Trends and Issues
July 2018

TIAA Institute

Potential vs. realized savings under automatic enrollment

John Beshears,
Harvard University
and NBER

James J. Choi,
Yale University
and NBER

David Laibson,
Harvard University
and NBER

Brigitte C. Madrian,
Harvard University
and NBER

I. Overview

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 any 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.

II. Data and methodology

We studied 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. 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.

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. These outcomes include: eligibility for, participation in, contributions to, balances in, loans from and withdrawals from the savings plan. Table 2 reports these outcomes and various demographic characteristics.

III. Key results

We find that automatic enrollment 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)).[1] 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)).[2] 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)).[3]

Figure 1 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 1 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 1d with ratio of actual plan balances to starting pay in Figure 2. 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 1, 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

[1] L3 = cumulative non-rollover leakage rate

[2] L2 = cumulative non-rollover + loan leakage rates

[3] L1 = cumulative rollover + cumulative non-rollover + loan leakage rates

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 1), so the smaller number is probably closer to the truth, although with a downward bias.

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 3, 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 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} 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 4 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 4 excludes rollovers, it illustrates the significant impact that withdrawals have on both the pre- and post-AE cohorts.

Figures 5 and 6 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 7 and 8, 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 7, 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 8, we measure how much of the increase in potential plan balances shown in Figure 7 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 9 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 9 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.

IV. 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.

References

Argento, Robert, Victoria L. Bryant, and John Sabelhaus, 2015. "Early Withdrawals from Retirement Accounts during the Great Recession." *Contemporary Economic Policy* 33(1), 1-16.

Beshears, John, James J. Choi, David Laibson, and Brigitte C. Madrian. 2008. "The Importance of Default Options for Retirement Saving Outcomes: Evidence from the United States." In Stephen J. Kay and Tapen Sinha, eds., *Lessons from Pensions Reform in the Americas*, Oxford: Oxford University Press, 59-87.

Choi, James J., David Laibson, Brigitte C. Madrian, and Andrew Metrick, 2002. "Defined Contribution Pensions: Plan Rules, Participant Decisions, and the Path of Least Resistance." In James Poterba, ed., *Tax Policy and the Economy*, Vol. 16, 67-114.

Choi, James J., David Laibson, Brigitte C. Madrian, and Andrew Metrick, 2004. "For Better or For Worse: Default Effects and 401(k) Savings Behavior." In David A. Wise, ed., *Perspectives on the Economics of Aging*, Chicago: Chicago University Press, 81-126.

Madrian, Brigitte C. and Dennis F. Shea, 2001. "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior." *Quarterly Journal of Economics* 116(4), 1149-1187.

About the authors

John Beshears is the Terrie F. and Bradley M. Bloom Associate Professor of Business Administration in the Negotiation, Organizations & Markets Unit of Harvard Business School. He also serves as a faculty research fellow at the National Bureau of Economic Research. Before joining HBS, he was an assistant professor of finance at the Stanford Graduate School of Business.

Professor Beshears's primary area of research is behavioral economics, which combines insights from psychology and economics to explore individual decision making and market outcomes.

His work has been published in the *Journal of Finance*, the *Journal of Financial Economics*, *Review of Financial Studies*, the *Journal of Public Economics*, the *Journal of Economic Behavior & Organization and Proceedings of the National Academy of Sciences of the United States of America*. Additional work has been featured in *The Economist*, *The Wall Street Journal*, *The New York Times*, *BusinessWeek* and *Time*.

After earning his Ph.D. in business economics at HBS, Professor Beshears was a postdoctoral fellow at the National

James J. Choi is Professor of Finance at the Yale School of Management. His research addresses issues spanning behavioral finance, behavioral economics, household finance, capital markets, health economics, and sociology. His work on default options has led to changes in 401(k) plan design at many U.S. corporations and has influenced pension legislation in the U.S. and abroad.

Choi's research also has examined the influence of racial, gender, and religious identity on economic preferences, investor ignorance of mutual fund fees, the effect of deadlines and peer information on savings choices, and how retail investor sentiment in China affects stock returns. He earned his A.B. in applied mathematics and Ph.D. in economics from Harvard University.

David Laibson is the Robert I. Goldman Professor of Economics. He leads Harvard University's Foundations of Human Behavior Initiative. Laibson's research focuses on the topic of behavioral economics, with emphasis on household finance, macroeconomics, aging, and intertemporal choice. Laibson is also a member of the National Bureau of Economic Research, where he directs the National Institute of Aging Roybal Center for Behavior Change in Health and Savings, and is a Research Associate in the Aging, Asset Pricing, and Economic Fluctuations Working Groups. Laibson serves on the Board of the Russell Sage Foundation and on Harvard's Pension Investment Committee. Laibson serves on the advisory board of the Social Science Genetics Association Consortium. Laibson has served as the Chair of the Department of Economics at Harvard University and as member of the Academic Research Council of the Consumer Financial Protection Bureau. Laibson is a recipient of a Marshall Scholarship. He is a Fellow of the Econometric Society and the American Academy of Arts and Sciences. He is a two-time recipient of the TIAA-CREF Paul A. Samuelson Award for Outstanding Scholarly Writing on Lifelong Financial Security. Laibson holds degrees from Harvard University (AB in Economics, Summa), the London School of Economic (MSc in Econometrics and Mathematical Economics), and the Massachusetts Institute of Technology (Ph.D. in Economics). He received his PhD in 1994 and has taught at Harvard since then. In recognition of his teaching, he has been awarded Harvard's ΦBK Prize and a Harvard College Professorship.

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.

Madrian's current research focuses on behavioral economics and household finance, with a particular focus on household saving and investment behavior. Her work in this area has impacted the design of employer-sponsored savings plans in the U.S. and has influenced pension-reform legislation both in the U.S. and abroad. She also is engaged in research on health, using the lens of behavioral economics to understand health behaviors and improve health outcomes.

Madrian received her Ph.D. in economics from the Massachusetts Institute of Technology and studied economics as an undergraduate at Brigham Young University. She is the recipient of the National Academy of Social Insurance Dissertation Prize (first place, 1994) and a two-time recipient of the TIAA Paul A. Samuelson Award for Scholarly Research on Lifelong Financial Security (2002 and 2011).

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 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 III of this report.

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

A. All Hires

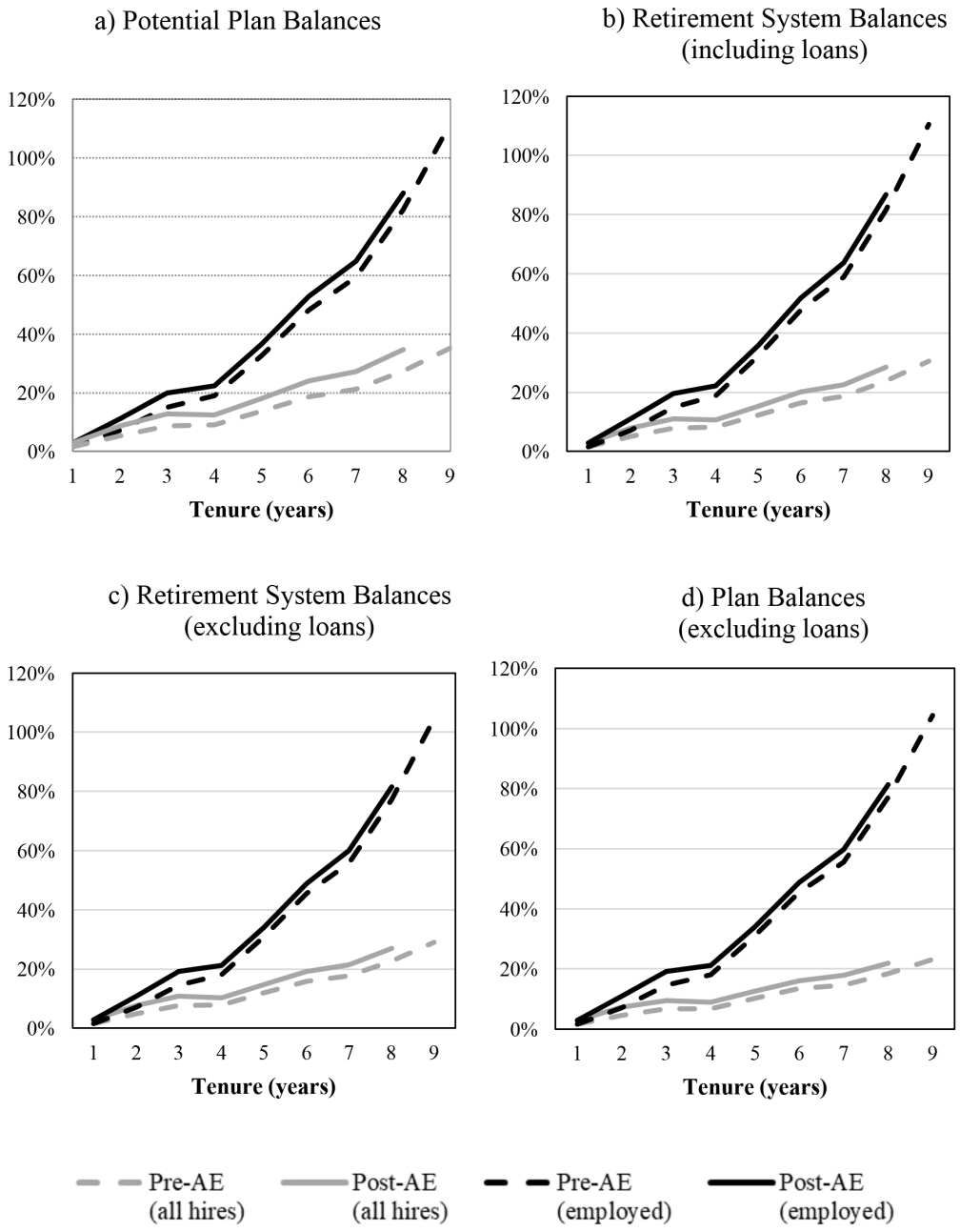
	Tenure (years)			
	2	4	6	8
Contribution-Inferred Retirement System Balances (incl. loans)				
Pre-AE	-5.7%	-9.6%	-11.3%	-13.0%
Post-AE	-10.1%	-14.8%	-16.5%	-17.8%
Differential Impact (Post-Pre)	17.1%	28.3%	34.0%	36.0%
Contribution-Inferred Retirement System Balances (excl. loans)				
Pre-AE	-6.6%	-12.4%	-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%

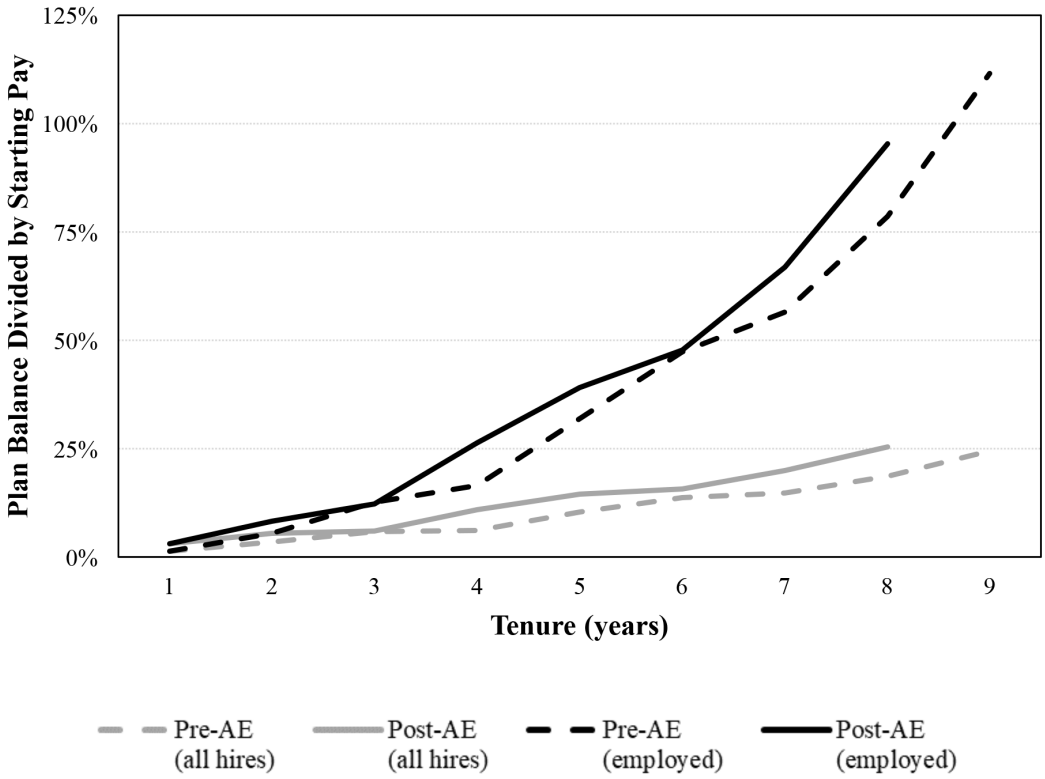
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The continuously employed subsample is restricted to those continuously employed through and eligible for the plan at the indicated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

Figure 1. Contribution-inferred balances relative to starting pay (person-weighted)



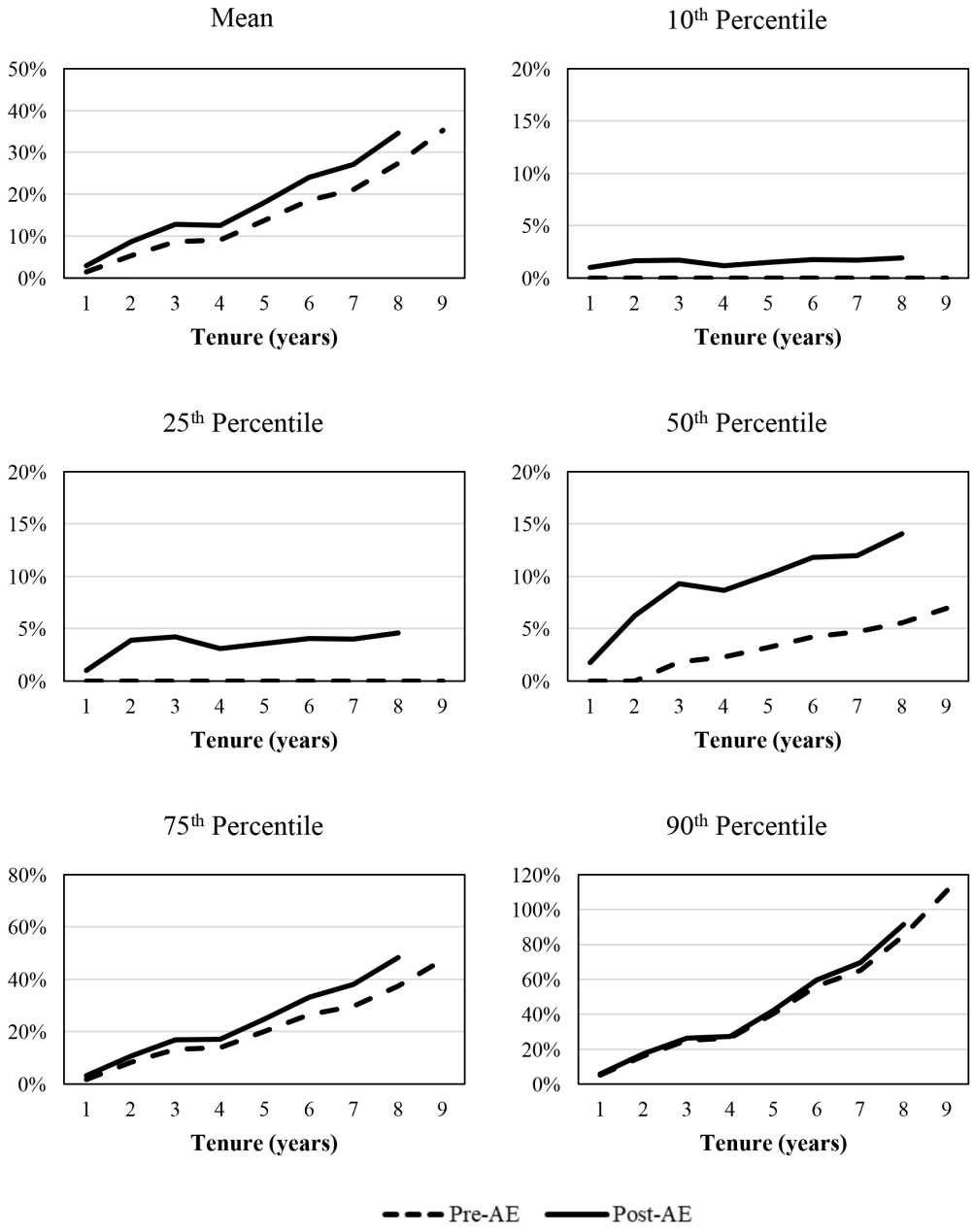
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1 (panel A). The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of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

Figure 2. Savings plan balances relative to starting pay



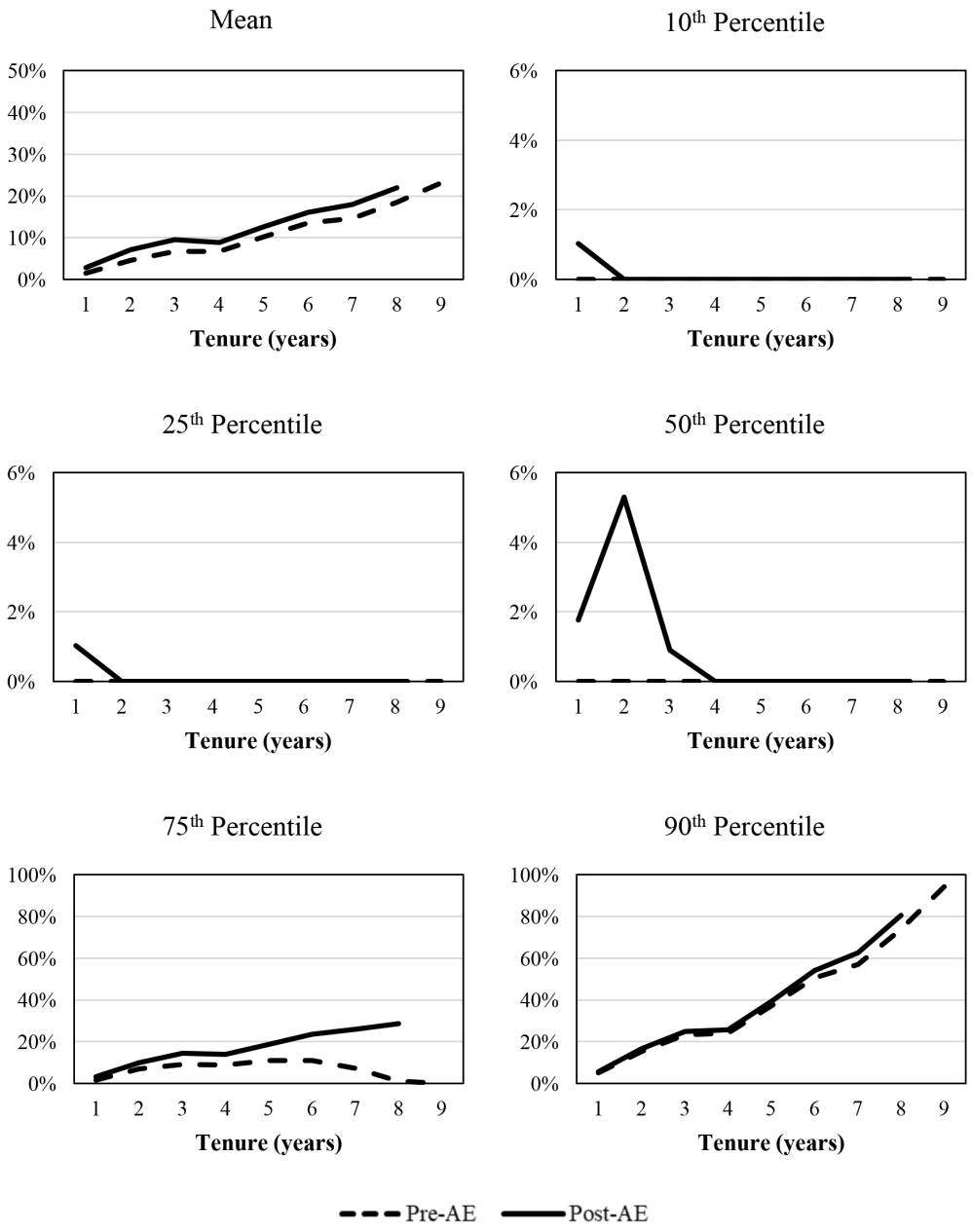
Source: Authors' calculations. The sample is all hires continuously employed through tenure year one as defined in Appendix Table 1. The "employed" subsample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure. Plan balances include before-tax, 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 3. Contribution-inferred potential plan balances relative to starting pay (all hires)



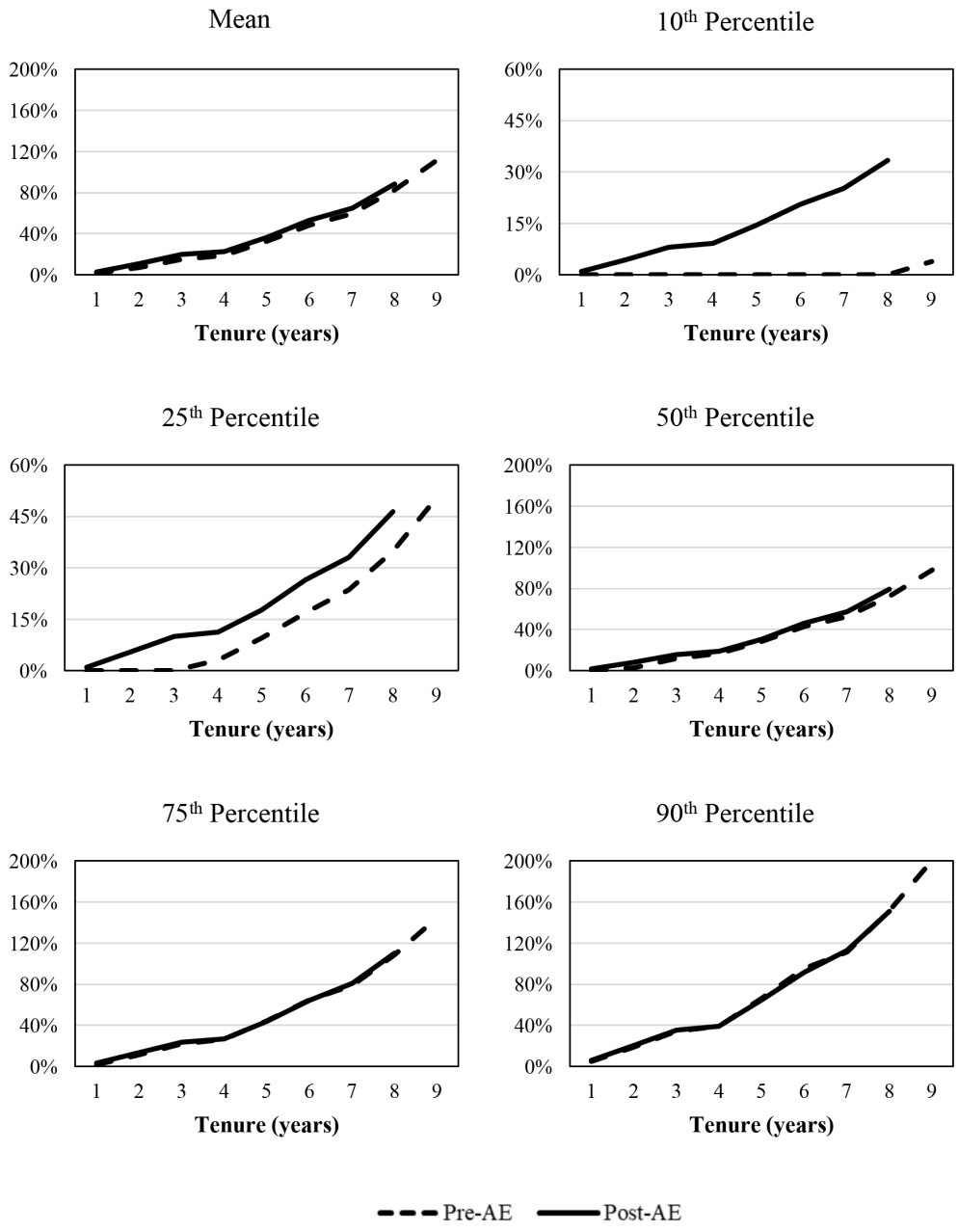
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Contribution-inferred potential plan balances are calculated as described in Section III of this report. Starting pay is the annualized salary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

Figure 4. Contribution-inferred plan balances relative to starting pay (all hires)



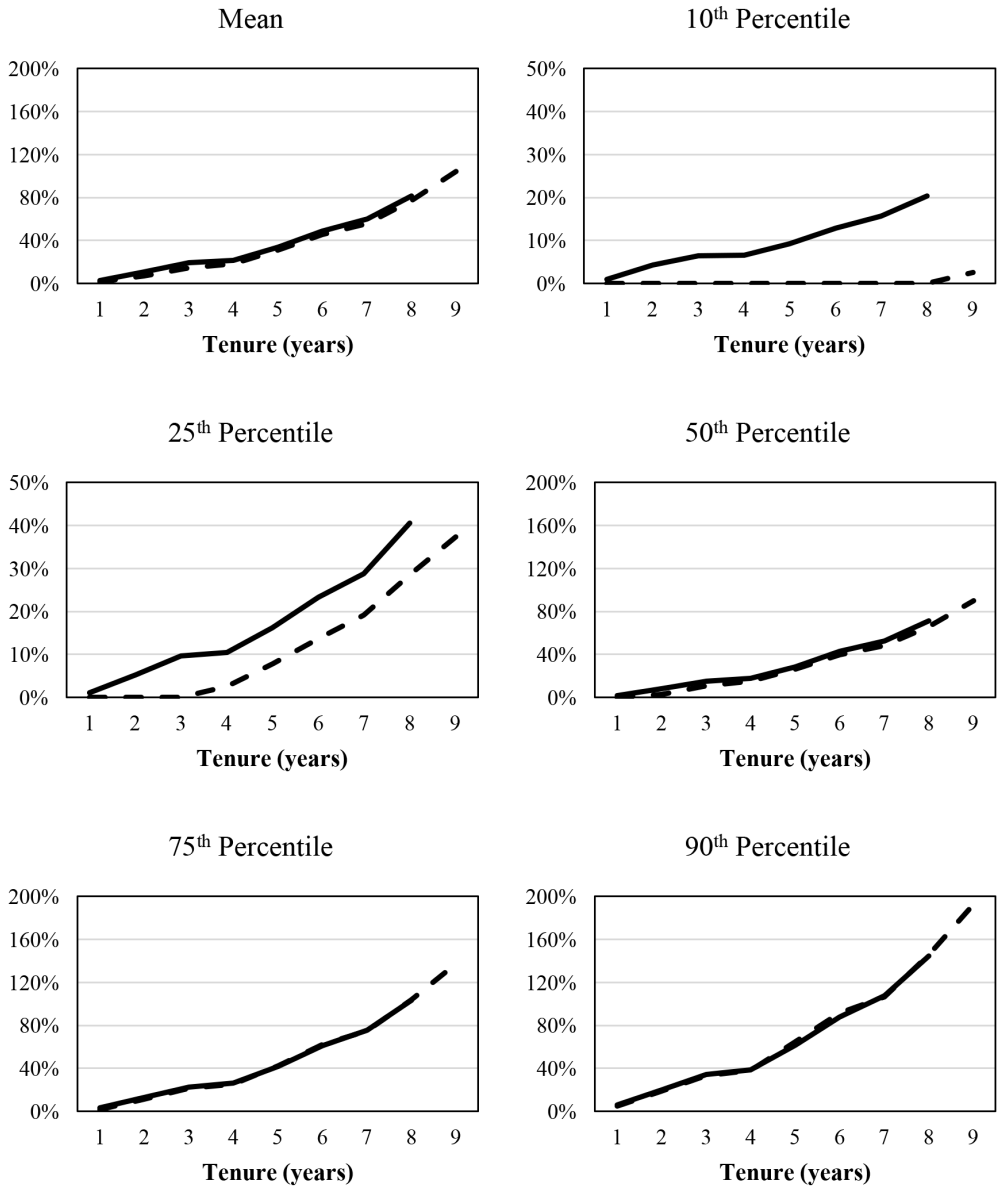
Source: Authors' calculations. The sample is all hires continuously employed through and eligible for the plan at tenure year one as defined in Appendix Table 1. Contribution-inferred plan balances are calculated as described in Section III of this report. Starting pay is the annualized salary during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

Figure 5. Contribution-inferred potential plan balances to starting pay (continuously employed)



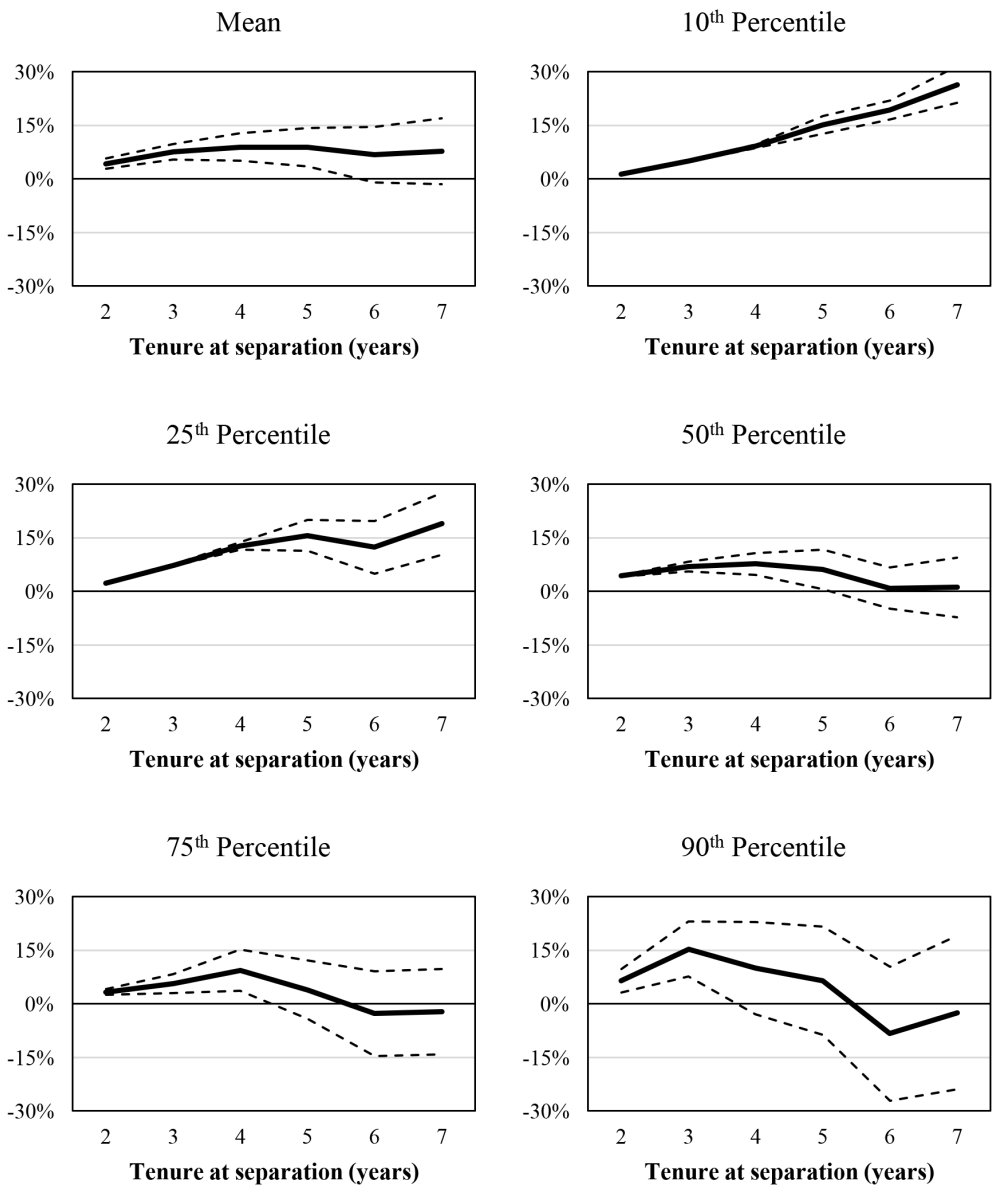
Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. Contribution-inferred potential plan balances are calculated as described in Section III of this report. Starting pay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

Figure 6. Contribution-inferred plan balances to starting pay (continuously employed)



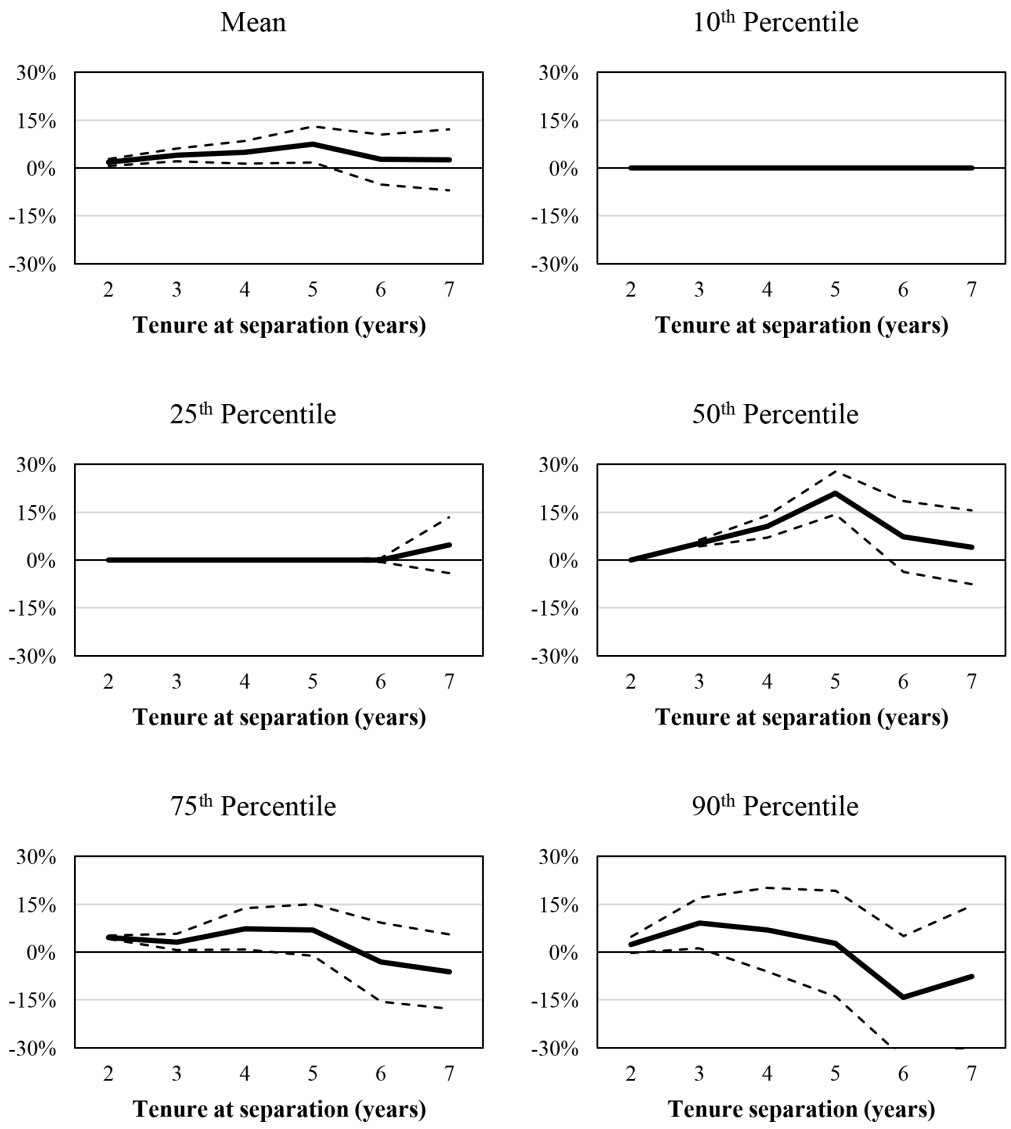
Source: Authors' calculations. The sample is restricted to those continuously employed through and eligible for the plan at the indicated level of tenure as defined in Appendix Table 1. Contribution-inferred plan balances are calculated as described in Section III of this report. Starting pay is the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

Figure 7. Post – pre-AE contribution-inferred potential plan balances relative to starting pay eight years after hire by year of separation (separated employees)



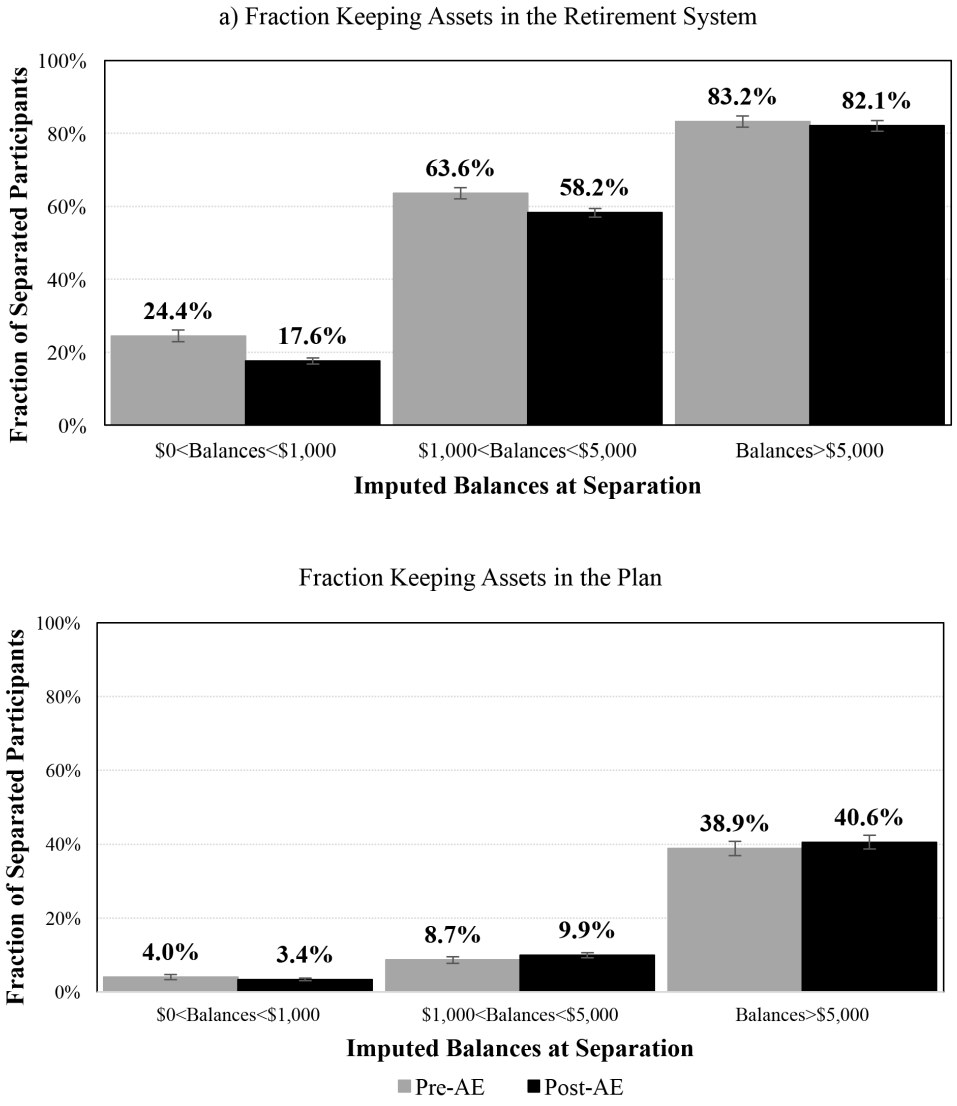
Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm prior to tenure year eight. Contribution-inferred potential plan balances are calculated as described in Section III of this report 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 8. 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 III of this report 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 9. Asset preservation following separation by imputed balances at separation

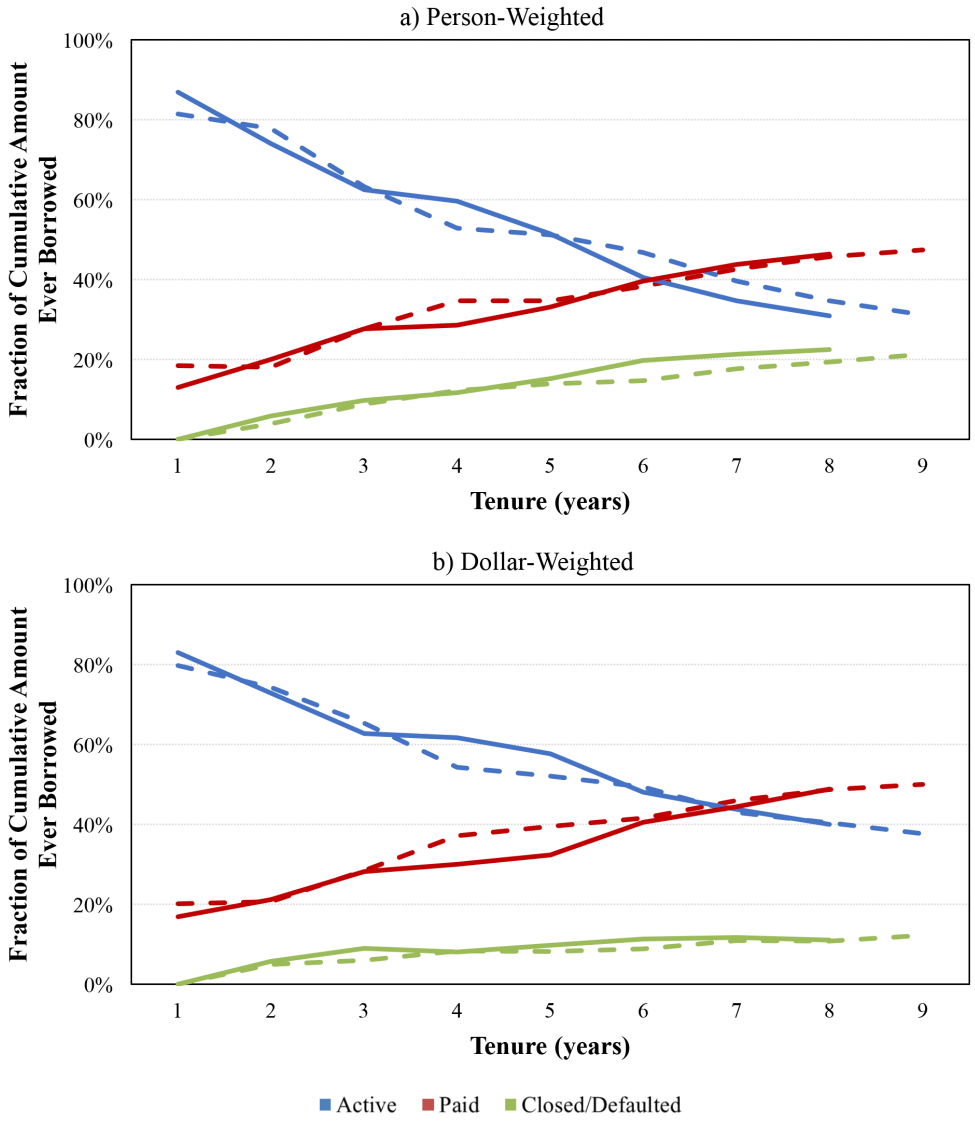


Source: Authors' calculations. The sample is all hires continuously employed through tenure year one (as defined in Appendix Table 1) who subsequently separated from the firm prior to tenure year 8. Imputed balances at separation are calculated as described in Section III of this report. Preserving assets 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.

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

	Pre-AE Cohort		Post-AE Cohort	
	Hired 7/1/2004 to 6/30/2005		Hired 7/1/2005 to 6/30/2006	
Date of year-end data observation	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 Figure 1. Loan repayment and default as a fraction of cumulative loan amounts



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 outstanding), have been repaid, or have been closed without being repaid (default) at the indicated level of tenure.