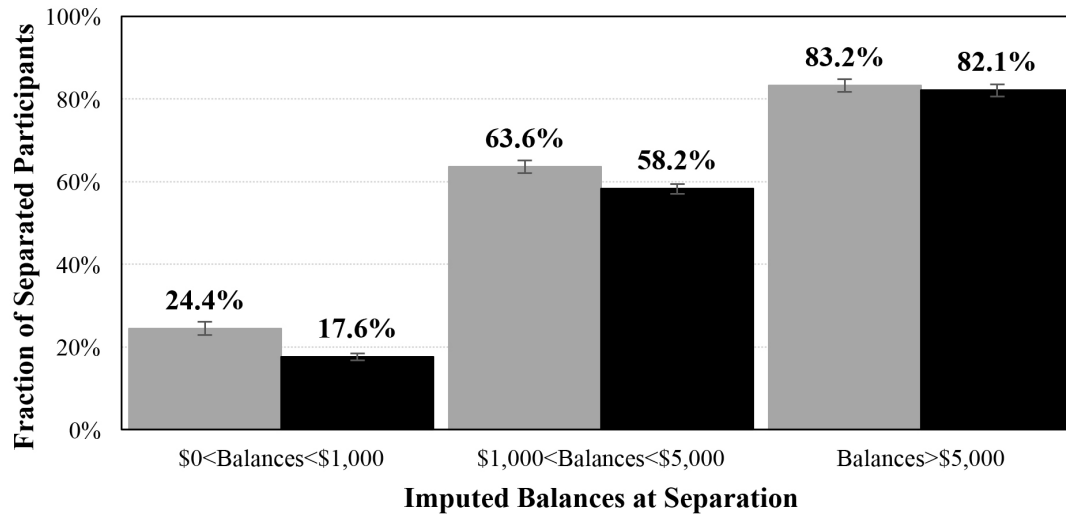
Fraction Keeping Assets in the Plan
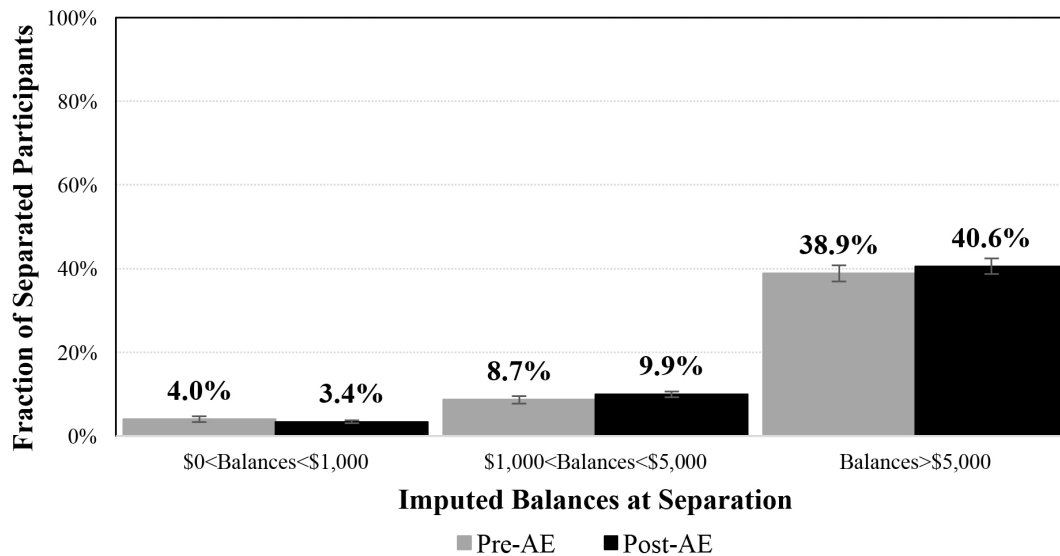
Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm prior to tenure year 8. Imputed balances at separation are calculated as described in Section IV of the paper. Preserving assets following separation is defined as taking a rollover withdrawal between separation and the year-end following the year of separation or having positive plan balances at the year-end following the year of separation.

Figure 18. Contribution-inferred balances relative to starting pay (person-weighted)
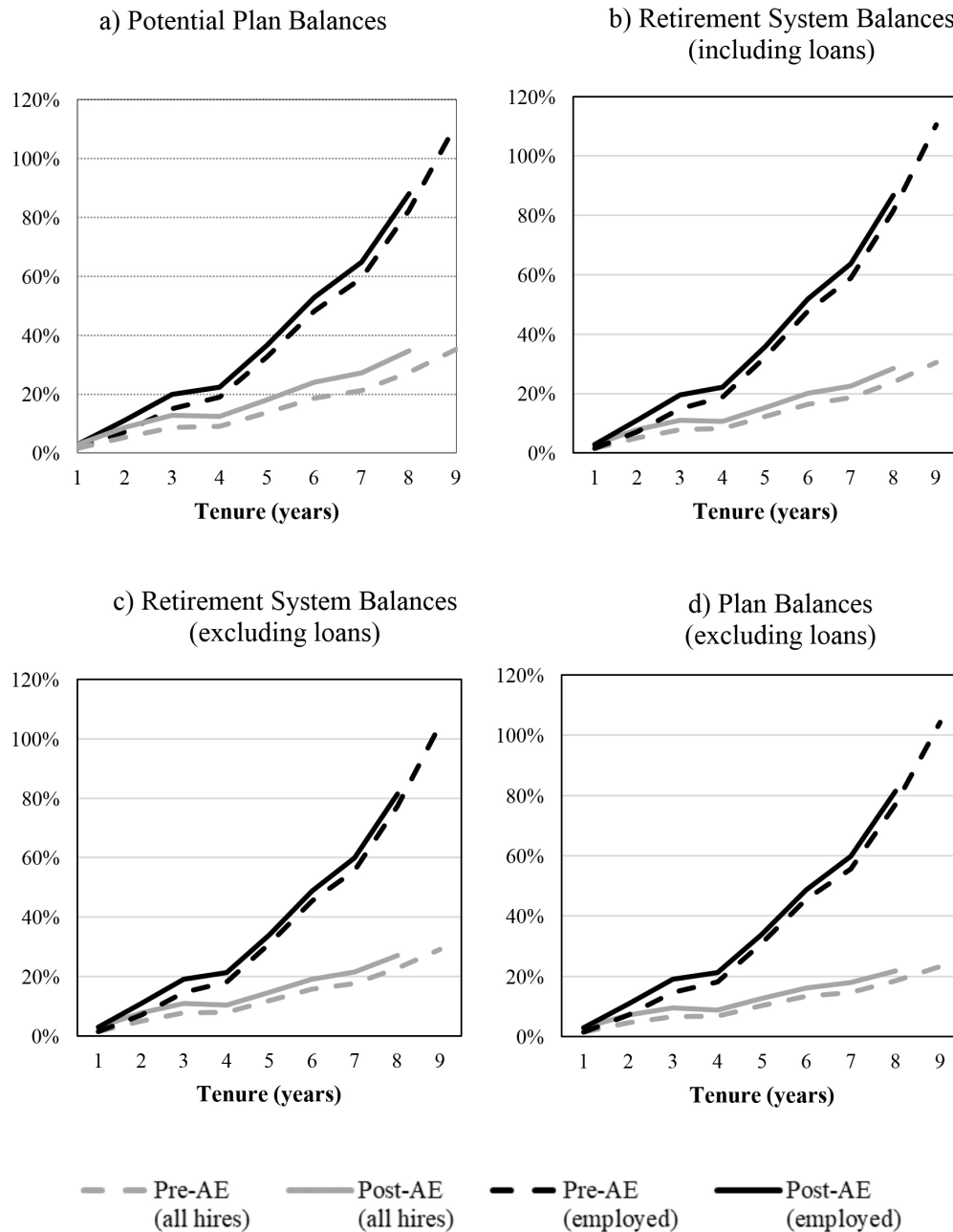
a) Potential Plan Balances

b) Retirement System Balances
(including loans)

c) Retirement System Balances
(excluding loans)

d) Plan Balances
(excluding loans)

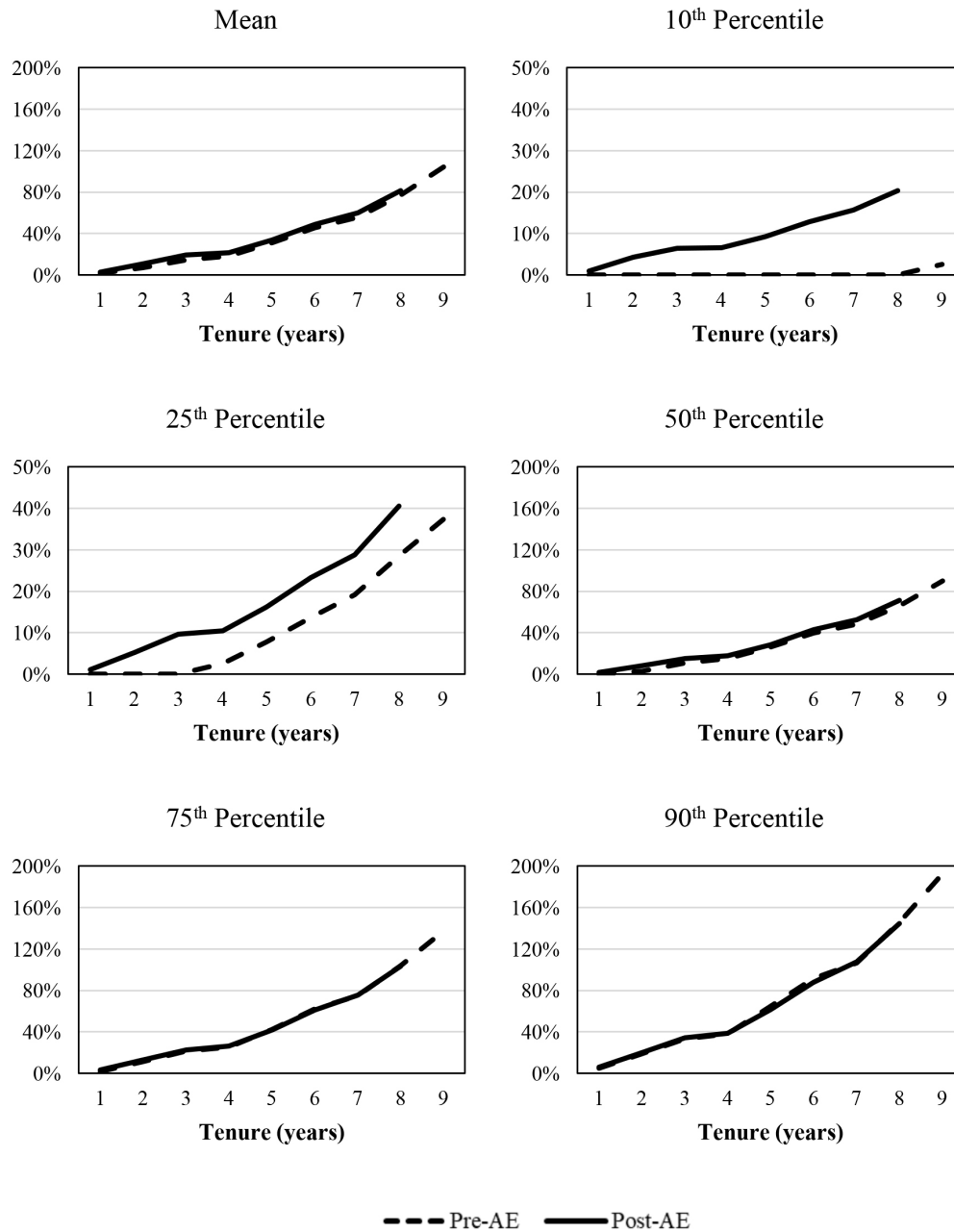Pre-AE (all hires) Post-AE (all hires) Pre-AE (employed) Post-AE (employed)

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The "empl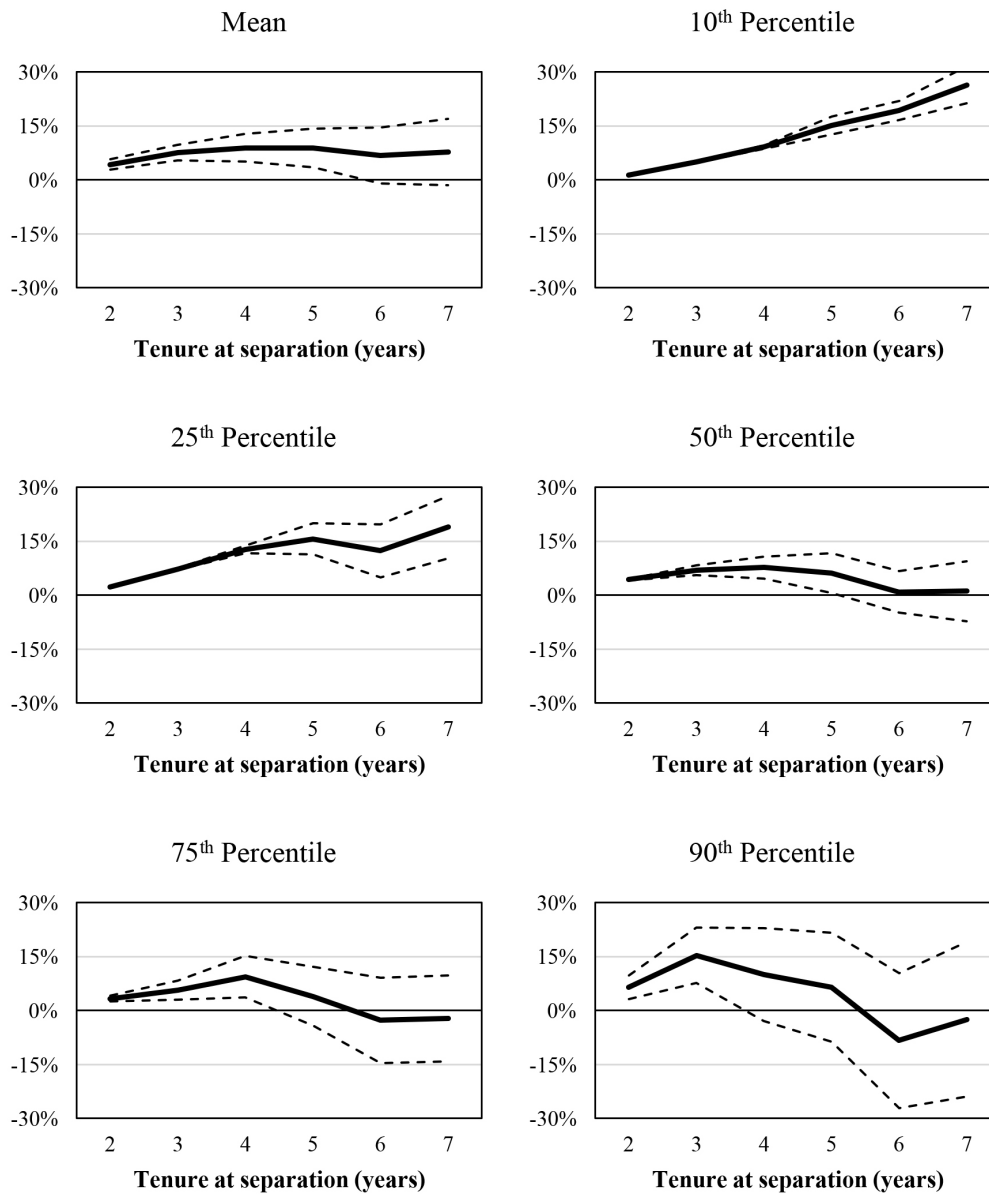oyed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (panel B). The different measures of contribution-inferred balances are calculated as described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 19. Ultimate destination of savings plan contributions (person-weighted)
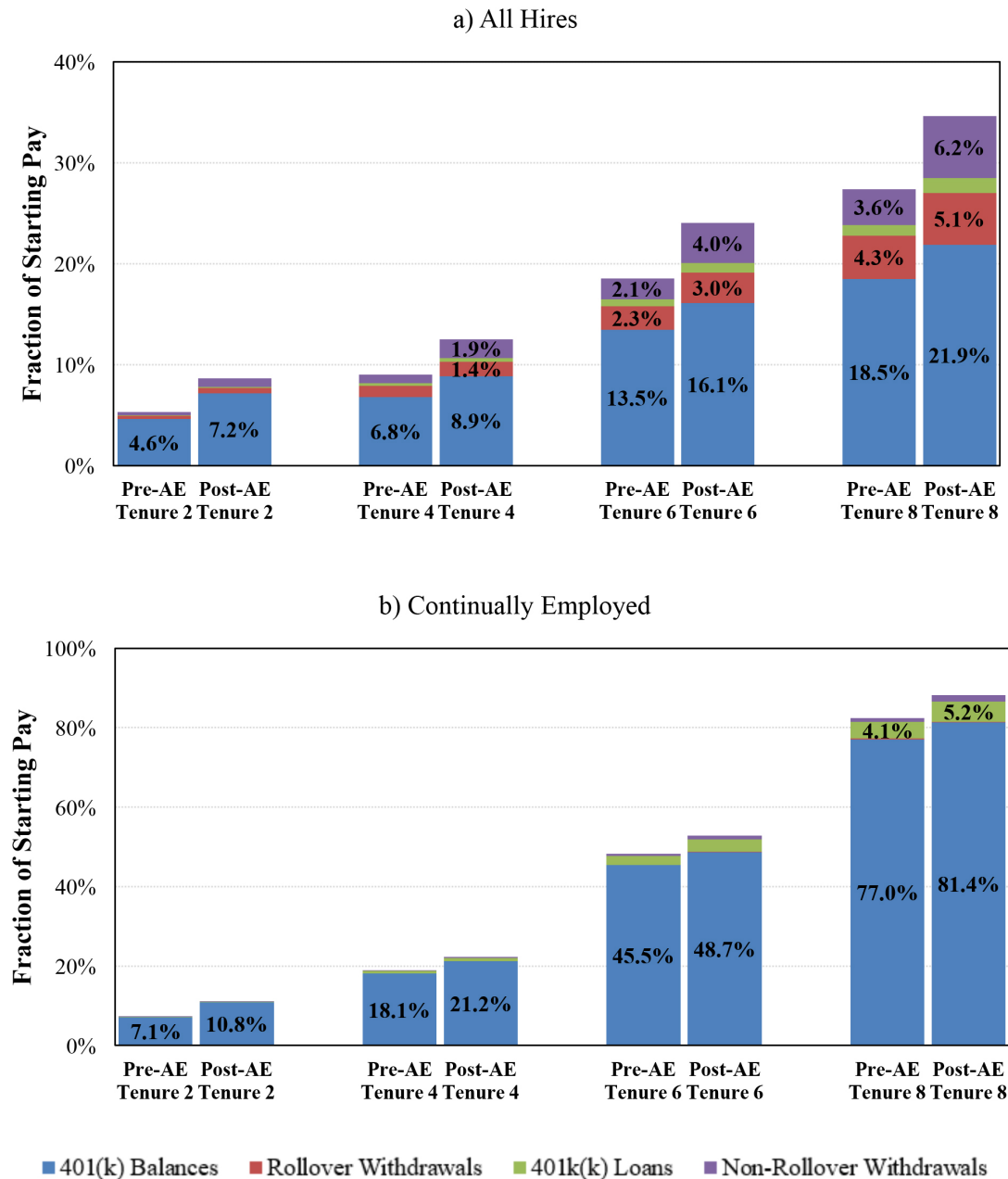
a) All Hires

b) Continually Employed

Legend: ■ 401(k) Balances ■ Rollover Withdrawals ■ 401k(k) Loans ■ Non-Rollover Withdrawals

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The continuously employed subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (panel B). The methodology used to ascribe contributions to different destinations is described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 20. Contribution-inferred potential plan balances relative to starting pay (all hires)

Mean

10th Percentile

25th Percentile

50th Percentile

75th Percentile

90th Percentile

- - - Pre-AE ——— Post-AE

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Contribution-inferred potential plan balances are calculated as described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 21. Contribution-inferred plan balances relative to starting pay (all hires)

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Contribution-inferred plan balances are calculated as described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 22. Contribution-inferred potential plan balances to starting pay (continuously employed)
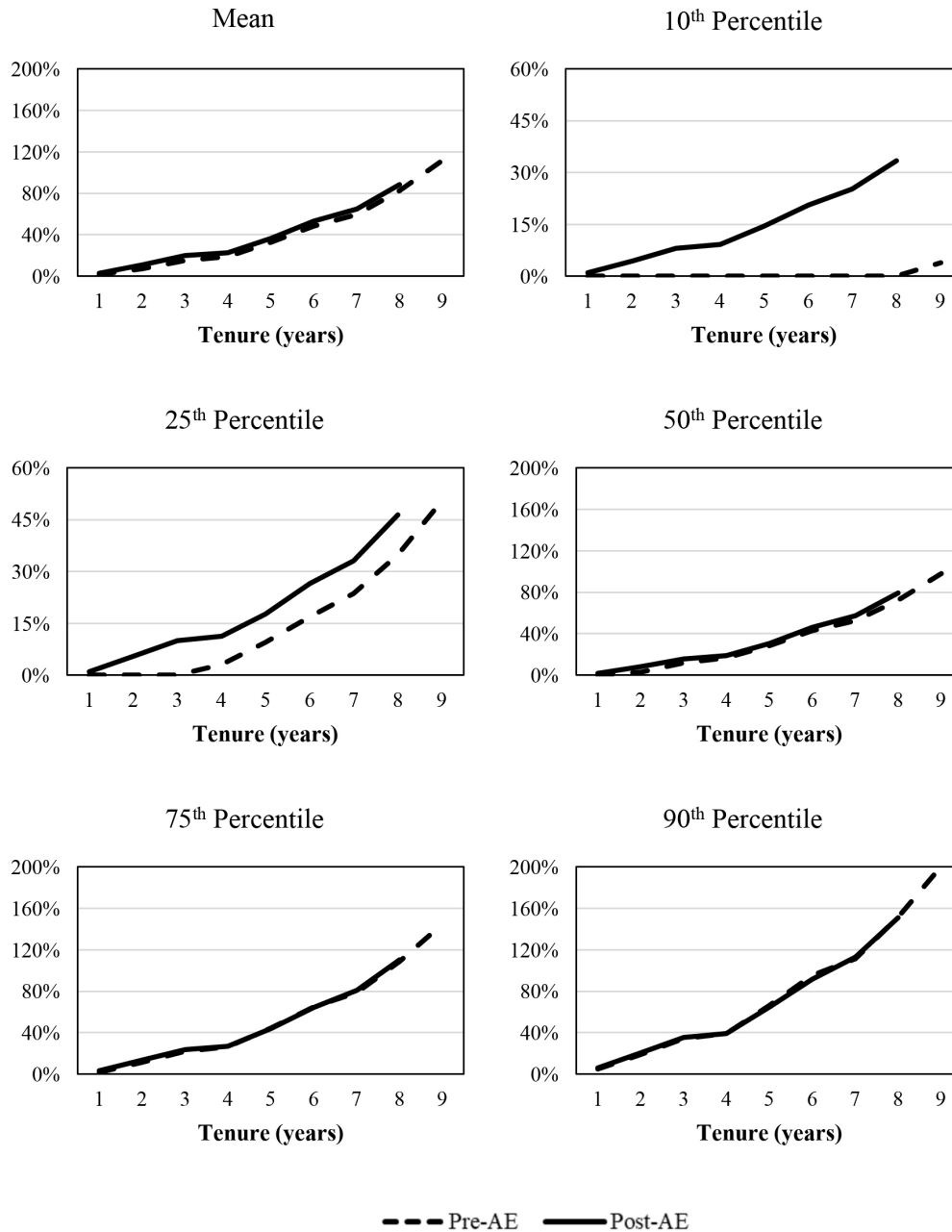
Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. Contribution-inferred potential plan balances are calculated as described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 23. Contribution-inferred plan balances to starting pay (continuously employed)

Mean

10th Percentile

25th Percentile

50th Percentile

75th Percentile

90th Percentile

- - - Pre-AE   —— Post-AE

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. Contribution-inferred plan balances are calculated as described in Section IV of the paper. Starting pay is the annualized salary during the calendar year corresponding to tenure year.

Figure 24. Post – Pre-AE contribution-inferred potential plan balances relative to starting pay eight years after hire by year of separation (separated employees)

Mean

10th Percentile

25th Percentile

50th Percentile

75th Percentile

90th Percentile

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm prior to tenure year eight. Contribution-inferred potential plan balances are calculated as described in Section IV of the paper and measured at tenure year eight. Starting pay is the annualized salary during the calendar year corresponding to tenure year. 95% confidence interval is included.

Figure 25. Post – Pre-AE Contribution-inferred retirement system balances (excluding loans) relative to starting pay eight years after hire by year of separation (separated employees)
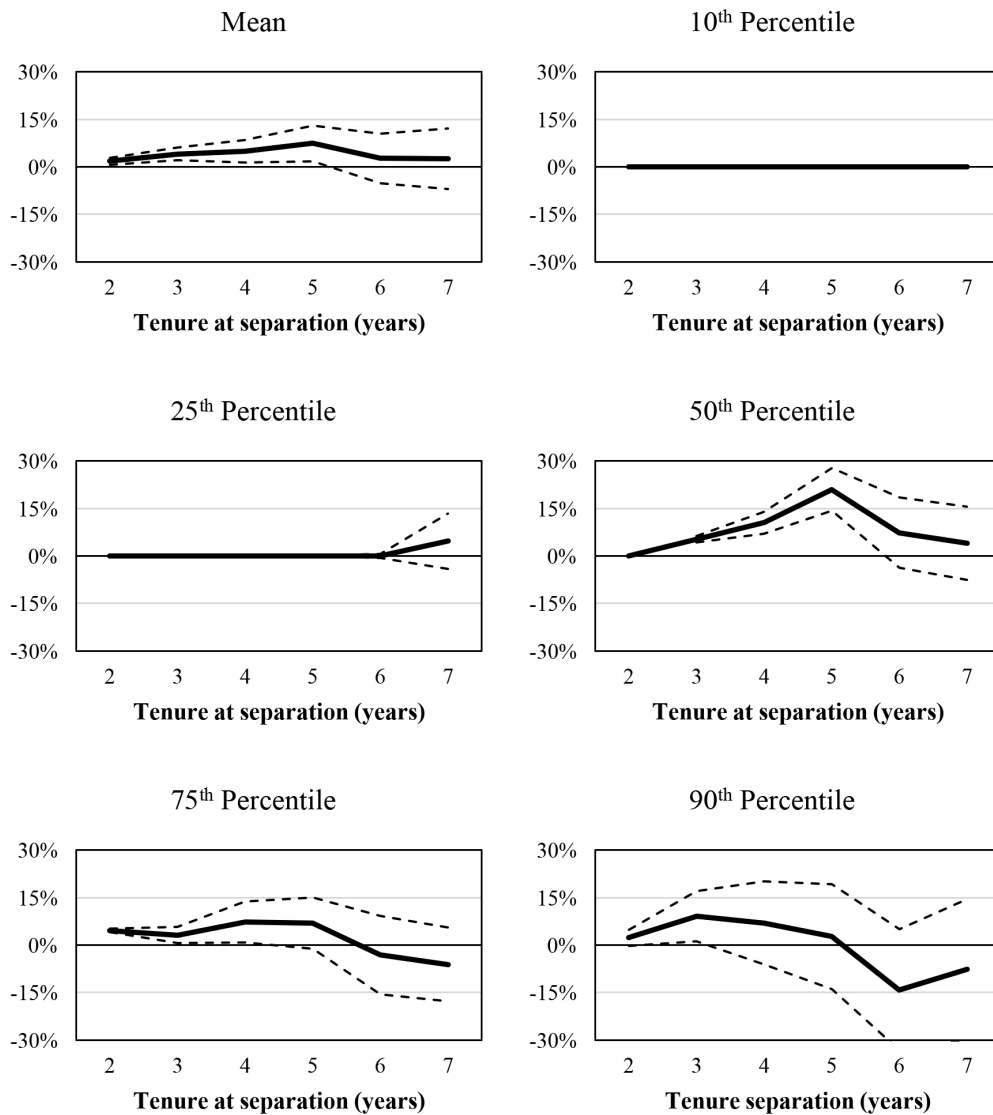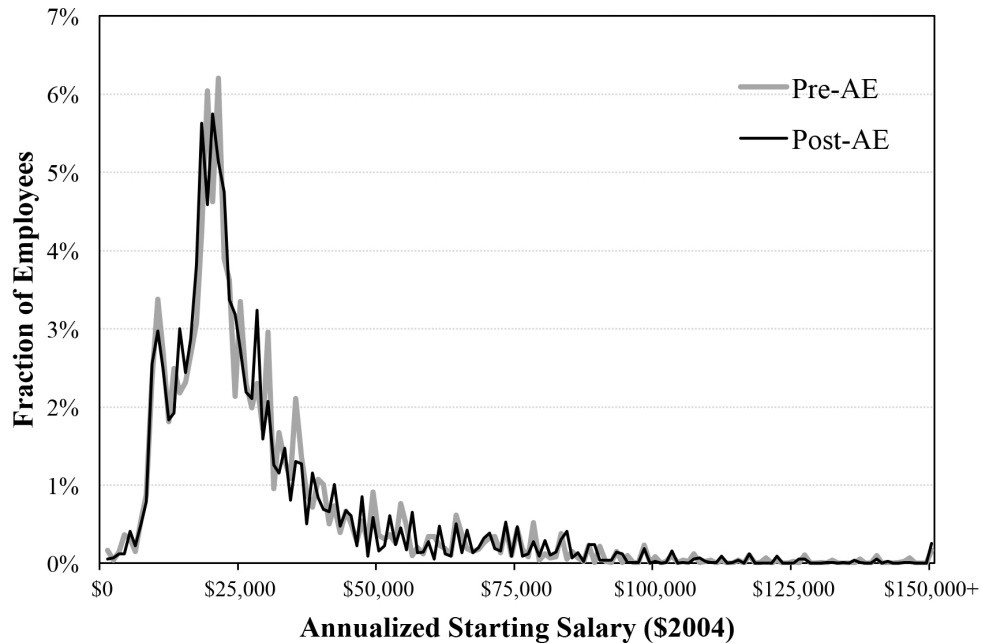

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm prior to tenure year eight. Contribution-inferred retirement system balances are calculated as described in Section IV of the paper and measured at tenure year eight. Starting pay is the annualized salary during the calendar year corresponding to tenure year. 95% confidence interval is included.

Appendix Table 1. Tenure Levels of the Pre- and Post-AE cohorts at different points in calendar time

| Date of year-end data observation | Pre-AE Cohort | | Post-AE Cohort | |
| | Hired 7/1/2004 to 6/30/2005 | | Hired 7/1/2005 to 6/30/2006 | |
	Tenure label	Tenure range	Tenure label	Tenure range
12/31/2005	Year 1	6-17 months	N/A	N/A
12/31/2006	Year 2	18-29 months	Year 1	6-17 months
12/31/2007	Year 3	30-41 months	Year 2	18-29 months
12/31/2008	Year 4	42-53 months	Year 3	30-41 months
12/31/2009	Year 5	54-65 months	Year 4	42-53 months
12/31/2010	Year 6	66-77 months	Year 5	54-65 months
12/31/2011	Year 7	78-89 months	Year 6	66-77 months
12/31/2012	Year 8	90-101 months	Year 7	78-89 months
12/31/2013	N/A	N/A	Year 8	90-101 months

Appendix Table 2. Distribution of starting salaries by cohort (in $2004)

| Average Starting Salary	Pre-AE cohort	Post-AE cohort
1st starting salary quartile	$11,717	$12,081
2nd starting salary quartile	$19,397	$19,417
3rd starting salary quartile	$26,870	$26,685
4th starting salary quartile	$57,363	$58,565

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Starting salary is the annualized salary during the calendar year corresponding to tenure year one. Salaries are deflated to 2004 dollars using growth in seasonally adjusted average weekly earnings for private sector workers from the Current Employment Statistics survey. Quartile cutoffs are determined by pooling deflated starting salaries of both cohorts together.

Appendix Figure 1. Distribution of time to plan eligibility
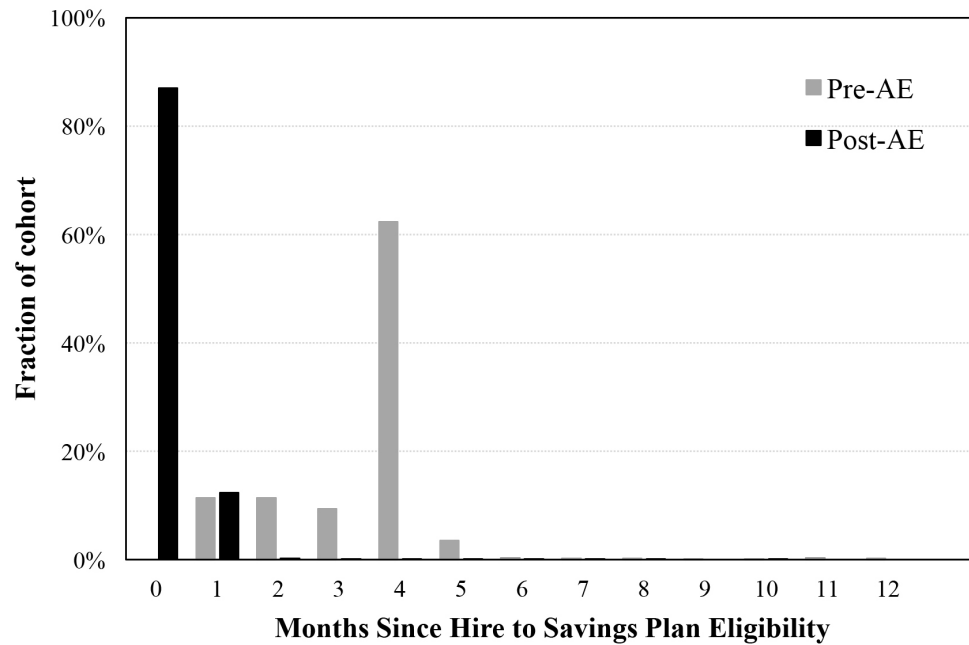
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1.

Appendix Figure 2. Employee retention rate by starting salary quartile

1st Starting Salary Quartile

2nd Starting Salary Quartile

3rd Starting Salary Quartile

4th Starting Salary Quartile

- - - Pre-AE ——— Post-AE

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one. The employee retention rate is defined as the fraction of these employees continuously employed through the indicated level of tenure as defined in Appendix Table 1.

Appendix Figure 3. Distribution of starting salaries by cohort ($2004)

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Starting salary is the annualized salary during the calendar year corresponding to tenure year one. Salaries are deflated to 2004 dollars using growth in seasonally adjusted average weekly earnings for private sector workers from the Current Employment Statistics survey. Salaries are binned into buckets of $1,000 except for the final bucket, which includes all those with a starting salary equal to or greater than $150,000.

Appendix Figure 4. Cumulative distribution of hire months

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1.

Appendix Figure 5. Distribution of monthly contribution rates (continuously employed)
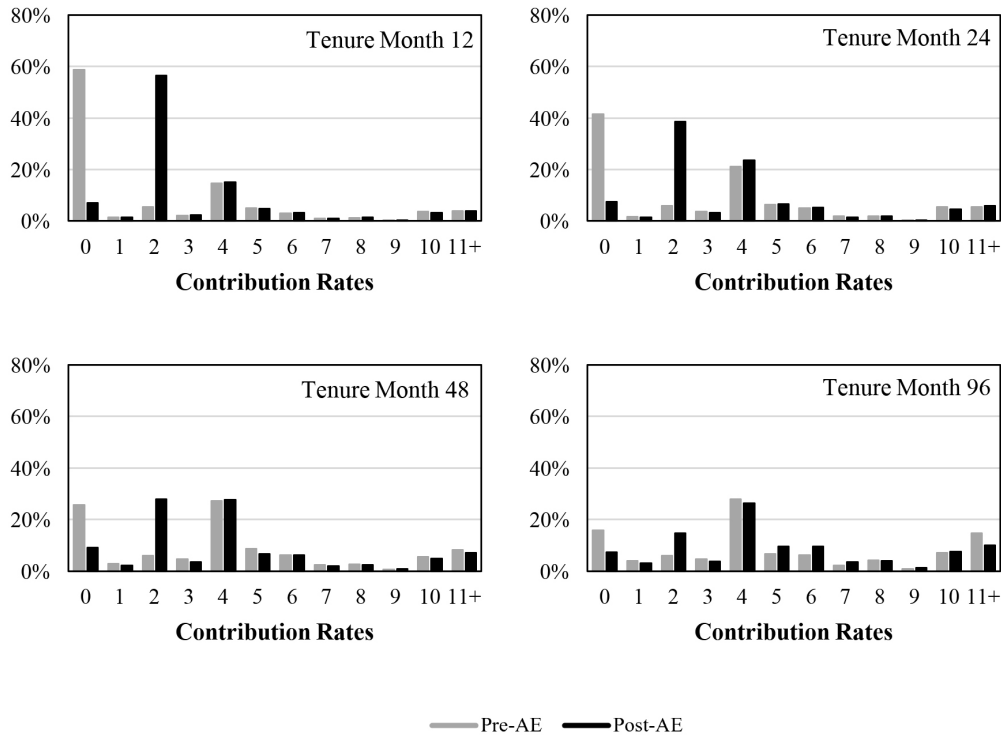
Pre-AE Post-AE

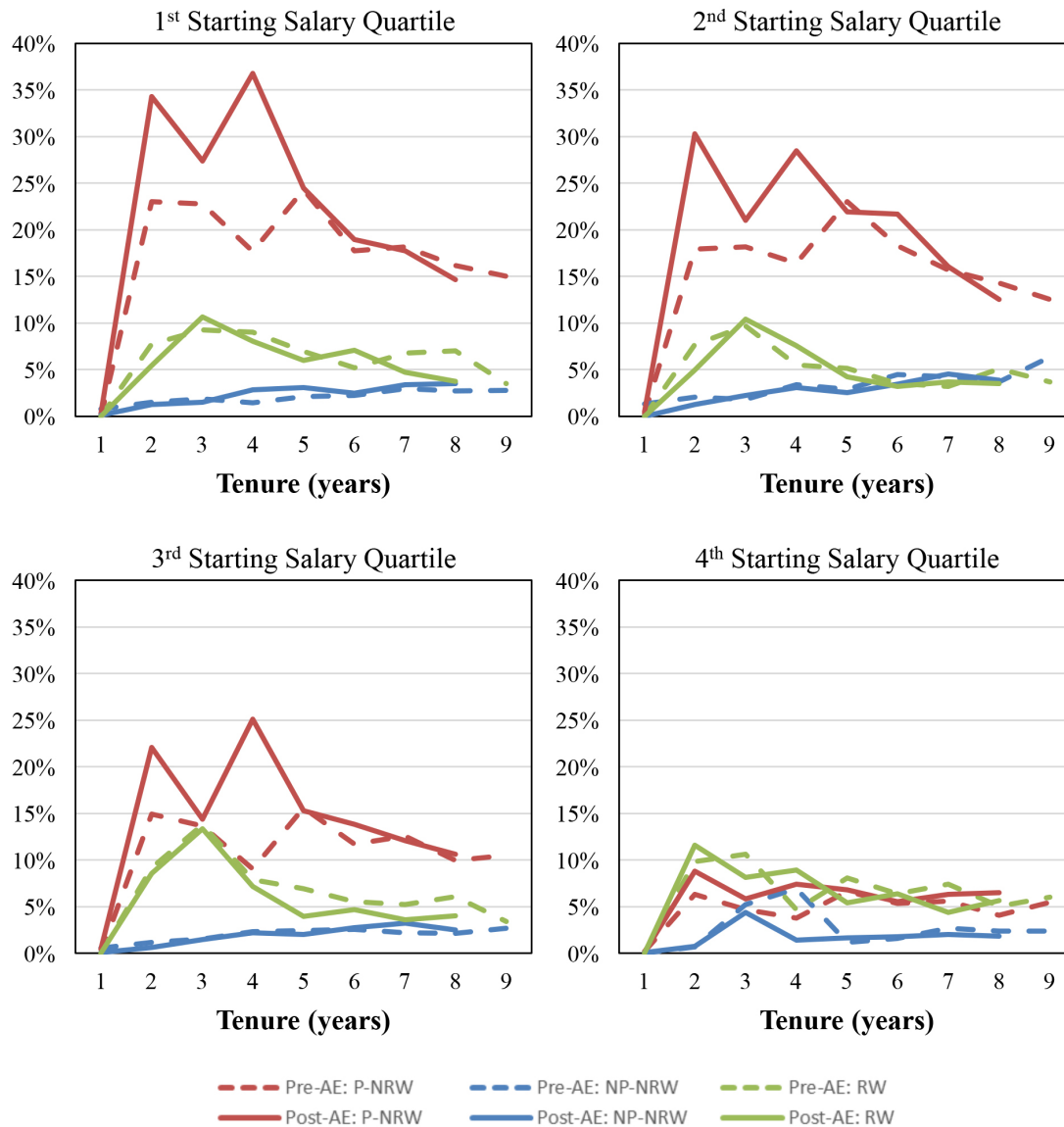Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. The contribution rate is the sum of employee before-tax, after-tax, and Roth contribution rates as a percentage of pay. Each histogram plots the distribution of employee contribution rates at the indicated month of tenure as defined as time since hire.

Appendix Figure 6. Distribution of monthly contribution rates, by salary quartile (continuously employed)
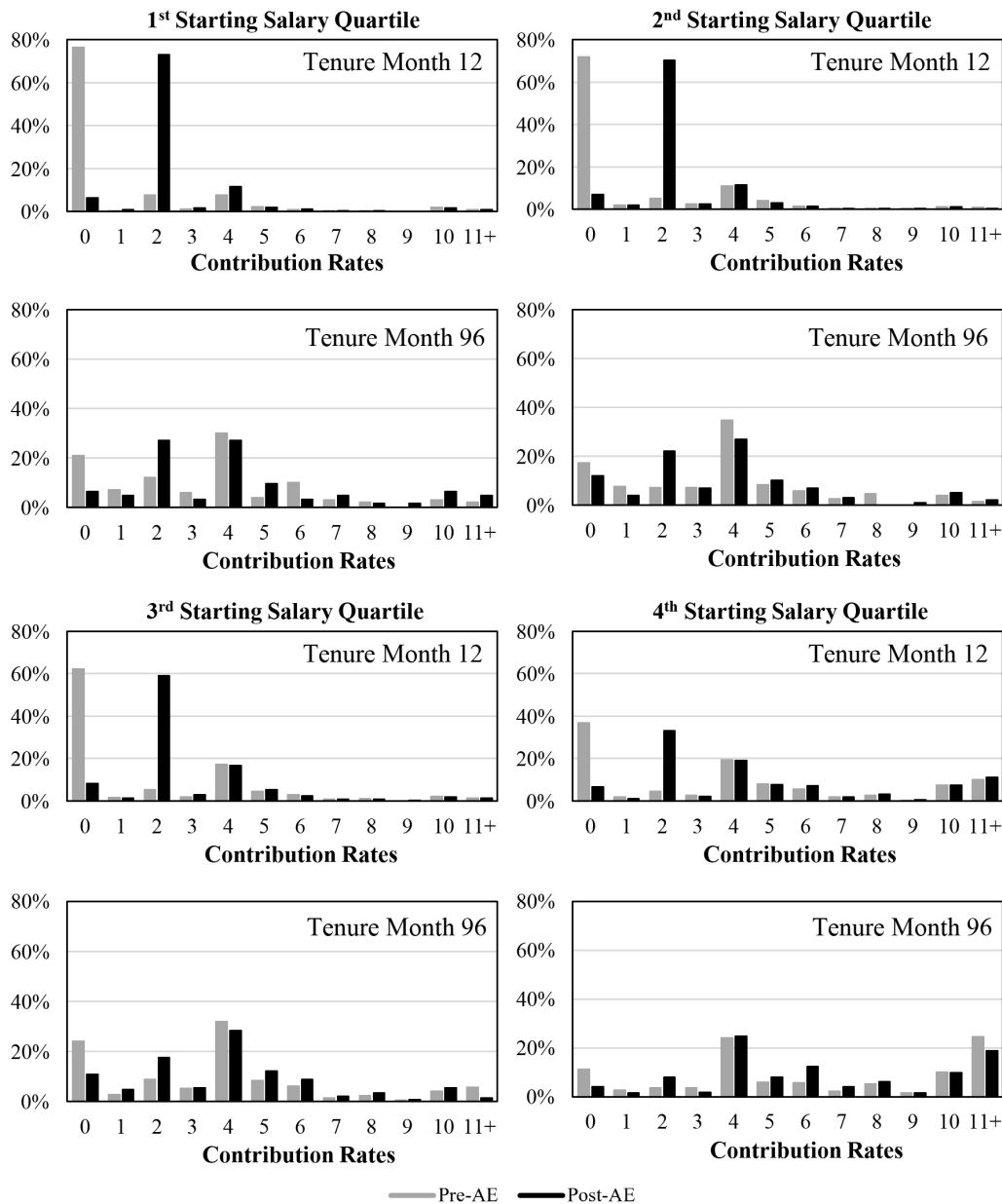
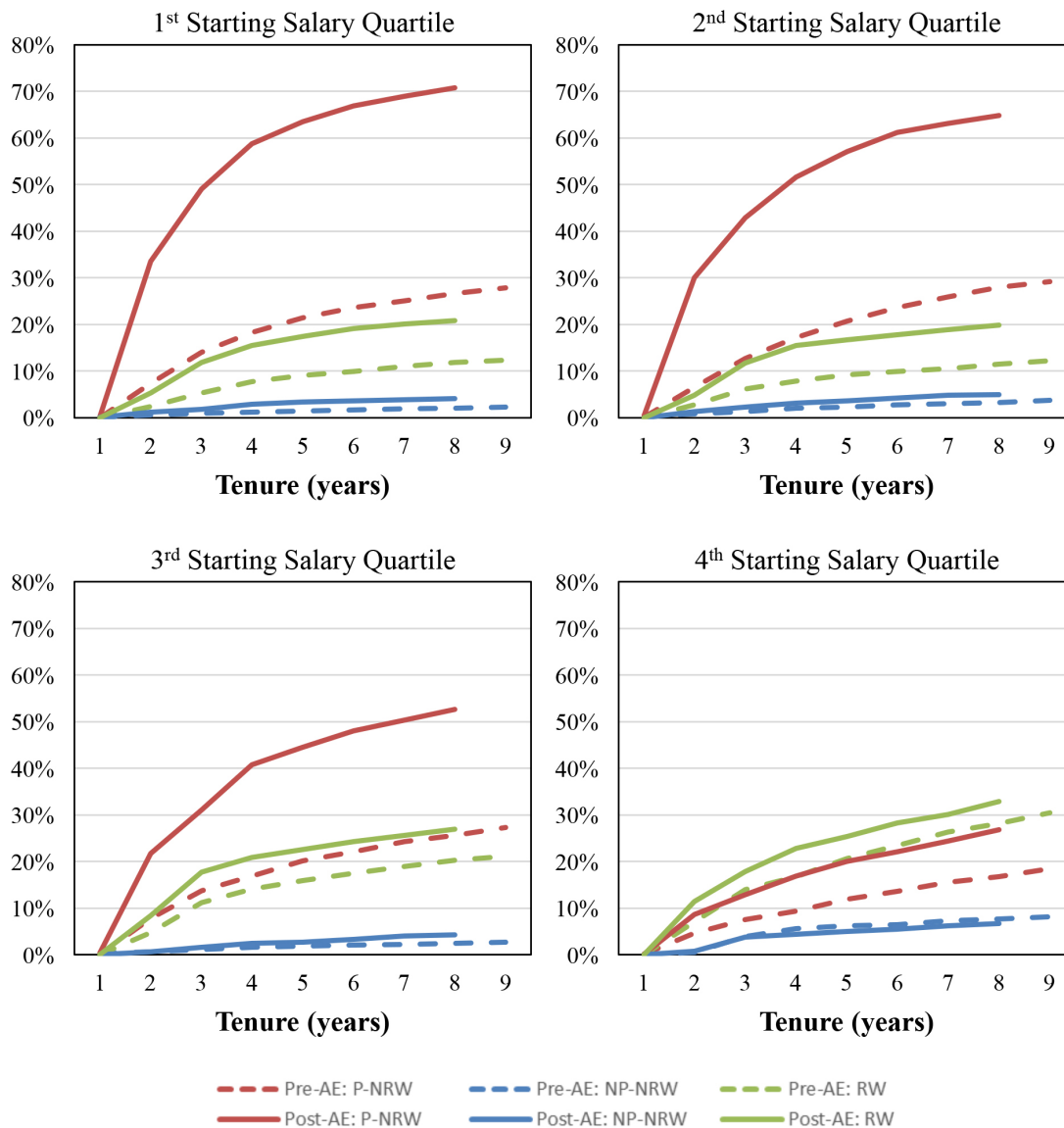

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. The contribution rate is the sum of employee before-tax, after-tax, and Roth contribution rates as a percentage of pay. Each histogram plots the distribution of employee contribution rates at the indicated month of tenure as defined as time since hire.

Appendix Figure 7. Savings plan balances relative to starting pay by salary quartile
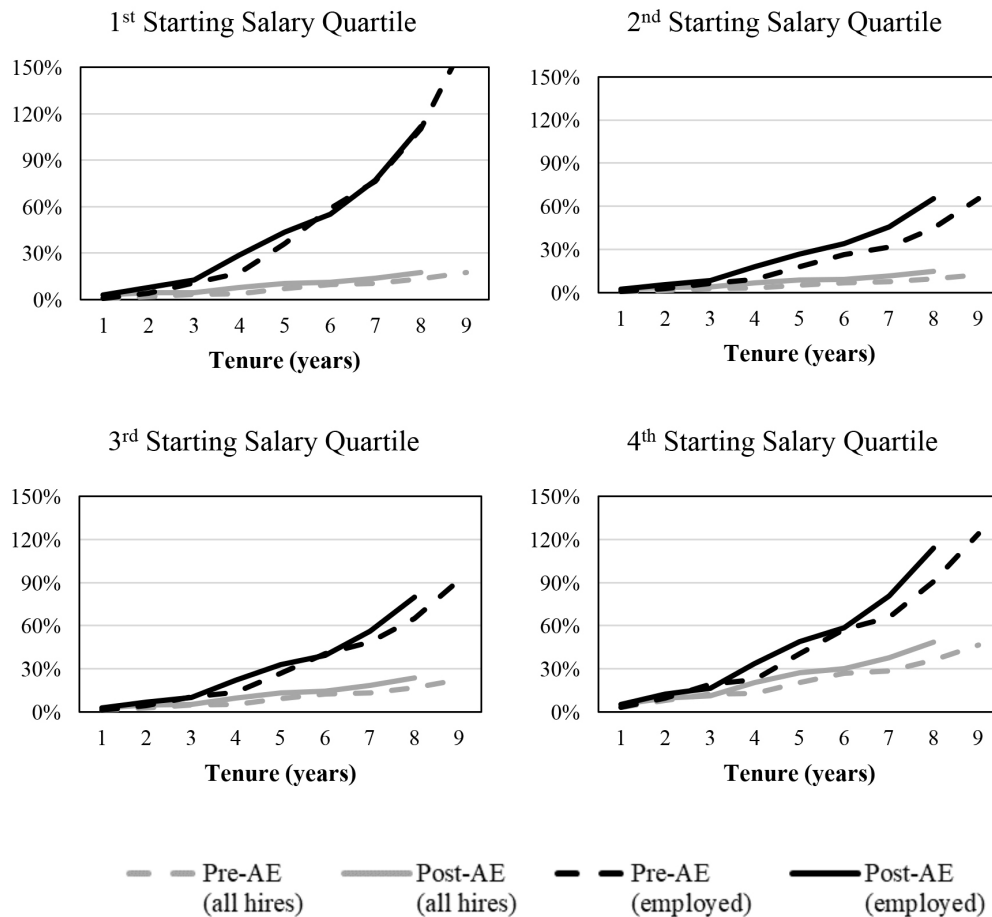
1st Starting Salary Quartile

2nd Starting Salary Quartile

3rd Starting Salary Quartile

4th Starting Salary Quartile

Legend:
- Pre-AE (all hires)
- Post-AE (all hires)
- Pre-AE (employed)
- Post-AE (employed)
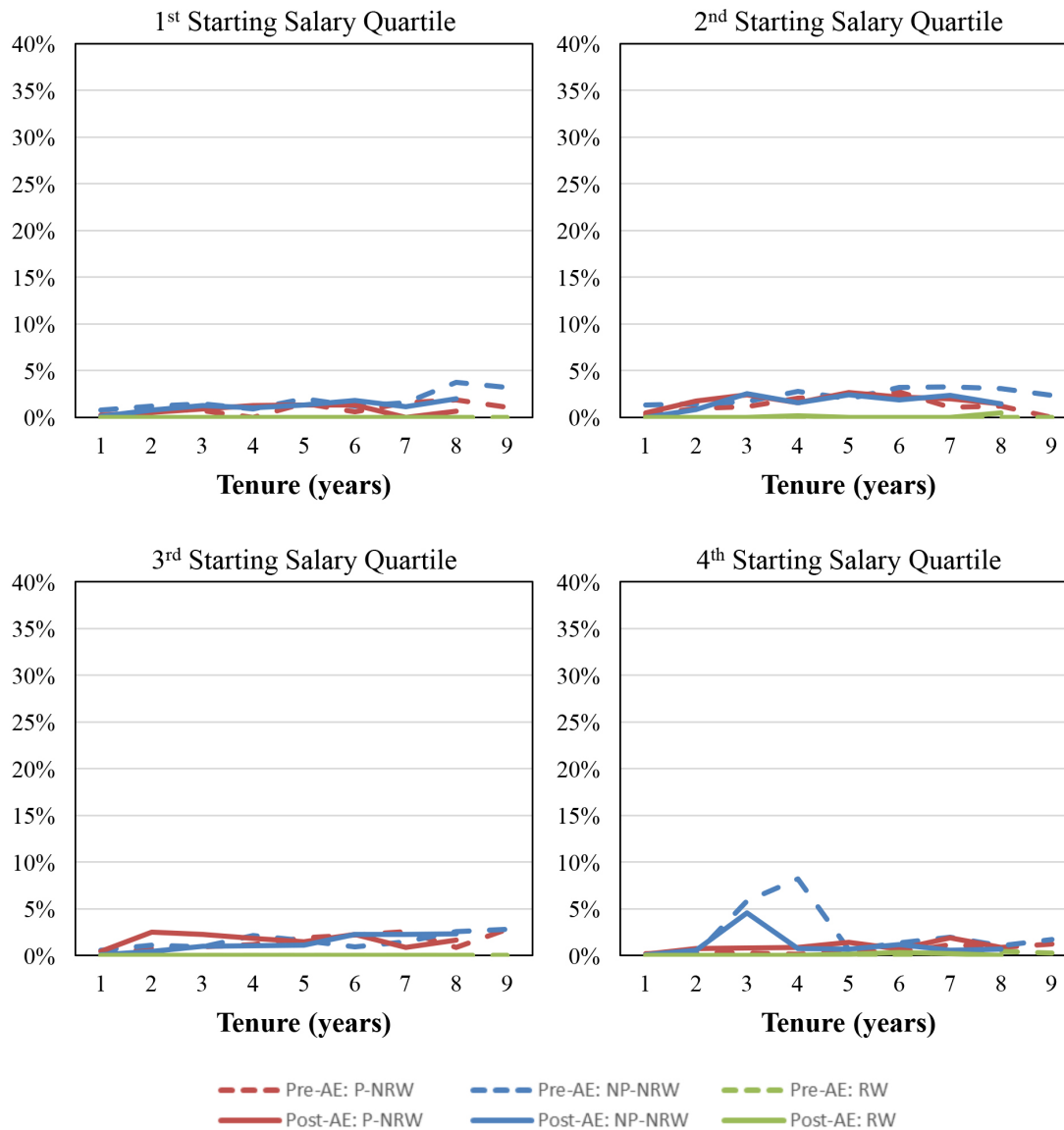
Source: Authors' calculations. The sample is all hires continuously employed through tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. Plan balances include before-tax, after-tax, Roth, and employer match balances. Outstanding 401(k) loan amounts are excluded. Starting pay is the annualized salary during the calendar year corresponding to tenure year one. Person-weighted ratio.

Appendix Figure 8. Average number of outstanding loans for participants with a loan (continuously employed)
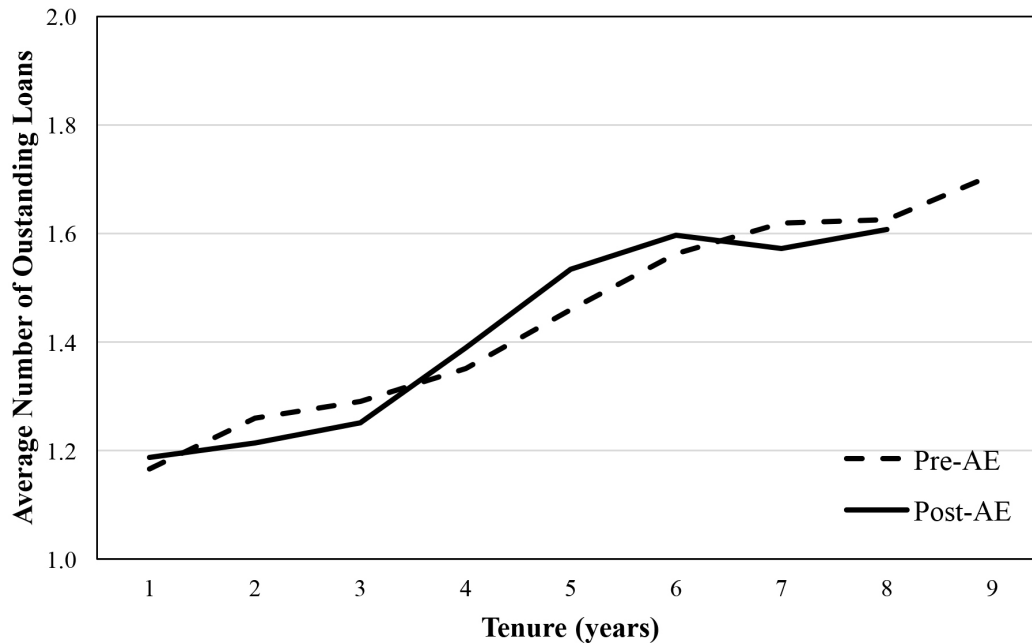
Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for and participating in the plan with a non-zero outstanding loan balance at the indicated level of tenure as defined in Appendix Table 1. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure shows average number of outstanding loans for participants with a loan.

Appendix Figure 9. Loan repayment and default as a fraction of cumulative loan amounts
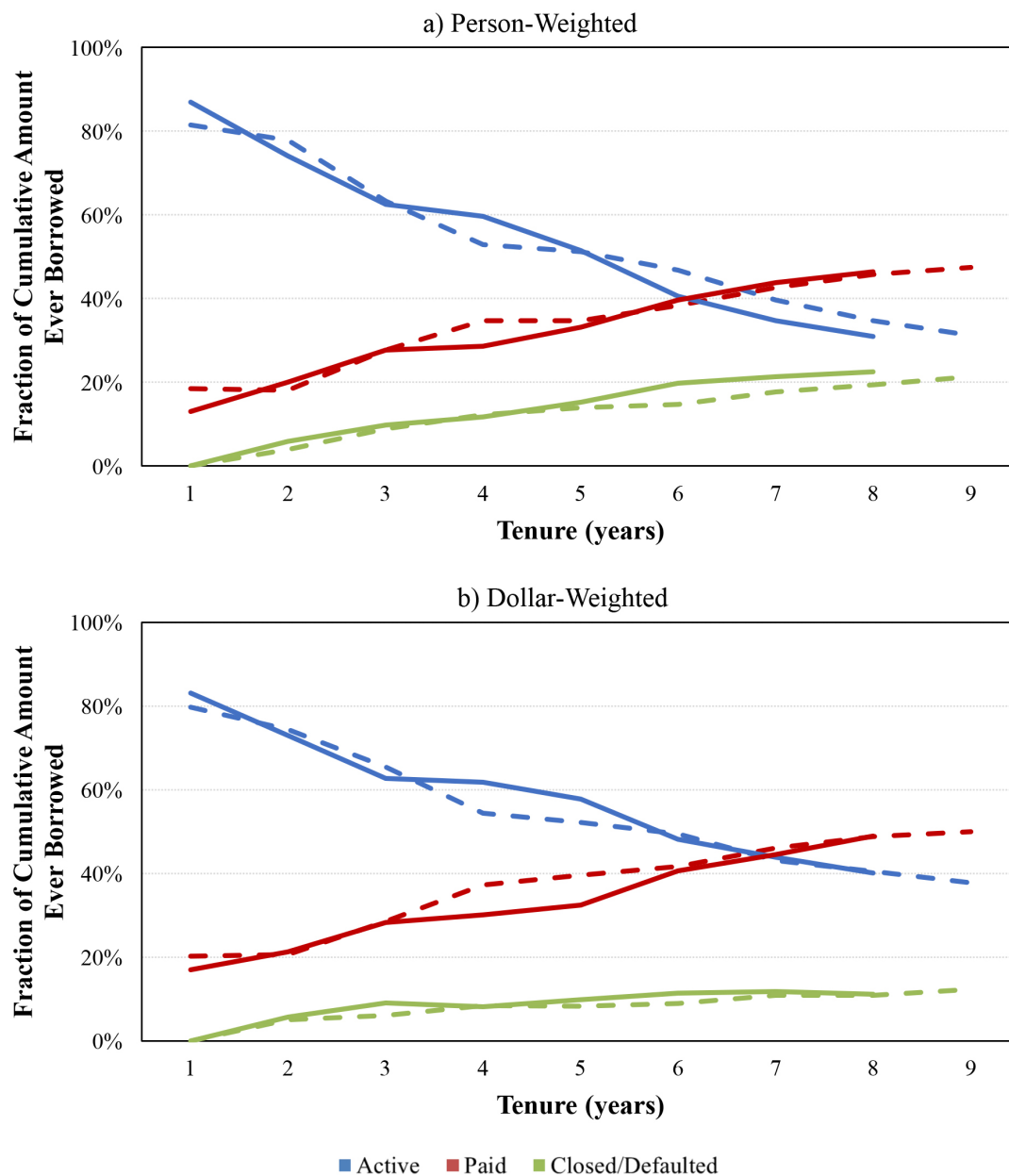
a) Person-Weighted

b) Dollar-Weighted

■ Active ■ Paid ■ Closed/Defaulted

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plans at tenure year one (as defined in Appendix Table 1) who have ever participated in the savings plan and taken out a plan loan. The figure shows the fraction of cumulative loan amounts ever borrowed that are active (still oustanding), have been repaid, or have been closed without being repaid (default) at the indicated level of tenure.

Appendix Figure 10. Fraction of participants with a withdrawal, by starting salary quartile (all hires)

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) and participating in the plan (defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year). The figure plots the fraction of participants with a penalized non-rollover withdrawal, non-penalized non-rollover withdrawal, or rollover withdrawal during the indicated tenure year.

Appendix Figure 11. Fraction of individuals who have ever taken a withdrawal, by salary quartile (all hires)

Source: Authors' calculations. The sample is all hires continuously employed through tenure year one as defined in Appendix Table 1. The figure plots the cumulative fraction of all hires (regardless of plan participation) who have ever taken a penalized non-rollover withdrawal, a non-penalized non-rollover withdrawal, or a (non-penalized) rollover withdrawal through the indicated tenure year.

Appendix Figure 12. Fraction of participants with a withdrawal, by salary quartile (continuously employed)
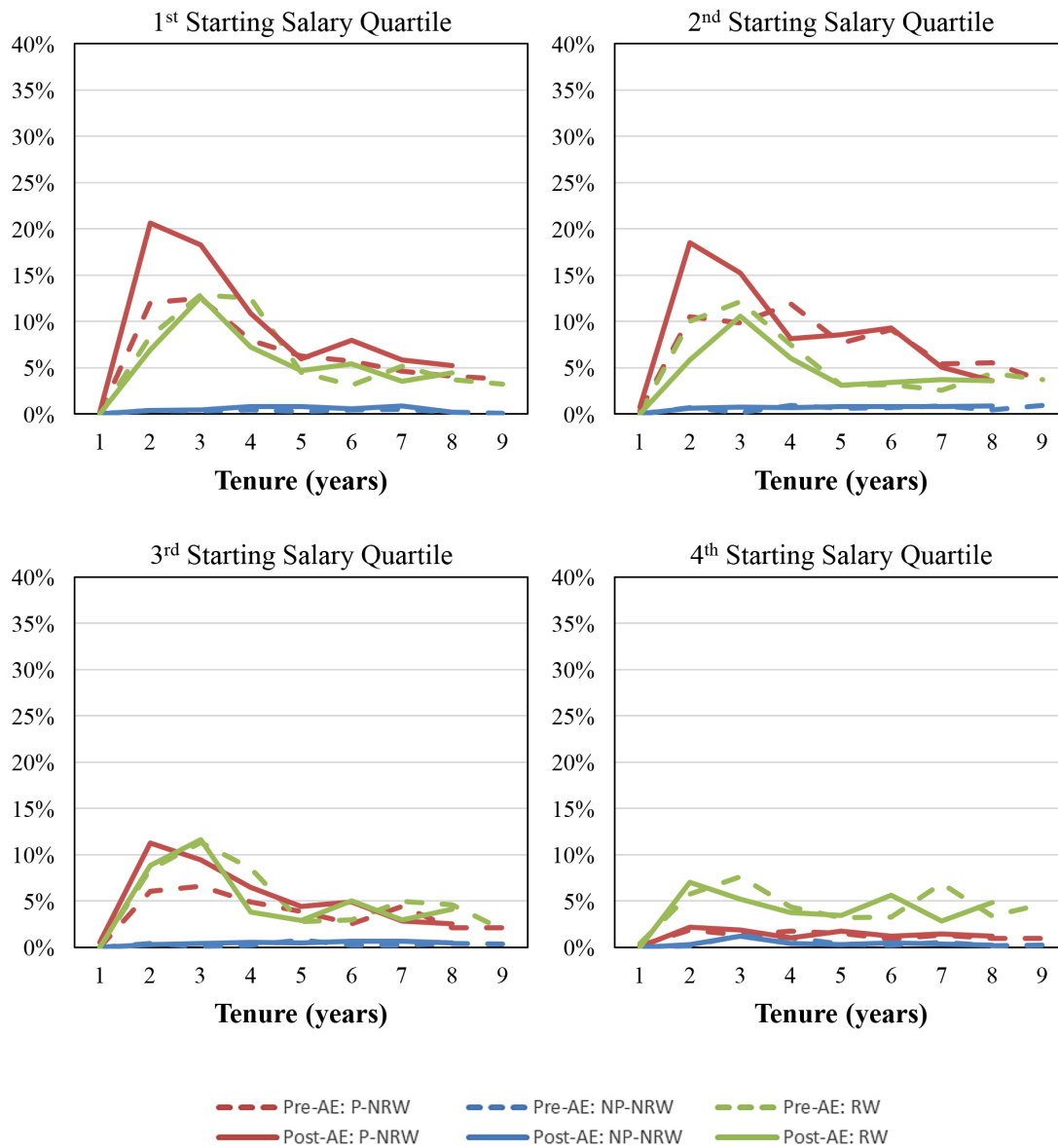

Source: Authors' calculations. The sample is restricted to those continuously employed through the indicated tenure year (as defined in Appendix Table 1) and participating in the plan (defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year). This figure plots the fraction of participants with a penalized non-rollover withdrawal, a non-penalized non-rollover withdrawal, or a (non-penalized) rollover withdrawal during the indicated tenure year.

Appendix Figure 13. Fraction of individuals who have ever taken a withdrawal, by salary quartile (continuously employed)

Legend:
- Pre-AE: P-NRW
- Pre-AE: NP-NRW
- Pre-AE: RW
- Post-AE: P-NRW
- Post-AE: NP-NRW
- Post-AE: RW

Source: Authors' calculations. The sample is restricted to those continuously employed through the indicated tenure year as defined in Appendix Table 1. The figure plots the cumulative fraction of employees (regardless of plan participation) who have ever taken a penalized non-rollover withdrawal, a non-penalized non-rollover withdrawal, or a (non-penalized) rollover withdrawal through the indicated tenure year.

Appendix Figure 14. Yearly withdrawals as a fraction of plan balances, by salary quartile (all hires, person-weighted)
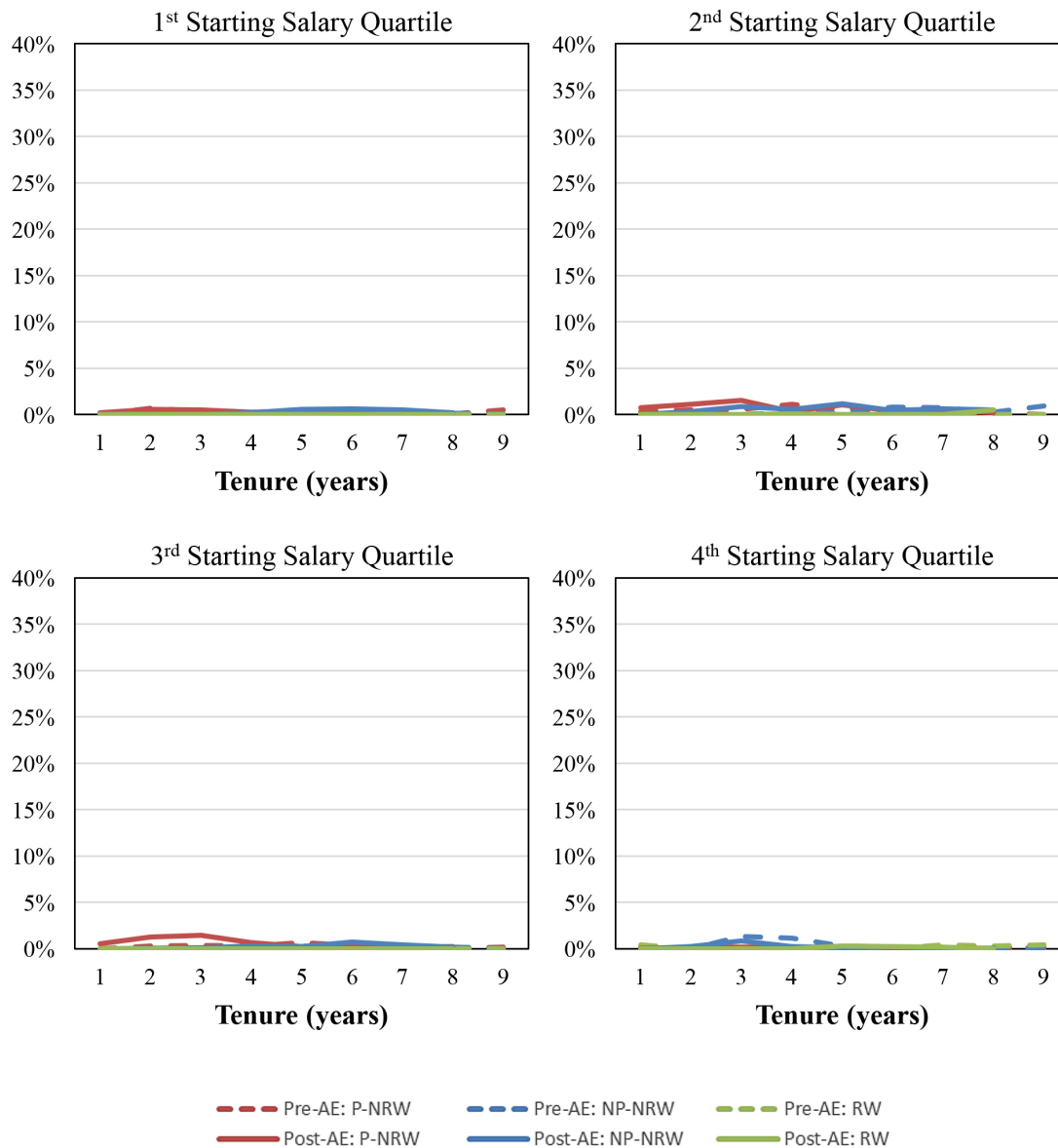
Source: Authors' calculations. The sample is all hires continuously employed through tenure year one and participating in the plan at the indicated level of tenure. Participation is defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year. The figure plots the person-weighted value of calendar year penalized non-rollover withdrawals, non-penalized non-rollover withdrawals, and (non-penalized) rollover withdrawals, as a fraction of the sum of year-end plan balances and calendar-year withdrawals.

Appendix Figure 15. Yearly withdrawals as a fraction of plan balances, by salary quartile (all hires; dollar-weighted)

Appendix Figure 16. Yearly withdrawals as a fraction of plan balances, by salary quartile (continuously employed, person-weighted)
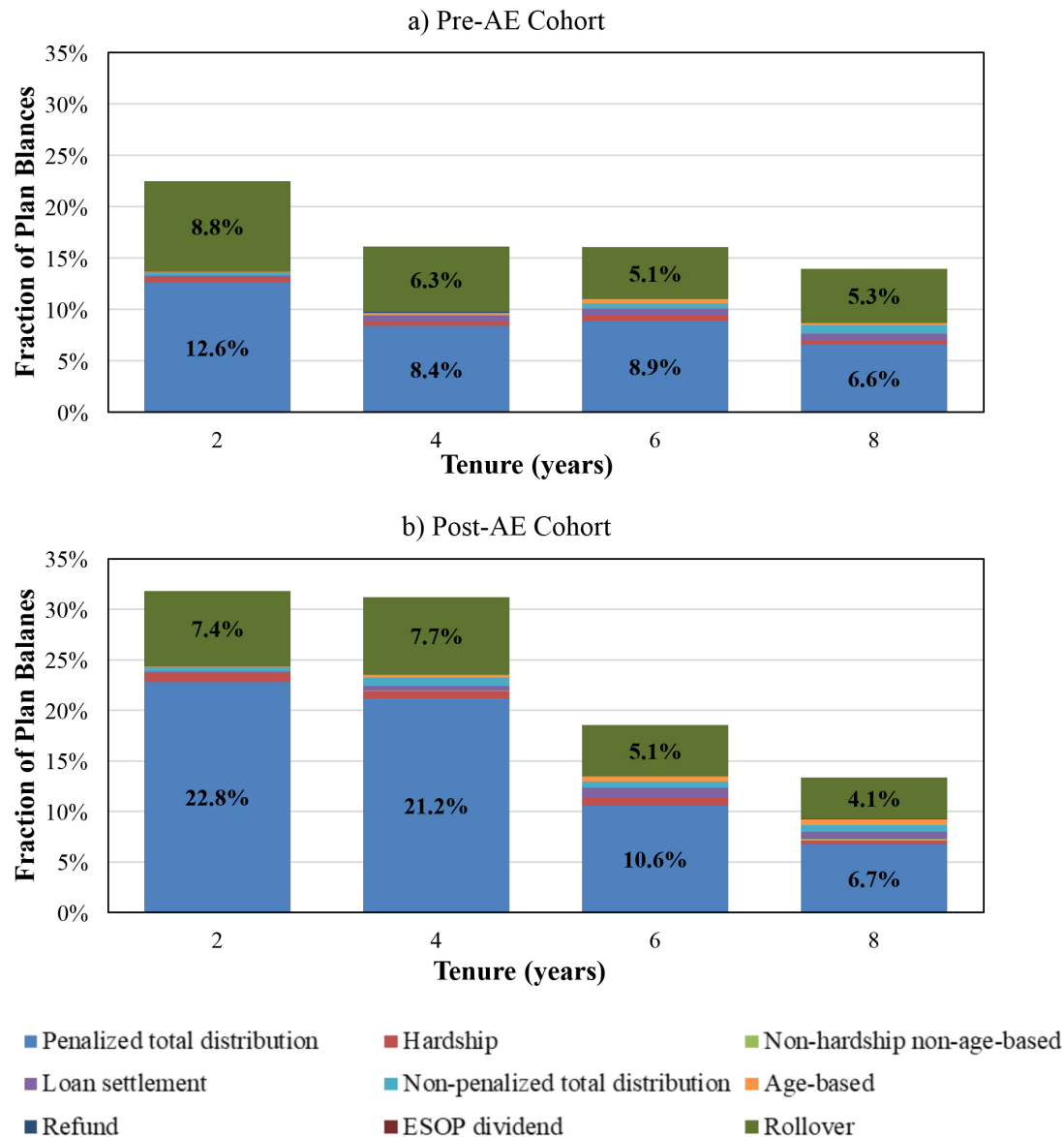

Source: Authors' calculations. The sample is restricted to those continuously employed through the indicated tenure year (as defined in Appendix Table 1) and participating in the plan (defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year). The figure plots the person-weighted value of calendar year penalized non-rollover withdrawals, non-penalized non-rollover withdrawals, and (non-penalized) rollover withdrawals, as a fraction of the sum of year-end plan balances and calendar-year withdrawals.

Appendix Figure 17. Yearly withdrawals as a fraction of plan balances, by salary quartile (continuously employed, dollar-weighted)
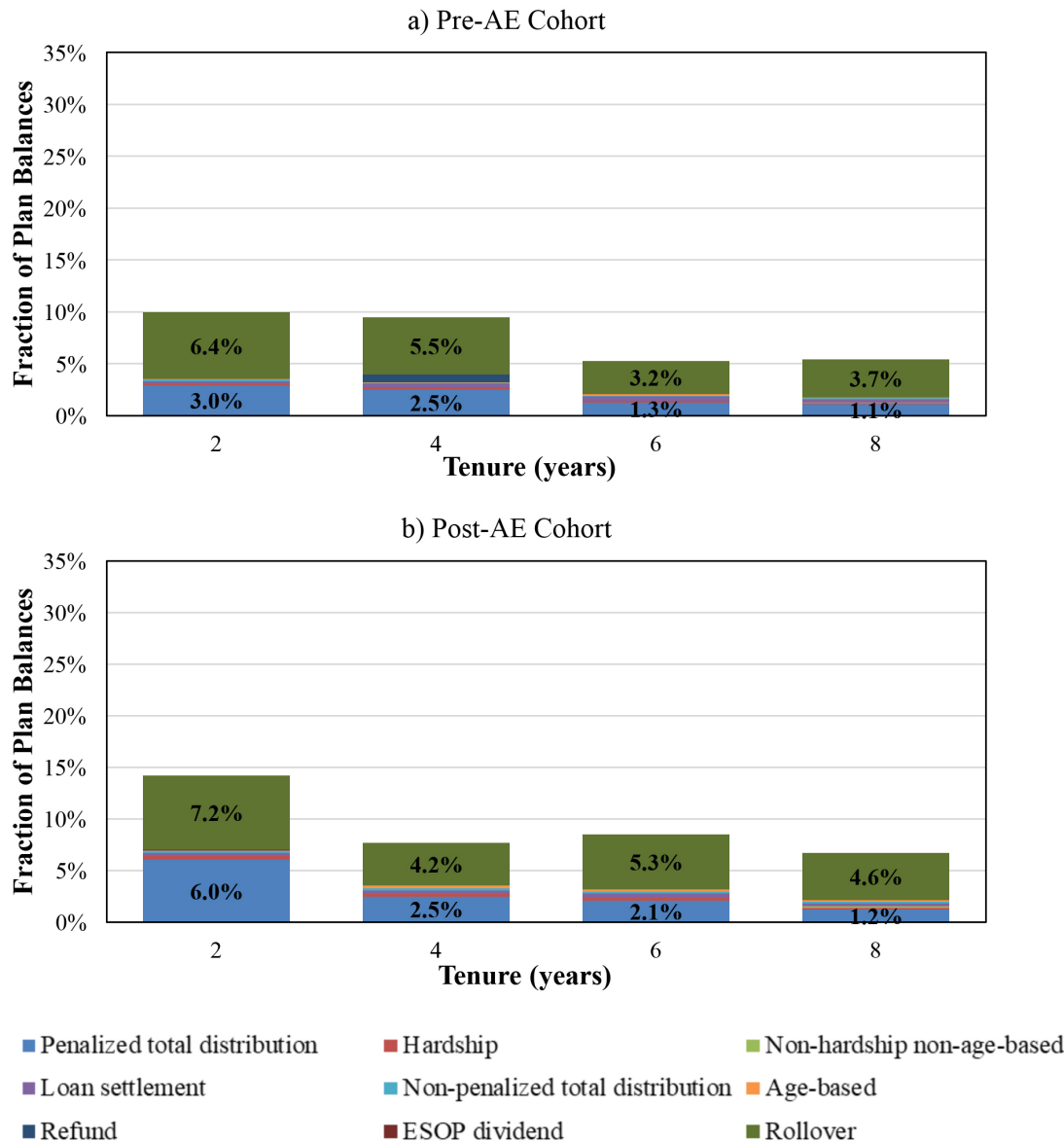

Source: Authors' calculations. The sample is restricted to those continuously employed through the indicated tenure year (as defined in Appendix Table 1) and participating in the plan (defined as having either a positive balance at the indicated level of tenure or having activity in the plan during the previous calendar year). The figure plots the dollar-weighted value of calendar year penalized non-rollover withdrawals, non-penalized non-rollover withdrawals, and (non-penalized) rollover withdrawals, as a fraction of the sum of year-end plan balances and calendar-year withdrawals.

Appendix Figure 18. Categorized yearly withdrawals as a fraction of plan balances (all hires, person-weighted)

a) Pre-AE Cohort

b) Post-AE Cohort

Legend:
- Penalized total distribution
- Hardship
- Non-hardship non-age-based
- Loan settlement
- Non-penalized total distribution
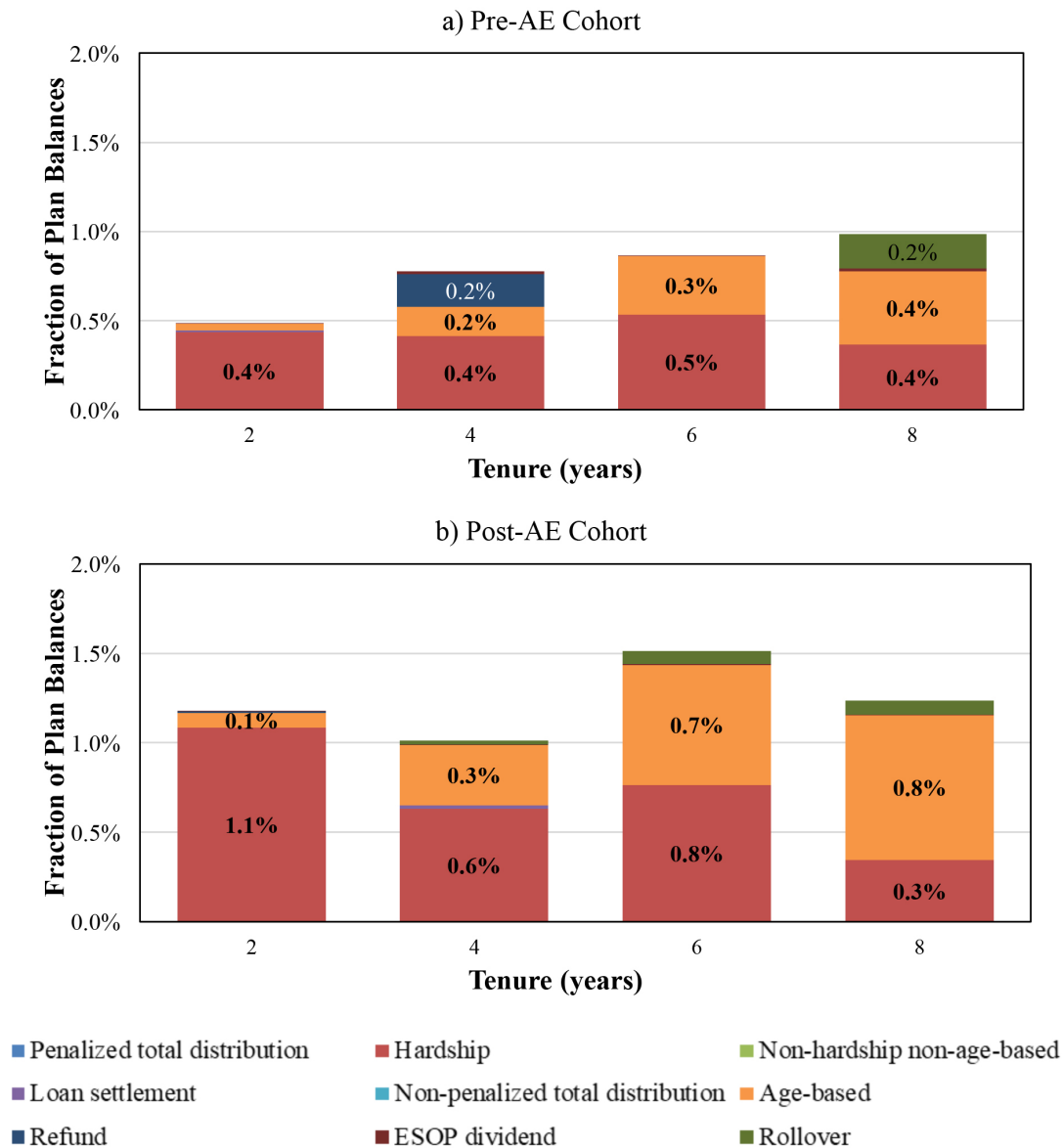- Age-based
- Refund
- ESOP dividend
- Rollover

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one (as defined in Appendix Table 1) who have ever participated in the savings plan and taken a plan withdrawal. The figures plot person-weighted withdrawals, by category, made during the calendar year as a faction of the sum year-end balances and all calendar-year withdrawals. Penalized total distributions are total taken at separation before age 55, while non-penalized ones are taken after age 55. Age-based withdrawals are in-service withdrawals taken after age 59½. Loan settlements are withdrawals used to pay off outstanding plan loans. Refunds are contributions returned to highly compensated employees to comply with plan non-discrimination tests. ESOP dividend withdrawals result from elections to receive ESOP dividend payments as cash.

a) Pre-AE Cohort

b) Post-AE Cohort

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one (as defined in Appendix Table 1) who have ever participated in the savings plan and taken a plan withdrawal. The figures plot dollar-weighted withdrawals, by category, made during the calendar year as a faction of the sum year-end balances and all calendar-year withdrawals. Penalized total distributions are total taken at separation before age 55, while non-penalized ones are taken after age 55. Age-based withdrawals are in-service withdrawals taken after age 59½. Loan settlements are withdrawals used to pay off outstanding plan loans. Refunds are contributions returned to highly compensated employees to comply with plan non-discrimination tests. ESOP dividend withdrawals result from elections to receive ESOP dividend payments as cash.

Appendix Figure 20. Categorized yearly withdrawals as a fraction of plan balances (continuously employed, person-weighted)

a) Pre-AE Cohort

b) Post-AE Cohort

Legend:
- Penalized total distribution
- Loan settlement
- Refund
- Hardship
- Non-penalized total distribution
- ESOP dividend
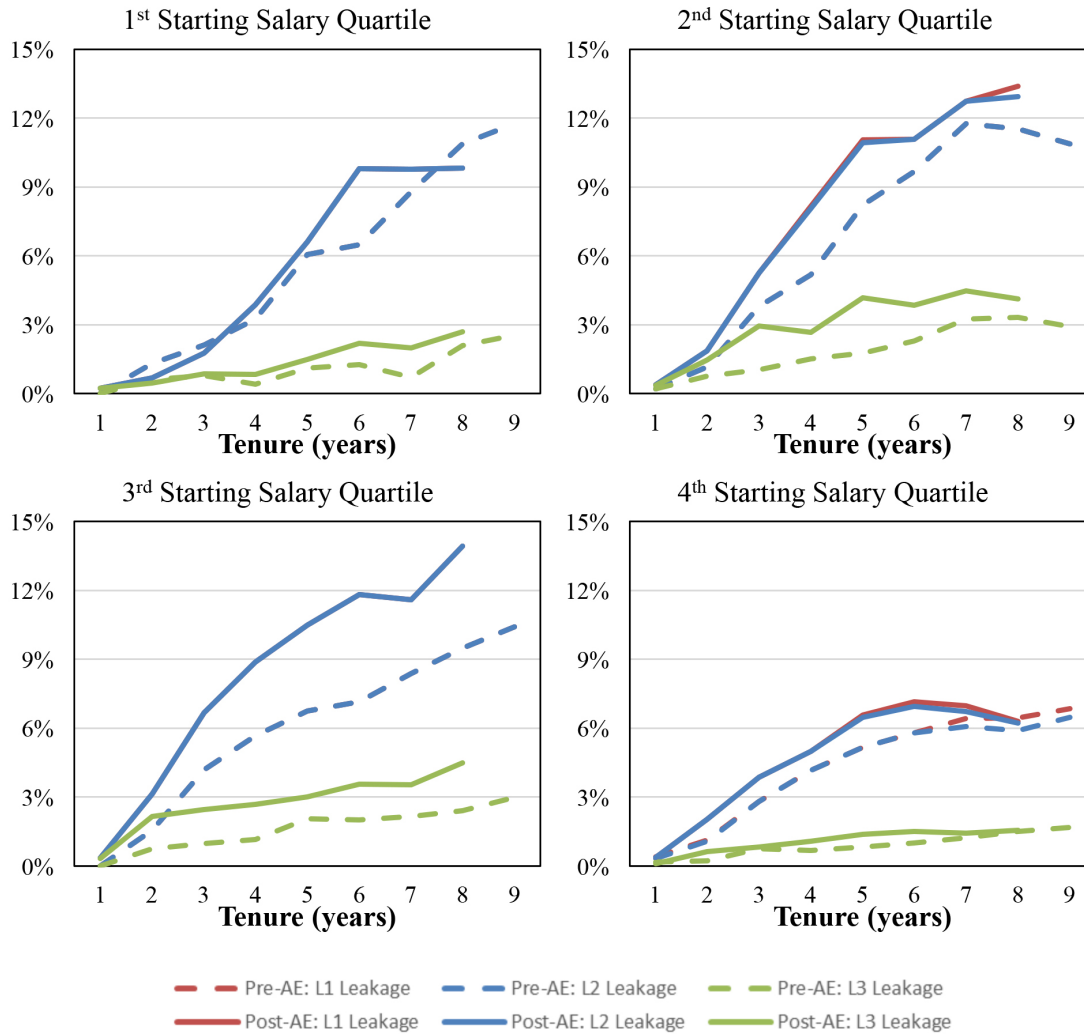- Non-hardship non-age-based
- Age-based
- Rollover

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (as defined in Appendix Table 1) and who have ever participated in the savings plan and taken a plan withdrawal. The figures plot person-weighted withdrawals, by category, made during the calendar year as a faction of the sum year-end balances and all calendar-year withdrawals. Penalized total distributions are total taken at separation before age 55, while non-penalized ones are taken after age 55. Age-based withdrawals are in-service withdrawals taken after age 59½. Loan settlements are withdrawals used to pay off outstanding plan loans. Refunds are contributions returned to highly compensated employees to comply with plan non-discrimination tests. ESOP dividend withdrawals result from elections to receive ESOP dividend payments as cash.

Appendix Figure 21. Categorized yearly withdrawals as a fraction of plan balances (continuously employed, dollar-weighted)

a) Pre-AE Cohort

b) Post-AE Cohort

Legend:
- Penalized total distribution
- Loan settlement
- Refund
- Hardship
- Non-penalized total distribution
- ESOP dividend
- Non-hardship non-age-based
- Age-based
- Rollover

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure (as defined in Appendix Table 1) and who have ever participated in the savings plan and taken a plan withdrawal. The figures plot dollar-weighted withdrawals, by category, made during the calendar year as a faction of the sum year-end balances and all calendar-year withdrawals. Penalized total distributions are total taken at separation before age 55, while non-penalized ones are taken after age 55. Age-based withdrawals are in-service withdrawals taken after age 59½. Loan settlements are withdrawals used to pay off outstanding plan loans. Refunds are contributions returned to highly compensated employees to comply with plan non-discrimination tests. ESOP dividend withdrawals result from elections to receive ESOP dividend payments as cash.

Appendix Figure 22: Cumulative L1, L2 and L3 leakage rates, by salary quartile (all hires, person-weighted)
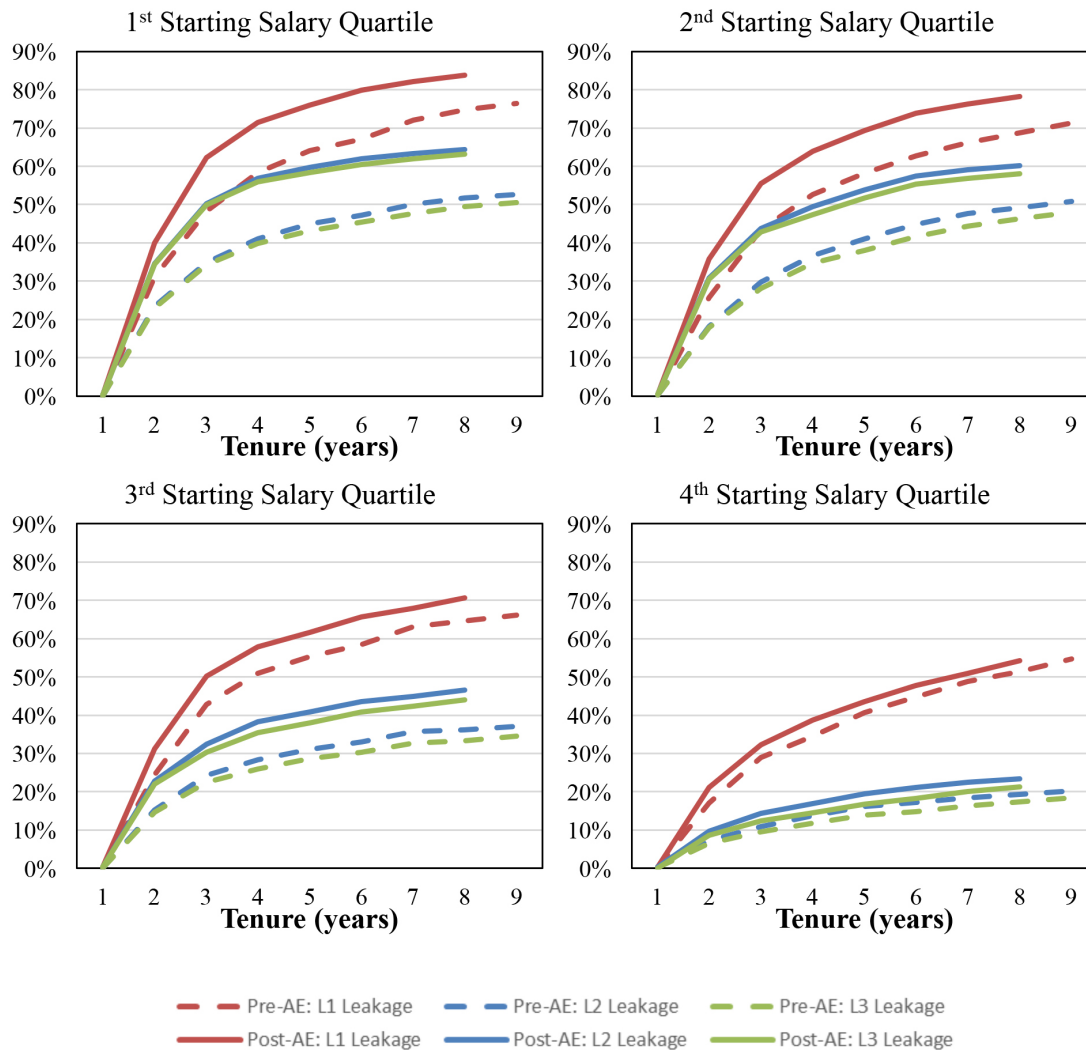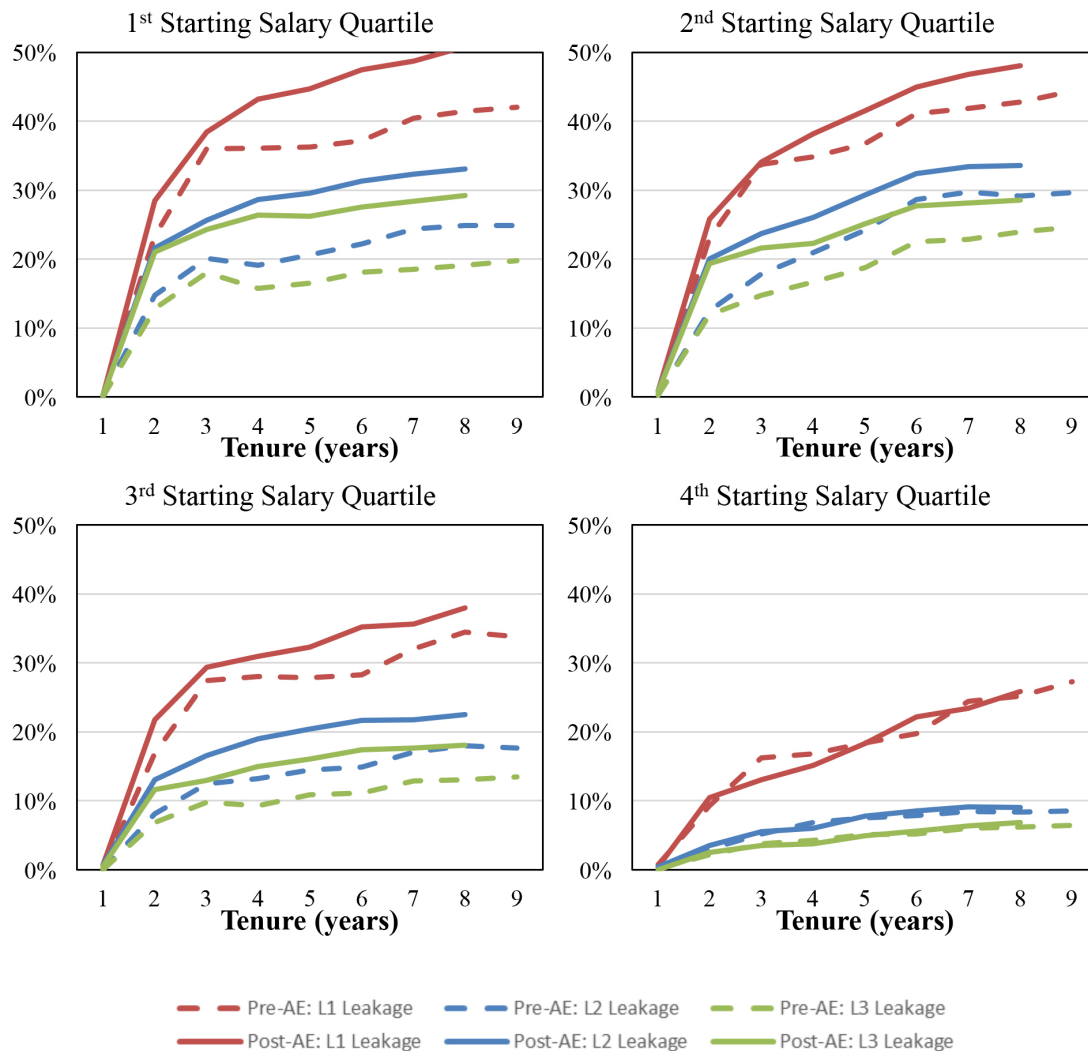
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.

Appendix Figure 23: Cumulative L1, L2 and L3 leakage rates, by salary quartile (continuously employed, person-weighted)
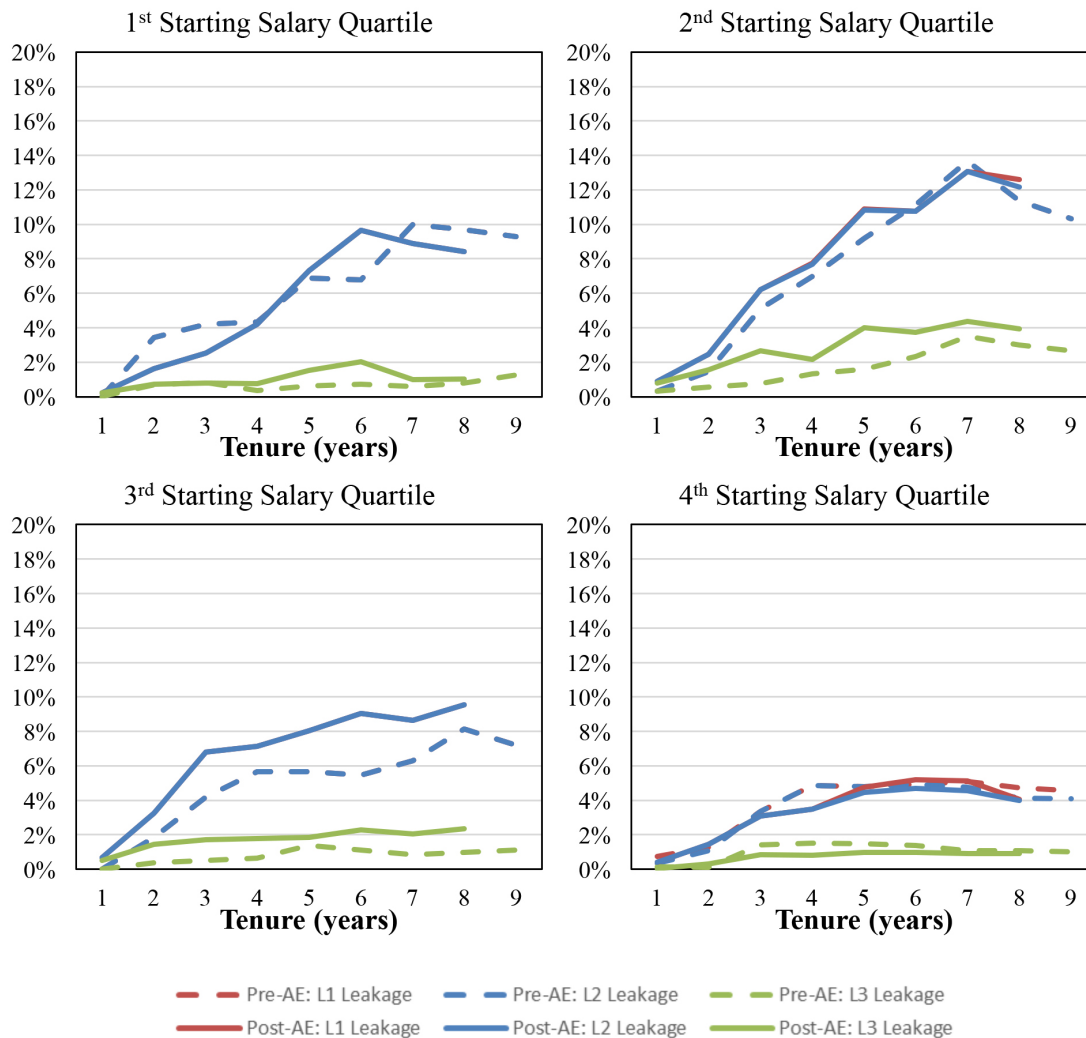

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.

Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.

Appendix Figure 25: Cumulative L1, L2 and L3 leakage rates, by salary quartile (continuously employed; dollar-weighted)

Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. L1 leakage is the sum of cumulative non-rollover withdrawals, outstanding plan loan balances and cumulative rollover withdrawals. L2 leakage is the sum of cumulative non-rollover withdrawals and outstanding plan loan balances. L3 leakage is cumulative non-rollover withdrawals. Leakage rates are calculated by dividing leakage by withdrawal-adjusted balances. L1, L2 and L3 leakage and withdrawal-adjusted balances are calculated as described in Section IV of the paper.