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Online Appendix A for
"Borrowing to Save? The Impact of Automatic Enrollment on Debt"

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In this appendix, we estimate the automatic enrollment effect on TSP contributions and debt using a regression discontinuity design with hire month as the assignment variable. In our baseline estimate, we find that automatic enrollment causes cumulative TSP contributions to increase by 5.8% of first-year pay at 47 months of tenure.[1] The 95% confidence interval for this estimate is [4.8%, 6.7%], which does not contain the 4.1% estimate we obtain in the main text of the paper. Thus, the estimate in the main text of the paper is on the conservative end of estimates of the effect of automatic enrollment on TSP contributions. At the same horizon, we estimate that automatic enrollment causes a negligible change in Vantage score, and we detect no statistically significant automatic enrollment effect on debt excluding auto loans and first mortgages or on auto loans. We do find a statistically significant increase in first mortgage balances of 12.5% of first-year pay. The confidence intervals of the estimates for the credit score and debt outcome measures include the point estimates in the main text, except in the case of first mortgage balances, where the regression discontinuity design yields a confidence interval that is above the main text's point estimate.

We prefer the empirical methodology in the main text for two reasons. First, the main text's methodology yields smaller standard errors than the regression discontinuity design. Second, and more importantly, we are concerned that the regression discontinuity estimates may be misleading because they likely reflect not only the effect of automatic enrollment but also the effect of month-to-month variability in the types of employees hired. The regression results in the main text are less vulnerable to this concern because they involve averages over many months of new hires. Appendix Table A1 suggests that this concern regarding the regression discontinuity design is warranted. The table reports demographic characteristics of the cohort hired during the month before the implementation of automatic enrollment (July 2010) and the

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[1] Intuitively, the regression discontinuity design compares individuals hired immediately before versus immediately after August 1, 2010, when automatic enrollment was implemented. We observe credit variables at the end of June and at the end of December in each year, so the regression discontinuity design estimates the effect of automatic enrollment at the end of December 2010 (5 months of tenure), at the end of June 2011 (11 months of tenure), etc. We focus on estimates at 43-48 months of tenure in the main text of the paper, so in this appendix we focus on estimates at 47 months of tenure.

cohort hired during the first month after the implementation of automatic enrollment (August 2010). These two cohorts play an outsized role in the regression discontinuity estimates. Compared to the July 2010 cohort, the August 2010 cohort is lower-income, less educated, and less likely to hold a professional position. The magnitudes of the differences are larger between the two one-month cohorts than between the two one-year cohorts analyzed in the main text, suggesting that month-to-month variation is indeed smoothed out when averaging over more months.[2]

A.I. Methodology

Individuals in our sample were subject to automatic enrollment if and only if they were hired on or after August 1, 2010. We run a separate ordinary least squares regression for each date t on which an outcome is measured:

$$y_{it} = \alpha + \beta_1 post_i + \beta_2 hiremonth_i + \beta_3 (post_i \times hiremonth_i) + \gamma X_i + \epsilon_i, \qquad (A.1)$$

where i indexes individuals, y_{it} is the outcome for person i as of date t, $post_i$ indicates whether person i was hired in August 2010 or later, $hiremonth_i$ is the signed number of months between person i's hire month and August 2010, and X_i is a vector of individual characteristics measured as of hire (log deflated salary, geographic location, education, college major, job type, gender, race, and age).

Our data contain the employee's month of hire but not the day of hire, so we assume that employees were hired in the middle of each month. For example, August 2010 hires are coded as having $hiremonth_i = 0.5$, and July 2010 hires are coded as having $hiremonth_i = -0.5$. The coefficient of interest is β_1, the extrapolated difference in y between those hired an instant before August 1, 2010, and those hired at the very beginning of August 1, 2010. Because all outcomes in the regression are measured as of the same calendar date, there is no need to control separately for calendar time effects. Also, on a given calendar date, those hired an instant before August 1, 2010, have the same tenure as those hired at the beginning of August 1, 2010, so there is no need

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[2] For the purpose of conducting statistical inference, the issue of month-to-month variation could be addressed in the regression discontinuity design by clustering standard errors by month of hire, which is the finest level of granularity on hire date available in the data set. However, asymptotically valid standard error calculations may not be reliable given the small number of observed hire months. Furthermore, these calculations do not remedy the problem that the point estimates may be misleading.

to control separately for tenure effects. Due to the small number of running variable values, we do not cluster standard errors by the assignment variable.

In order for β_1 to be an unbiased estimate of the treatment effect of automatic enrollment, month of hire around August 2010 must be as-if randomized, conditional on observables. Since employees can easily implement the automatic enrollment defaults themselves, there is little incentive to self-sort across the August 2010 hire threshold, so as-if conditional randomization is plausible. However, recall from our discussion of Appendix Table A1 that we are concerned that month-to-month variability in the types of employees hired may have made July 2010 new hires different from August 2010 hires in observable and unobservable ways.

When analyzing credit outcomes, we use as our outcome variable the change relative to the June 2009 level. This within-individual differencing purges time-invariant individual differences in credit levels from the outcome.

We present our results under several bandwidths (4, 8, and 12 months on each side of the hire date threshold) to illustrate that they are not particularly sensitive to bandwidth choice. We also implement a formal bandwidth selection algorithm. The optimal bandwidth algorithms of Imbens and Kalyanaraman (2012) and Calonico, Cattaneo, and Titiunik (2014) do not apply to our setting because they require a continuous assignment variable, whereas the assignment variable in our data set (hire month) is discrete.[3] We instead use a leave-one-out cross-validation procedure as in Ludwig and Miller (2005).[4] For each outcome variable measured at 47 months of tenure, we perform the following procedure for each possible bandwidth up to 12 months. For each observation corresponding to an employee hired in July 2010 or August 2010, we estimate a separate regression using the regression discontinuity specification with the bandwidth under consideration, dropping the focal observation from the sample. We then calculate the squared difference between the regression's predicted value for the focal observation and the focal observation's actual value. Taking the mean of these squared prediction errors across the regressions that use the bandwidth under consideration (one regression for each employee hired in July 2010 or August 2010) gives a measure of the accuracy with which the bandwidth under

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[3] Imbens, Guido, and Karthik Kalyanaraman, 2012. "Optimal bandwidth choice for the regression discontinuity estimator." *Review of Economic Studies* 79, pp. 833-959. Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik, 2014. "Robust nonparametric confidence intervals for regression-discontinuity designs." *Econometrica* 82, pp. 2295-2326.

[4] Ludwig, Jens, and Douglas L. Miller, 2005. "Does Head Start improve children's life chances? Evidence from a regression discontinuity design." NBER Working Paper 11702.

consideration predicts outcomes at the regression discontinuity threshold. The leave-one-out cross-validation procedure favors the bandwidth with the lowest mean squared prediction error.

A.II. Results

Appendix Table A2 presents the results from the regression discontinuity analysis. The leave-one-out cross-validation procedure applied to outcomes measured at 47 months of tenure indicates that the lowest mean squared prediction error is achieved with a bandwidth of 9 months for cumulative total TSP contributions, 12 months for Vantage score, 11 months for debt excluding auto loans and first mortgages, 12 months for auto debt, and 11 months for first mortgage debt. For the sake of consistency across outcome variables, our discussion below focuses on results obtained using a 12-month bandwidth, but the findings are qualitatively similar using other bandwidths.

At 47 months of tenure (corresponding to the 43-48 month tenure bucket that is our preferred long-run horizon in the main text), automatic enrollment increases cumulative total TSP contributions by 5.8% of first-year income (95% confidence interval = [4.8%, 6.7%]). There is an economically negligible effect on Vantage score at 47 months of 0.2 points (95% confidence interval = [-2.7, 3.1]). There is no significant effect on debt excluding auto loans and first mortgages at the same horizon; the point estimate is 1.1% of first-year income (95% confidence interval = [-1.1%, 3.2%]). There is a statistically significant increase in auto debt of 1.6% of income at 35 months of tenure, but the statistical significance disappears at later horizons, and the point estimate at 47 months is 1.1% (95% confidence interval = [-0.4%, 2.6%]). First mortgage debt shows a significant increase starting at 17 months of tenure, and by 47 months, automatic enrollment increases first mortgage debt balances by 12.5% of first-year income (95% confidence interval = [3.6%, 21.4%]).

Appendix Figures A1-A5 present visual analogues of the above analysis using the 12-month bandwidth. The vertical axes represent the residual values $\tilde{y}_{it}$ from regressions of the outcome variable y_{it} on the covariates X_i. The fitted lines are from regressions of the form:

$$\tilde{y}_{it} = a + b_1 post_i + b_2 hiremonth_i + b_3 (post_i \times hiremonth_i) + u_i. \tag{A.2}$$

The data points plotted are the average residualized value of the outcome for people with that hire month.[5]

If our identifying assumptions are valid, we should estimate no effect of automatic enrollment on outcomes *prior* to hire. Appendix Table A3 shows the results of these placebo tests. There are no estimates for outcomes at tenure month -13, since this tenure corresponds to June 2009, the baseline date from which we compute differences. We also do not use bandwidths of 8 and 12 months for tenure month -7 (December 2009), since the wider bandwidths cause both individuals hired and individuals not hired as of December 2009 to be included in the pre-AE cohort sample, and the assumption of local linearity may not hold across a sample of both hired and not-yet-hired individuals.

We find no significant pre-hire effects on credit score and auto debt through tenure month -37. For first mortgage debt, there are significant positive effects at tenure months -25, -31, and -37, but only when using a 12-month bandwidth. For debt excluding auto loans and first mortgages, there are significant positive effects at tenure months -25, -31, and -37 when using a 12-month bandwidth, and there are significant positive effects at tenure months -31 and -37 when using an 8-month bandwidth. On the one hand, these significant differences appear only at a point fairly distant in the past, and with *t*-statistics hovering around 2, their statistical significance is not overwhelming given the large number of tests we have run in Appendix Table A3. On the other hand, the fact that there are any significant placebo results at all casts some doubt on the validity of the regression discontinuity design.

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[5] The *b* coefficients are close but not identical to the β coefficients in Appendix Table A2. Per the Frisch-Waugh-Lovell Theorem, we could produce identical estimates by residualizing the regressors in a similar way, but at the cost of visual clarity.

Appendix Table A1. Comparison of employees hired in month before versus month of automatic enrollment implementation

	Pre-AE (Jul '10 hires)	Post-AE (Aug '10 hires)	Difference	*p*-value of difference
Avg. starting salary	$56,981	$53,849	-3,132	0.000
Avg. age at hire	39.0	38.9	0.0	0.918
Male	63.2%	65.2%	2.0%	0.109
White	52.4%	57.8%	5.5%	0.000
Black	10.9%	10.3%	-0.5%	0.533
Hispanic	2.8%	3.4%	0.6%	0.197
Asian	2.8%	3.9%	1.1%	0.029
Native American	0.7%	0.9%	0.1%	0.636
Missing race	30.4%	23.7%	-6.7%	0.000
High school only	42.1%	47.3%	5.3%	0.000
Some college, no degree	12.3%	12.6%	0.3%	0.744
Associate degree	5.1%	5.1%	0.1%	0.882
Bachelor's degree	21.8%	18.1%	-3.6%	0.001
Graduate degree	17.7%	15.8%	-1.9%	0.057
Unknown education	1.1%	1.0%	-0.1%	0.601
STEM major | college	30.8%	28.2%	-2.6%	0.165
Business major | college	25.4%	27.3%	2.0%	0.279
Other major | college	43.8%	44.4%	0.6%	0.755
Administrative position	29.5%	31.7%	2.2%	0.076
Blue collar position	8.6%	7.4%	-1.2%	0.107
Clerical position	7.6%	6.8%	-0.8%	0.250
Professional position	25.5%	19.4%	-6.2%	0.000
Technical position	16.6%	16.2%	-0.4%	0.651
Other position	12.2%	18.5%	6.4%	0.000
Has credit report in six months before hire	82.8%	83.2%	0.4%	0.677
Avg. Vantage Score in six months before hire, conditional on having Vantage Score	689.3	688.1	-1.2	0.671
# of obs. (*N*)	2,432	3,402		

Appendix Table A2. The effect of automatic enrollment on cumulative TSP contributions and debt changes since June 2009

Each cell shows the treatment effect estimated from a separate regression for which the specification is found in equation (A.1). All dependent variables except Vantage credit score are normalized by first-year income. Bandwidth refers to the number of hire months on either side of August 2010 that are included in the regression. The regressions include all people who remain employed as of that calendar date. Standard errors robust to heteroskedasticity are in parentheses below point estimates.

| | Bandwidth | Tenure (months) | | | | | | | | |
		5	11	17	23	29	35	41	47	53
Cumulative total TSP contributions	4 months	0.012**	0.021**	0.028**	0.030**	0.038**	0.041**	0.045**	0.048**	0.047**
		(0.001)	(0.001)	(0.002)	(0.003)	(0.004)	(0.006)	(0.007)	(0.008)	(0.010)
	8 months	0.013**	0.023**	0.032**	0.035**	0.045**	0.049**	0.055**	0.061**	0.061**
		(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.005)	(0.006)	(0.007)
	12 months	0.013**	0.021**	0.031**	0.033**	0.043**	0.046**	0.052**	0.058**	0.059**
		(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)	(0.005)	(0.006)
Vantage credit score	4 months	1.05	0.35	0.16	0.28	2.06	0.19	0.13	-1.13	0.62
		(1.64)	(1.80)	(2.01)	(2.11)	(2.27)	(2.39)	(2.49)	(2.59)	(2.75)
	8 months	-0.65	0.46	1.11	0.00	0.70	0.49	0.95	1.48	1.89
		(1.16)	(1.27)	(1.42)	(1.50)	(1.61)	(1.69)	(1.78)	(1.83)	(1.94)
	12 months	-1.27	0.33	0.26	-0.42	-0.16	0.02	-0.53	0.21	-0.12
		(0.95)	(1.04)	(1.16)	(1.22)	(1.31)	(1.37)	(1.45)	(1.50)	(1.58)
Debt excluding auto, first mortgage (D1)	4 months	0.005	-0.010	-0.010	0.001	0.010	-0.001	0.013	0.023	0.025
		(0.011)	(0.012)	(0.013)	(0.014)	(0.015)	(0.016)	(0.018)	(0.019)	(0.020)
	8 months	0.005	-0.004	-0.001	0.002	0.002	0.006	0.009	0.015	0.009
		(0.008)	(0.008)	(0.010)	(0.010)	(0.011)	(0.011)	(0.013)	(0.013)	(0.014)
	12 months	0.007	-0.003	-0.004	0.001	0.000	0.005	0.007	0.011	0.010
		(0.006)	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)	(0.011)	(0.011)	(0.012)
Auto debt	4 months	0.012	0.008	0.006	0.005	0.017	0.024*	0.009	0.011	0.004
		(0.007)	(0.008)	(0.010)	(0.010)	(0.011)	(0.012)	(0.012)	(0.013)	(0.014)
	8 months	0.009	0.011	0.006	0.008	0.015	0.018*	0.010	0.009	0.004
		(0.005)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)
	12 months	0.003	0.010*	0.007	0.008	0.012	0.016*	0.009	0.011	0.009
		(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)
First mortgage debt	4 months	0.063	0.056	0.165**	0.166**	0.036	0.102	0.088	0.162*	0.089
		(0.045)	(0.049)	(0.057)	(0.060)	(0.067)	(0.070)	(0.076)	(0.078)	(0.083)
	8 months	0.065*	0.077*	0.140**	0.131**	0.089	0.117*	0.094	0.169**	0.118*
		(0.032)	(0.035)	(0.040)	(0.043)	(0.047)	(0.050)	(0.054)	(0.056)	(0.059)
	12 months	0.024	0.042	0.091**	0.076*	0.069	0.096*	0.050	0.125**	0.080
		(0.026)	(0.028)	(0.032)	(0.034)	(0.038)	(0.041)	(0.044)	(0.045)	(0.048)

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

Appendix Table A3. Placebo tests: The effect of automatic enrollment on debt changes relative to June 2009, prior to hire
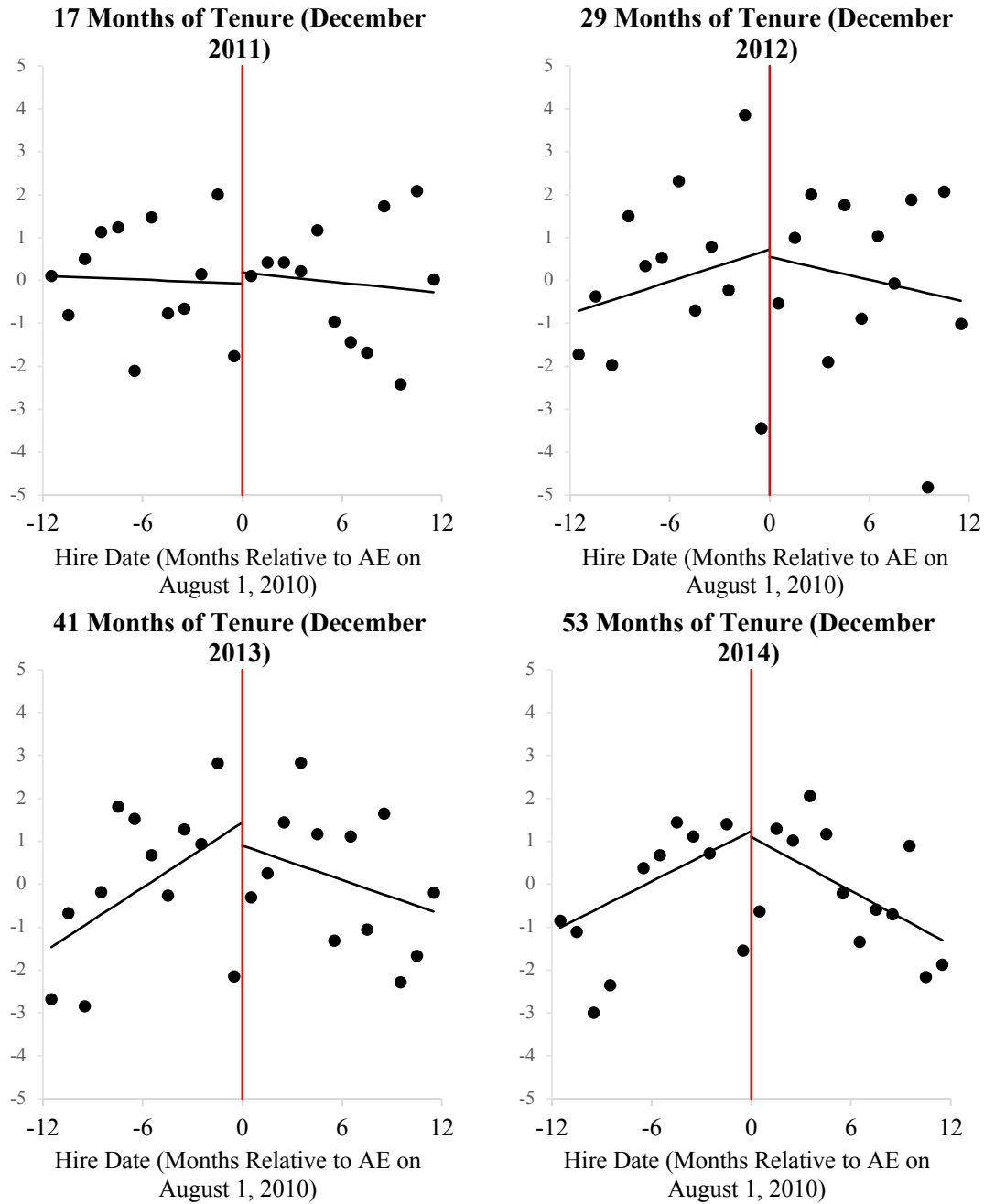
Each cell shows the treatment effect estimated from a separate regression for which the specification is found in equation (A.1). All dependent variables except Vantage credit score are normalized by first-year income. All variables are changes relative to June 2009. Bandwidth refers to the number of hire months on either side of August 2010 that are included in the regression. The regressions include all people who ever appear in our data with a positive tenure. Standard errors robust to heteroskedasticity are in parentheses below point estimates.

|		Tenure (months)					
	Bandwidth	-37	-31	-25	-19	-13	-7
Vantage credit score	4 months	-1.32	-1.86	-1.46	-0.36	--	0.69
		(1.83)	(1.69)	(1.46)	(1.16)		(1.16)
	8 months	-1.23	-0.92	-0.57	0.04	--	--
		(1.30)	(1.20)	(1.03)	(0.82)		
	12 months	-1.20	-0.78	-0.26	0.46	--	--
		(1.07)	(0.98)	(0.85)	(0.67)		
Debt excluding auto, first mortgage (D1)	4 months	0.012	0.021	0.013	0.009	--	-0.005
		(0.012)	(0.011)	(0.009)	(0.007)		(0.007)
	8 months	0.020*	0.020*	0.012	0.007	--	--
		(0.009)	(0.008)	(0.006)	(0.005)		
	12 months	0.017*	0.017**	0.011*	0.004	--	--
		(0.007)	(0.007)	(0.005)	(0.004)		
Auto debt	4 months	-0.007	-0.008	-0.004	-0.003	--	0.003
		(0.007)	(0.006)	(0.005)	(0.004)		(0.004)
	8 months	0.000	-0.003	-0.003	-0.003	--	--
		(0.005)	(0.004)	(0.004)	(0.003)		
	12 months	0.003	-0.001	-0.001	-0.003	--	--
		(0.004)	(0.004)	(0.003)	(0.002)		
First mortgage debt	4 months	-0.040	-0.028	-0.056	-0.045	--	0.013
		(0.044)	(0.040)	(0.034)	(0.028)		(0.031)
	8 months	0.044	0.054	0.028	0.002	--	--
		(0.031)	(0.028)	(0.024)	(0.019)		
	12 months	0.054*	0.050*	0.046*	0.014	--	--
		(0.026)	(0.023)	(0.019)	(0.016)		

* Significant at 5% level. ** Significant at 1% level.
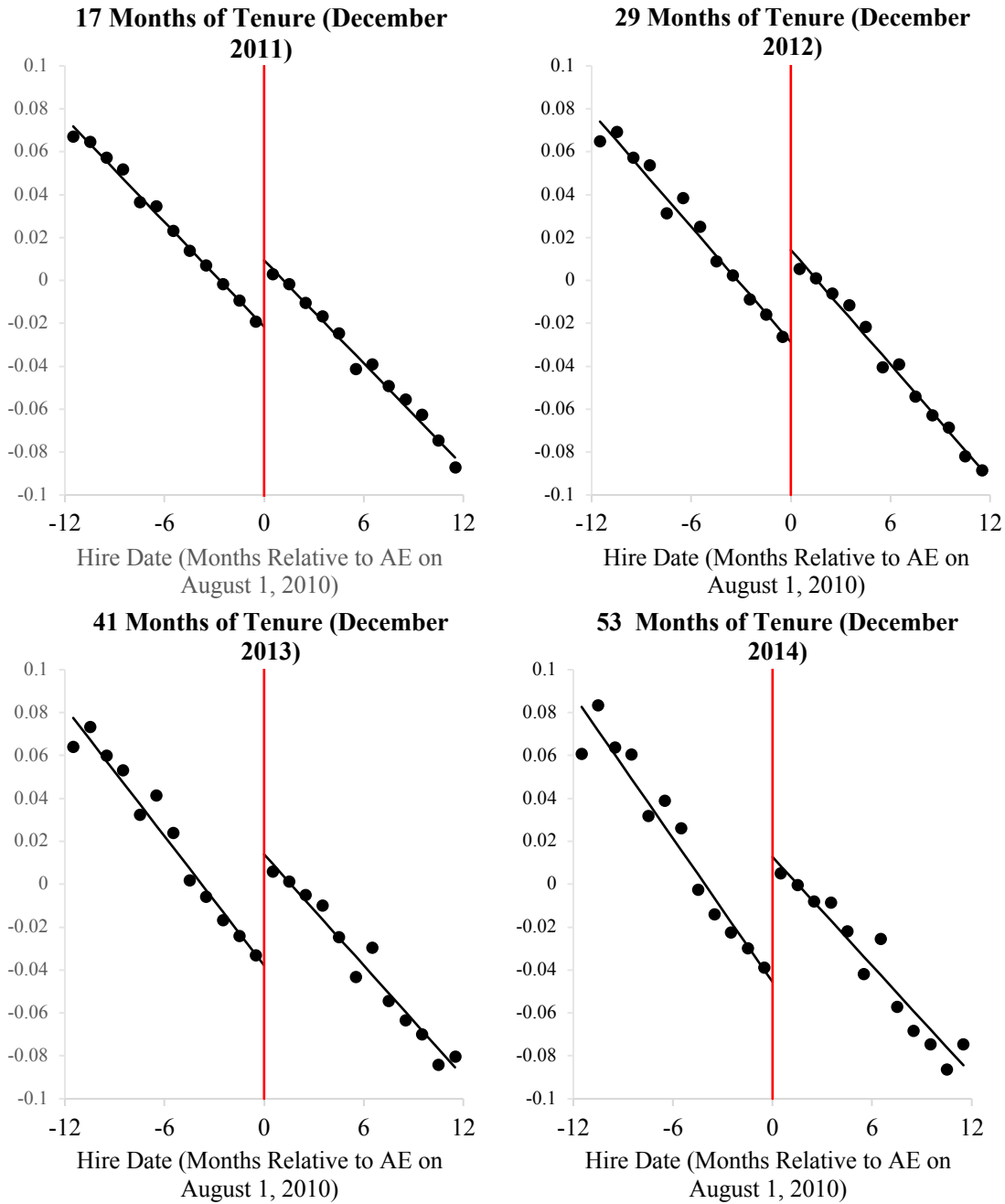
Appendix Figure A1. The effect of automatic enrollment on cumulative total TSP contributions to annualized first-year pay ratio, 12-month bandwidth. The plotted data points are average residualized values of the outcome variable measured at the date in each chart's title for those hired in the month indicated in the horizontal axis. The lines are fitted lines from the regression in equation (A.2).

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17 Months of Tenure (December 2011)

29 Months of Tenure (December 2012)

41 Months of Tenure (December 2013)

53 Months of Tenure (December 2014)

Appendix Figure A2. The effect of automatic enrollment on change since June 2009 in Vantage score, 12-month bandwidth. The plotted data points are average residualized values of the outcome variable measured at the date in each chart's title for those hired in the month indicated in the horizontal axis. The lines are fitted lines from the regression in equation (A.2).
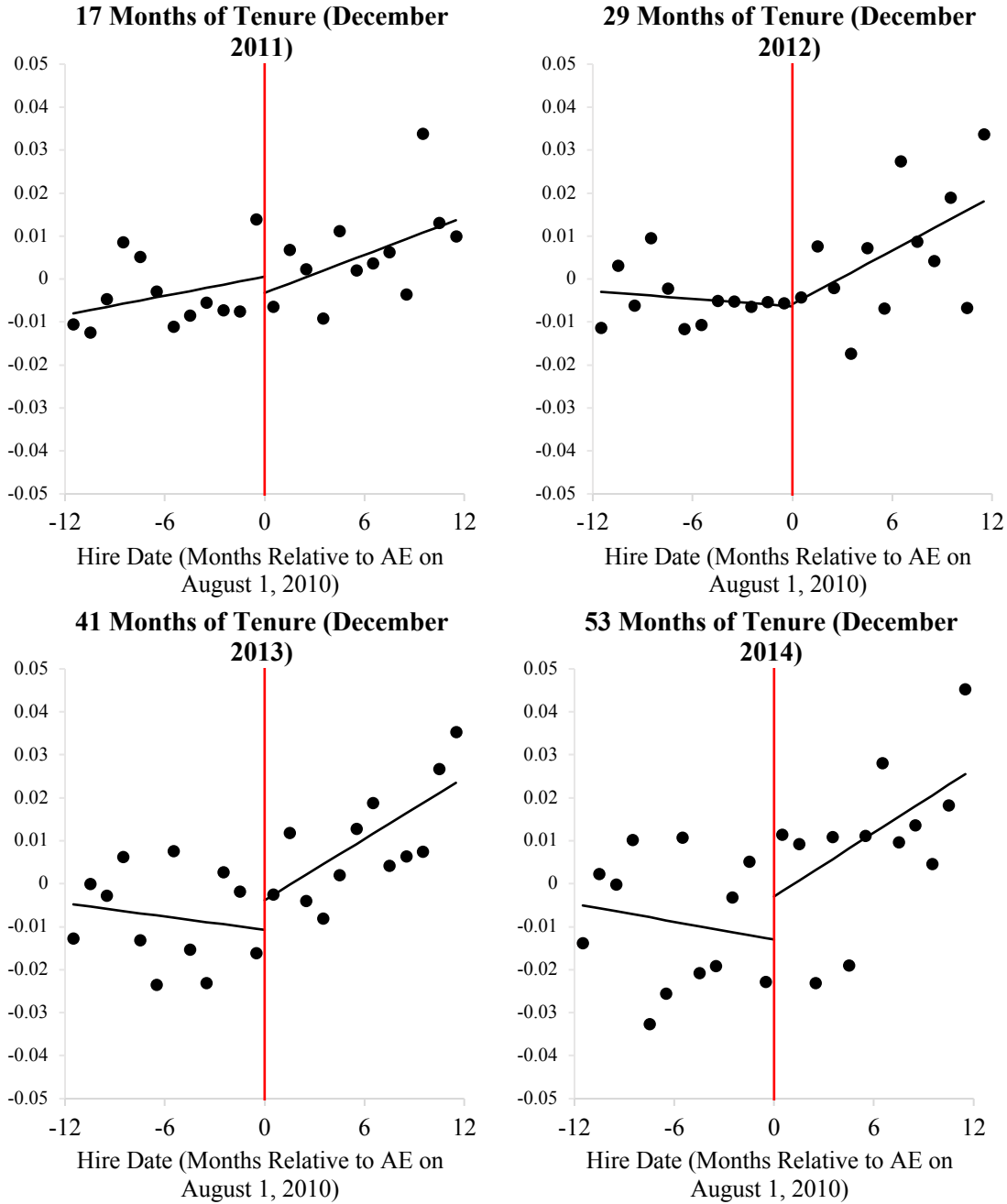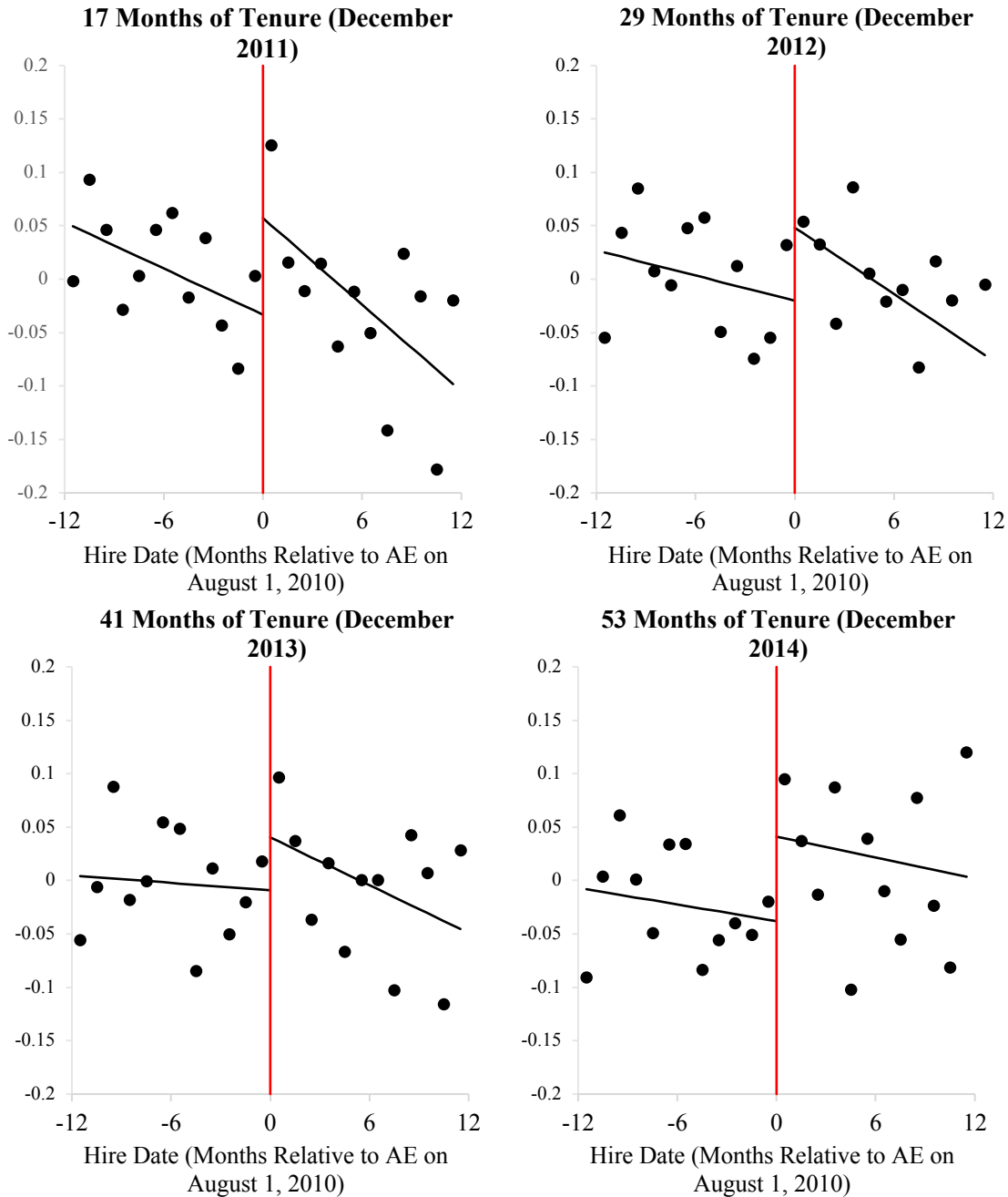
Appendix Figure A3. The effect of automatic enrollment on change since June 2009 in debt excluding auto and first mortgage debt (D1) to first-year pay, 12-month bandwidth. The plotted data points are average residualized values of the outcome variable measured at the date in each chart's title for those hired in the month indicated in the horizontal axis. The lines are fitted lines from the regression in equation (A.2).
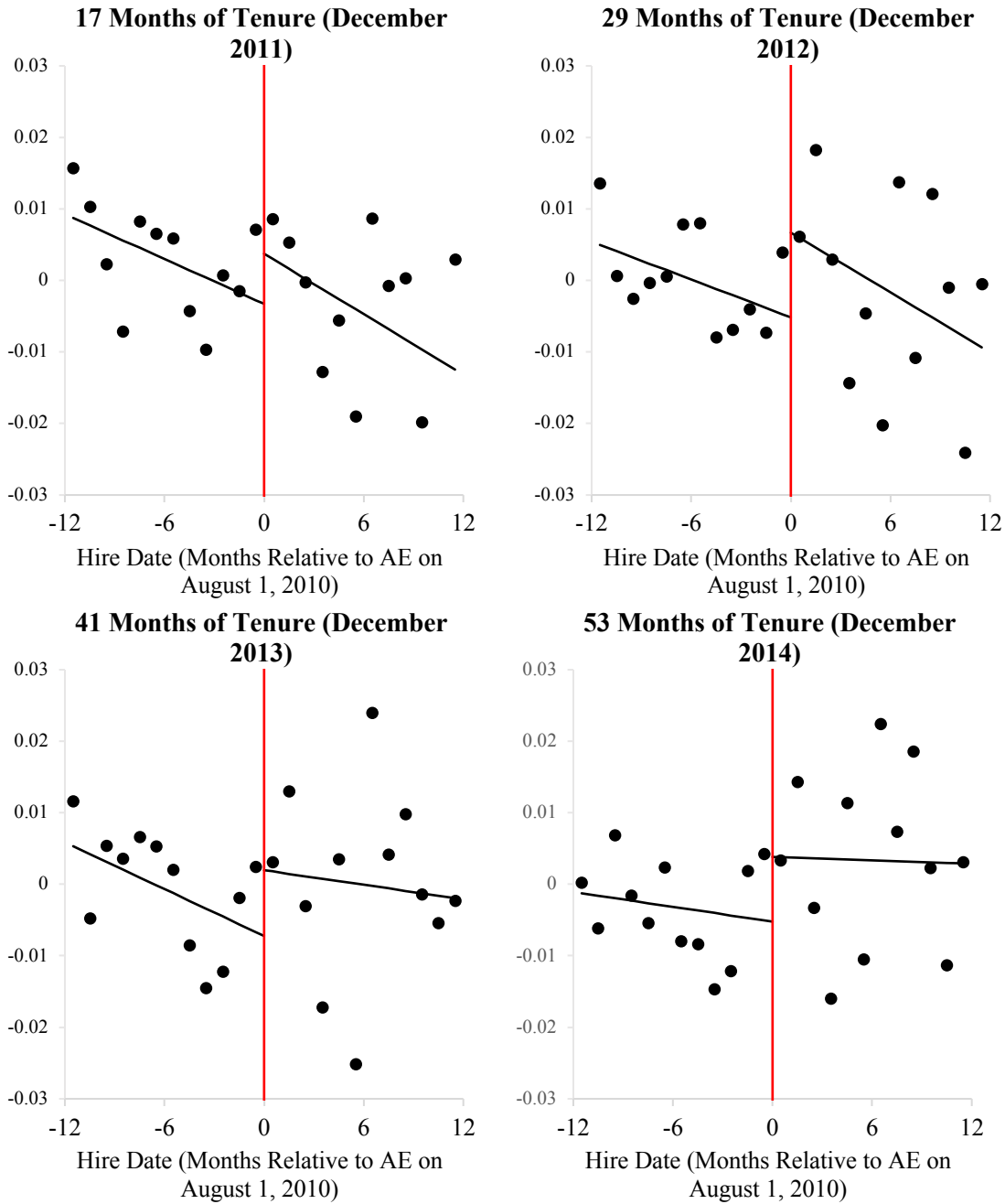
Appendix Figure A4. The effect of automatic enrollment on change since June 2009 in auto debt to first-year pay, 12-month bandwidth. The plotted data points are average residualized values of the outcome variable measured at the date in each chart's title for those hired in the month indicated in the horizontal axis. The lines are fitted lines from the regression in equation (A.2).

Appendix Figure A5. The effect of automatic enrollment on change since June 2009 in first mortgage debt to first-year pay, 12-month bandwidth. The plotted data points are average residualized values of the outcome variable measured at the date in each chart's title for those hired in the month indicated in the horizontal axis. The lines are fitted lines from the regression in equation (A.2).

Online Appendix B for
"Borrowing to Save? The Impact of Automatic Enrollment on Debt"

John Beshears, James J. Choi, David Laibson, Brigitte C. Madrian, William L. Skimmyhorn
August 12, 2020

In this appendix, we discuss a framework for thinking about the implications that changes
in auto and first mortgage debt have for net worth. We first consider impacts on net worth at the
time the loan is originated, and then net worth impacts in the years after loan origination.

B.I. Implications of auto debt and first mortgages for net worth at origination

It is helpful to recall the following balance sheet equation that holds in a frictionless
market upon the origination of a loan:

$$\Delta Secured\ debt = \Delta Durable\ assets + \Delta Financial\ assets. \qquad (B.1)$$

This equation says that, since borrowing that increases the present value of one's liabilities by $1
provides enough financing to buy an asset worth exactly $1, the present value of new debt
repayments equals the value of any durable asset acquired using the loan proceeds plus the
change in financial assets. Taking out a larger secured loan indicates the purchase of a more
valuable asset and/or a smaller spend-down of financial assets. If not all of the loan proceeds are
used to acquire an asset—for example, in a cash-out mortgage refinancing—the change in
financial assets could be positive. In any of these scenarios, the contemporaneous impact on net
worth—the increase in assets minus the increase in liabilities—is zero, although extracted equity
may subsequently be spent down.

An automatically enrolled household might purchase a more valuable durable because it
feels wealthier due to its increased TSP balances. Extra TSP balances can also ease financing
constraints, since they can be accessed through a TSP loan to increase a down payment, enabling
the household to get a larger secured loan.[6] To take an extreme example, Federal Housing
Administration mortgage loans are subject to a 96.5% loan-to-value ratio maximum, so an extra
dollar available for a down payment allows the household to access 96.5/3.5 = $27.57 more

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[6] Calls to Bank of America, Citibank, and JPMorgan Chase confirmed that loans from retirement savings plans can
be used for this purpose. We do not have access to individual-level data on TSP loans, but publicly available sources
indicate that during our sample period, the percentage of TSP participants who took a loan in a given year was
approximately 10% (see the Annual Reports of the Thrift Savings Plan available at
https://www.frtib.gov/ReadingRoom/index.html).

financing. The larger mortgage balance does not represent any contemporaneous net worth reduction in this transaction, since each dollar of borrowed TSP balances has been transformed into a dollar of home equity, and each additional dollar of mortgage debt is offset by an additional dollar of housing asset.

Conversely, an automatically enrolled household might take a larger loan to acquire a durable because it has fewer financial assets available to spend. Even though the transaction itself still has no effect on net worth in this case, the larger loan signals that automatic enrollment caused the household to draw down its non-TSP financial assets in the *past*. Hence, the portion of the loan increase that is attributable to non-TSP asset spenddown should be subtracted from TSP assets when calculating the net worth effect of automatic enrollment. Because most federal employees have minimal balances in checking and savings accounts outside the TSP[7] and automatic enrollment affects the left tail of the savings distribution most powerfully,[8] the impact of this channel may be relatively small. However, we cannot be sure because we do not observe non-TSP assets.

Finally, there is an additional cost to taking out a larger loan in the real world. Because of financial market frictions, expected borrowing costs per dollar of financing exceed expected lending rates of return. In other words, receiving financing worth X requires incurring a liability whose present value is $Y > X$. Consequently, even the contemporaneous impact of a secured asset purchase on net worth is negative and decreasing (i.e., becoming more negative) in the size of the loan. The average spread in the U.S. economy between borrowing and lending rates is approximately 2.0%.[9]

B.II. Implications of auto debt and first mortgages for the evolution of net worth after origination

Taking out a larger secured loan has potential implications for *future* net worth. We first consider the case where equity is not extracted as part of the transaction. Let W_t be wealth at

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[7] Gelman, Michael, Shachar Kariv, Matthew D. Shapiro, Dan Silverman, and Steven Tadelis, forthcoming. "How individuals respond to a liquidity shock: Evidence from the 2013 government shutdown." *Journal of Public Economics.*

[8] See Figure 1. Also see 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: University of Chicago Press, pp. 81-121.

[9] Mehra, Rajnish, Facundo Piguillem, and Edward C. Prescott, 2011. "Costly financial intermediation in neoclassical growth theory." *Quantitative Economics* 2, pp. 1-36.

time t, P_t be the price of asset a at time t, κ be costs as a fraction of asset value that owners pay but renters do not (e.g., property tax on homes), and r be the interest rate. In a frictionless market, the following two strategies for getting use of a for T periods have an identical effect on wealth T periods later: renting a for T periods, or buying it and then selling it T periods later. Thus, if a secured loan is used to purchase an asset but the household otherwise would have rented another asset that has the same rental value as the purchased asset, there is no effect on the path of future net worth. Expressing the $T = 1$ version of the above relationship, we get

$$W_t(1 + r) - rent_t = (W_t - P_t)(1 + r) - \kappa P_t + P_{t+1}. \tag{B.2}$$

Equation (B.2) holds whether or not $W_t \geq P_t$. We can solve (B.2) for the rental rate:

$$rent_t = P_t(r + \kappa) - (P_{t+1} - P_t). \tag{B.3}$$

Likewise, holding fixed the asset purchased, the size of the loan used to finance the purchase has no effect on future net worth. A larger loan does obligate the household to higher future interest payments, but these are exactly offset by the greater investment income generated by the assets that did not have to be spent down due to the larger loan.

Suppose, on the other hand, that a larger secured loan is taken out to purchase a more valuable asset a', with price $P'_t > P_t$, rather than renting a. Let W'_{t+1} be wealth at $t + 1$ if a' is purchased, and W_{t+1} be wealth at $t + 1$ if a is rented. Assume for simplicity that the price of both a and a' will experience proportional growth g between t and $t + 1$ and κ is the same for both assets. Then

$$W'_{t+1} - W_{t+1} = (W_t - P'_t)(1 + r) - \kappa P'_t + P'_t(1 + g) - [W_t(1 + r) - rent_t]$$
$$= (P'_t - P_t)(g - r - \kappa), \tag{B.4}$$

where we have substituted in the expression in equation (B.3) for $rent_t$. Equation (B.4) tells us that a larger secured loan erodes future net worth through interest payments that are higher by $(P'_t - P_t)r$. But a larger secured loan also affects future net worth through the differential ownership cost and price appreciation of the asset acquired, $(P'_t - P_t)(g - \kappa)$. Note that the expression for the effect of buying a more expensive asset instead of *buying* a cheaper asset is identical to the last expression in equation (B.4).

The price growth rate g is highly negative for vehicles; the average new car loses about 60% of its value over the first five years of its life.[10] In contrast, the Bureau of Economic

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[10] https://www.carfax.com/blog/car-depreciation/ (accessed November 24, 2017). Arguably, a good deal of the depreciation occurs the moment the vehicle is driven off the dealer's lot. However, there is a difference between the

Analysis estimates that a new one-to-four unit residential structure loses only 6% of its value to depreciation over the first five years of its life, and in many markets, homes experience price appreciation that can be forecast ex ante.[11] Therefore, a debt-financed purchase of a more expensive car is likely to result in future net worth erosion, but a debt-financed purchase of a more expensive house has ambiguous effects.

Secured loans can also increase net worth through a "forced savings" channel, where the secured loan repayment schedule causes the household to accumulate equity in the asset at a faster rate than it would have otherwise saved in total.[12] This channel is unlikely to be very effective when the asset depreciates quickly, so that little equity is accumulated over the course of the loan. Again, this implies that a larger auto loan is a more negative signal about future net worth than a larger first mortgage.

We next consider the future net worth implications of a cash-out mortgage refinancing. If all of the extracted equity is invested, then the transaction does not change the path of future net worth. If the extracted equity is all spent on non-durable goods and services, net worth falls by the full amount extracted. Across all the waves of the Survey of Consumer Finances from 1998 to 2016, respondents' stated rationale for cash-out refinancing is relatively stable: about 40% say it is for home improvement and repair, about 10% say it is for other investment, about 5% say it is to buy a home, about 5% say it is to buy a vehicle, and about 40% say it is for other purposes. According to one set of estimates, only 16% of extracted dollars are used for consumer expenditures, a category that includes vehicle purchases (a durable) and educational expenses (an investment in human capital); 26% of dollars go to repaying other debts; 45% go to home improvements, real estate, or business investment; 11% go to financial investment; and 2% go to taxes.[13] It may be appropriate to treat self-reported reasons for cash-out refinancing with skepticism, as survey respondents may wish to portray themselves as financially responsible.

"hold to maturity" value of the car—the present discounted value of the service flows it provides the owner over its entire useful life—and the liquidation value of the car, which is depressed by adverse selection in the used car market. The "hold to maturity" value probably does not drop much immediately after purchase, whereas the liquidation value does.

[11] We take the rate of depreciation from https://www.bea.gov/national/pdf/BEA_depreciation_rates.pdf (accessed November 24, 2017). For empirical evidence on ex-ante forecastable home price appreciation, see Case, Karl E., and Robert J. Shiller, 1989. "The efficiency of the market for single-family homes." *American Economic Review* 79, pp. 125-137.

[12] Bernstein, Asaf, and Peter Koudijs, 2020. "Mortgage amortization and wealth accumulation." Working paper.

[13] Canner, Glenn, Karen Dynan, and Wayne Passmore, 2002. "Mortgage refinancing in 2001 and early 2002." *Federal Reserve Bulletin* (December), pp. 469-481.

However, survey measures of expenditures (as opposed to what respondents say they will use their cash-out refinancing proceeds for) indicate that of the expenditure categories measured by the Panel Study of Income Dynamics, the positive effect of home equity extraction is highly concentrated in categories associated with housing investment.[14] Overall, the evidence suggests that the bulk of extracted equity that does not go towards debt repayment is invested. Of course, even if a household does not immediately use the proceeds from cash-out refinancing for non-durable goods and services, it may use them to increase its purchases of non-durable goods and services in the future.

B.III. Conclusion

Employees whose TSP contributions are increased by automatic enrollment are likely to have little non-TSP liquidity to begin with. Therefore, if automatic enrollment increases auto and first mortgage debt, it is probably because households are buying more valuable cars and homes, not because automatic enrollment caused households to spend down more non-TSP assets. If the former is true, then the short-run net worth implications of any increase in auto and first mortgage debt under automatic enrollment are minimal. In the long run, higher auto debt is more likely to presage net worth erosion than higher first mortgage debt.

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[14] Zhou, Xiaoqing, 2017. "Home equity extraction and the boom-bust cycle in consumption and residential investment." Bank of Canada Working Paper 2018-6.

Online Appendix C for
"Borrowing to Save? The Impact of Automatic Enrollment on Debt"

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In this appendix, we report analyses that supplement the analyses presented in the main text of the paper.

Appendix Tables C1-C4 use a coarsened exact matching approach to adjust for imbalance in observable characteristics across the pre-AE and post-AE cohorts. We implement this methodology as follows.

First, for each variable involved in the matching process, we partition the range of possible values into bins: the bins for deflated annualized starting salary are {<$30,000, $30,000-$44,999, $45,000-$59,999, $60,000-$74,999, ≥$75,000}; the bins for age at hire are {<30, 30-39, 40-49, ≥50}; the bins for gender are {male, female}; the bins for race are {white, Black, Hispanic or Asian or Native American or missing}; the bins for education are {high school only or unknown, some college or associate degree, bachelor's degree or graduate degree}; the bins for college major are {STEM, business, other or missing, not applicable}; and the bins for position are {administrative or clerical, professional or technical, blue collar or other}. Second, we assign each employee to a group defined by the combination of bins that contain the employee's covariate values. Third, we limit the sample to employees in groups that contain at least one employee from the pre-AE cohort and at least one employee from the post-AE cohort. This step drops 1.1% of employees in the pre-AE cohort and 0.9% of employees in the post-AE cohort. Fourth, we assign each employee in the post-AE cohort a weight of one, and we assign each employee in the pre-AE cohort a weight such that (1) the weighted distribution of pre-AE employees across groups is identical to the unweighted distribution of post-AE employees across groups and (2) all pre-AE employees within a given group are weighted equally. Fifth, we recalculate the results of our primary analyses using the trimmed sample and the weights defined in the previous step. Note that when we control for observable characteristics in these final regressions, we use the exact covariate values, not the bins defined in the first step of the coarsened exact matching algorithm.

Appendix Table C1 shows the comparison of characteristics for the pre-AE and post-AE cohorts using the coarsened exact matching weights. As intended, the coarsened exact matching

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procedure improves balance. Whereas the unweighted comparison of cohorts in Table 1 suggests that the post-AE cohort has observable characteristics that would predict slightly worse credit outcomes relative to the pre-AE cohort, the weighted comparison of cohorts in Appendix Table C1 features smaller differences across cohorts and suggests that, if anything, the post-AE cohort has observable characteristics that would predict slightly *better* credit outcomes relative to the weighted pre-AE cohort (e.g., the post-AE cohort has a higher fraction with graduate degrees than the weighted pre-AE cohort).[15]

Appendix Tables C2-C4 report the results of regressions with coarsened exact matching that are analogous to those presented in Tables 2-5, 7, and 8.

The remaining exhibits do not use coarsened exact matching. In Tables 2-5, 7, and 8, the regression sample includes individuals as long as they remain employed by the Army, so the sample composition changes as tenure increases and individuals terminate employment. Appendix Tables C5-C10 conduct the same analysis holding the sample fixed as tenure increases. Appendix Tables C5-C7 examine the sample of employees who remain employed at least until they reach 43-48 months of tenure. Appendix Tables C8-C10 examine the sample of employees who were ever hired, setting their contribution flows to zero after separation from employment.

Appendix Table C11 examines the effect of automatic enrollment on subcomponents of the outcome variable measuring debt excluding auto loans and first mortgages. Appendix Table C12 investigates the effects of automatic enrollment separately for single employees versus married employees, using a variety of proxies for marital status. Appendix Table C13 examines the effect of automatic enrollment on debt balances that an employee jointly holds with other individuals and debt balances associated with the employee as an authorized user on accounts where someone else is the primary account holder. Appendix Table C14 examines the effect of automatic enrollment on debt aggregates and on cumulative TSP contributions net of debt aggregates.

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[15] Indeed, the mean Vantage credit score for the post-AE cohort is statistically significantly greater than the weighted mean for the pre-AE cohort. We do not match on credit score because it is an outcome variable. We could have improved balance across the cohorts further by using finer bins in the coarsened exact matching procedure, but finer bins would force us to drop more employees from the sample, making estimated treatment effects less comparable to those from our main analysis. The point that we would like to emphasize from the matching analysis is not that it produces perfect balance in observable characteristics, but that our main conclusions do not change when we use a different method to correct for imbalance in observable characteristics.

Appendix Figure C1 shows participation rates in the TSP for the pre-AE and post-AE cohorts. Participation is defined as making a positive employee contribution to the TSP. Appendix Figures C2 and C3 show average auto loan and first mortgage balances normalized by annualized first-year pay at each calendar date separately for the pre- and post-AE cohorts.

Appendix Table C1. Comparison of pre- and post-automatic enrollment hire cohorts, reweighted using coarsened exact matching

	Pre-AE (Aug '09 – Jul '10 hires)	Post-AE (Aug '10 – Jul '11 hires)	Difference	p-value of difference
Avg. starting salary	$55,020	$55,909	889	0.000
Avg. deflated starting salary	$55,542	$55,909	367	0.107
Avg. age at hire	39.8	39.9	0.0	0.630
Male	61.6%	61.6%	0.0%	1.000
White	57.2%	57.2%	0.0%	1.000
Black	11.9%	11.9%	0.0%	1.000
Hispanic	3.7%	4.2%	0.5%	0.001
Asian	3.2%	3.5%	0.3%	0.046
Native American	0.9%	1.0%	0.1%	0.519
Missing race	23.1%	22.2%	-0.9%	0.013
High school only	47.4%	47.5%	0.1%	0.766
Some college, no degree	12.3%	12.2%	-0.1%	0.678
Associate degree	4.5%	4.7%	0.1%	0.516
Bachelor's degree	19.5%	18.4%	-1.1%	0.001
Graduate degree	15.2%	16.3%	1.1%	0.000
Unknown education	1.1%	1.0%	-0.1%	0.143
STEM major | college	25.6%	25.3%	-0.3%	0.612
Business major | college	27.7%	27.3%	-0.4%	0.493
Other major | college	46.7%	47.4%	0.7%	0.291
Administrative position	31.8%	31.8%	0.0%	0.933
Blue collar position	10.9%	9.0%	-1.8%	0.000
Clerical position	7.9%	7.9%	0.0%	0.884
Professional position	21.1%	21.0%	-0.1%	0.799
Technical position	18.4%	18.5%	0.1%	0.788
Other position	10.0%	11.8%	1.8%	0.000
Has credit report in six months before hire	83.3%	83.2%	-0.1%	0.756
Avg. Vantage Score in six months before hire, conditional on having Vantage Score	684.6	687.5	2.9	0.001
# of obs. (N)	31,720	26,551		

Appendix Table C2. Effect of automatic enrollment on cumulative TSP contributions, Vantage credit score outcomes, and debt excluding auto and first mortgages, reweighted using coarsened exact matching

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. Regressions where the dependent variable is contributions or an indicator for a credit score drop are estimated according to equation (2), and the other regressions are estimated according to equation (4). All dependent variables except for Vantage credit score and indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. Observations are weighted using the coarsened exact matching approach described in the appendix text.

	Cumulative total TSP contributions	Cumulative employee TSP contributions	Vantage credit score	Debt excluding auto, first mortgage	Vantage score dropped ≥25 points	Vantage score dropped ≥50 points
Tenure ≤ -18	--	--	-0.2 (0.9)	0.003 (0.007)	--	--
Tenure -17 to -12	--	--	0.1 (0.7)	-0.004 (0.005)	--	--
Tenure -11 to -6	--	--	-0.1 (0.5)	-0.003 (0.003)	--	--
Tenure 1 to 6	0.005** (0.001)	0.002** (0.000)	0.2 (0.5)	0.000 (0.004)	-0.006 (0.005)	-0.002 (0.004)
Tenure 7 to 12	0.011** (0.001)	0.004** (0.001)	0.1 (0.7)	-0.005 (0.006)	-0.012 (0.007)	-0.002 (0.006)
Tenure 13 to 18	0.017** (0.001)	0.006** (0.001)	0.5 (0.9)	-0.005 (0.007)	-0.015 (0.008)	-0.003 (0.006)
Tenure 19 to 24	0.024** (0.002)	0.009** (0.002)	0.5 (1.0)	-0.006 (0.007)	-0.015 (0.008)	-0.004 (0.007)
Tenure 25 to 30	0.031** (0.003)	0.012** (0.002)	0.4 (1.1)	-0.001 (0.008)	-0.012 (0.009)	-0.001 (0.007)
Tenure 31 to 36	0.037** (0.003)	0.014** (0.003)	0.0 (1.2)	-0.001 (0.009)	-0.010 (0.009)	-0.004 (0.007)
Tenure 37 to 42	0.043** (0.004)	0.017** (0.003)	0.6 (1.2)	0.000 (0.010)	-0.010 (0.009)	-0.001 (0.008)
Tenure 43 to 48	0.049** (0.004)	0.019** (0.004)	0.6 (1.3)	-0.001 (0.010)	-0.011 (0.010)	0.000 (0.008)
Tenure 49 to 53	0.054** (0.005)	0.021** (0.004)	1.8 (1.4)	-0.011 (0.011)	-0.005 (0.011)	-0.006 (0.009)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	No	No	Yes	Yes	No	No
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	423,483	423,483	663,791	801,395	346,993	346,993

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

**Appendix Table C3. Effect of automatic enrollment on credit delinquency,
reweighted using coarsened exact matching**

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). The dependent variables capturing debt amounts are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. Observations are weighted using the coarsened exact matching approach described in the appendix text.

	Has late balances	Amount of late balances	Has derogatory balances	Amount of derogatory balances	Has balances in collection	Amount of balances in collection
Tenure ≤ -18	0.003	-0.001	-0.005	0.001	-0.002	-0.001
	(0.004)	(0.001)	(0.004)	(0.002)	(0.005)	(0.001)
Tenure -17 to -12	0.000	-0.002*	0.002	0.000	-0.001	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.003)	(0.001)
Tenure -11 to -6	-0.003	-0.001	0.001	0.000	0.000	-0.001*
	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)	(0.000)
Tenure 1 to 6	-0.003	-0.001*	-0.002	-0.001	0.002	0.000
	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
Tenure 7 to 12	-0.004	-0.001	-0.001	0.000	-0.001	0.000
	(0.004)	(0.001)	(0.004)	(0.001)	(0.003)	(0.001)
Tenure 13 to 18	-0.003	-0.001	-0.003	0.000	-0.002	0.000
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure 19 to 24	-0.006	-0.001	-0.007	0.000	-0.001	0.000
	(0.004)	(0.001)	(0.004)	(0.001)	(0.005)	(0.001)
Tenure 25 to 30	0.002	-0.001	-0.009*	0.000	-0.004	0.000
	(0.005)	(0.001)	(0.004)	(0.001)	(0.005)	(0.001)
Tenure 31 to 36	0.002	0.000	-0.011*	0.000	-0.007	0.000
	(0.005)	(0.001)	(0.005)	(0.002)	(0.006)	(0.001)
Tenure 37 to 42	-0.002	-0.001	-0.005	0.001	-0.003	-0.001
	(0.005)	(0.001)	(0.005)	(0.001)	(0.006)	(0.001)
Tenure 43 to 48	-0.005	-0.001	-0.005	-0.001	-0.003	-0.001
	(0.005)	(0.001)	(0.005)	(0.001)	(0.006)	(0.001)
Tenure 49 to 53	-0.007	-0.001	-0.002	-0.001	-0.001	0.000
	(0.006)	(0.001)	(0.005)	(0.002)	(0.007)	(0.001)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	801,395	801,395	801,395	801,395	801,395	801,395

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

Appendix Table C4. Effect of automatic enrollment on auto debt, first mortgage debt, auto loan delinquency, first mortgage delinquency, and first mortgage foreclosure, reweighted using coarsened exact matching

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). All dependent variables except for indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. Observations are weighted using the coarsened exact matching approach described in the appendix text.

	Auto debt	First mortgage debt	Most recent auto loan delinquent, last 6 months	Most recent first mortgage delinquent, last 6 months	Has foreclosed first mortgage	Balances on foreclosed first mortgages
Tenure ≤ -18	-0.002	0.024	0.001	-0.001	0.000	0.004
	(0.004)	(0.024)	(0.003)	(0.003)	(0.001)	(0.005)
Tenure -17 to -12	-0.001	-0.011	0.000	0.002	0.001	0.005
	(0.003)	(0.018)	(0.002)	(0.002)	(0.001)	(0.005)
Tenure -11 to -6	0.001	-0.011	-0.001	0.000	0.001	0.006
	(0.002)	(0.012)	(0.002)	(0.002)	(0.001)	(0.004)
Tenure 1 to 6	0.001	0.027*	0.000	-0.001	0.000	-0.002
	(0.002)	(0.013)	(0.002)	(0.002)	(0.001)	(0.004)
Tenure 7 to 12	0.002	0.014	0.001	-0.002	0.002*	0.010*
	(0.004)	(0.019)	(0.002)	(0.002)	(0.001)	(0.005)
Tenure 13 to 18	0.005	0.023	-0.001	0.001	0.001	0.003
	(0.005)	(0.024)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 19 to 24	0.004	0.012	-0.001	0.002	0.000	0.004
	(0.005)	(0.027)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 25 to 30	0.006	0.020	-0.001	0.001	0.001	0.009
	(0.006)	(0.031)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 31 to 36	0.010	0.042	0.001	0.000	0.001	0.007
	(0.006)	(0.034)	(0.004)	(0.003)	(0.001)	(0.006)
Tenure 37 to 42	0.010	0.046	-0.001	0.003	0.002	0.009
	(0.007)	(0.037)	(0.004)	(0.003)	(0.001)	(0.006)
Tenure 43 to 48	0.011	0.045	-0.002	0.001	0.001	0.007
	(0.007)	(0.040)	(0.004)	(0.004)	(0.002)	(0.006)
Tenure 49 to 53	0.006	0.046	0.000	0.002	-0.001	0.000
	(0.008)	(0.045)	(0.004)	(0.004)	(0.002)	(0.007)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	801,395	801,395	801,395	801,395	801,395	801,395

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

**Appendix Table C5. Effect of automatic enrollment on cumulative TSP contributions,
Vantage credit score outcomes, and debt excluding auto and first mortgages:
Constant sample of employees who remain at least 43-48 months**

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. Regressions where the dependent variable is contributions or an indicator for a credit score drop are estimated according to equation (2), and the other regressions are estimated according to equation (4). All dependent variables except for Vantage credit score and indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The sample contains only people who remain employed at 43-48 months of tenure.

	Cumulative total TSP contributions	Cumulative employee TSP contributions	Vantage credit score	Debt excluding auto, first mortgage	Vantage score dropped ≥25 points	Vantage score dropped ≥50 points
Tenure ≤ -18	--	--	-1.5 (1.0)	0.009 (0.007)	--	--
Tenure -17 to -12	--	--	-0.9 (0.8)	-0.003 (0.005)	--	--
Tenure -11 to -6	--	--	-0.5 (0.6)	-0.003 (0.004)	--	--
Tenure 1 to 6	0.003** (0.001)	0.000 (0.000)	0.6 (0.6)	0.001 (0.004)	-0.009 (0.006)	0.001 (0.004)
Tenure 7 to 12	0.009** (0.001)	0.003** (0.001)	0.1 (0.8)	-0.002 (0.006)	-0.014 (0.008)	-0.003 (0.006)
Tenure 13 to 18	0.015** (0.002)	0.005** (0.001)	0.7 (1.0)	-0.001 (0.007)	-0.020* (0.009)	-0.004 (0.007)
Tenure 19 to 24	0.022** (0.002)	0.008** (0.002)	0.3 (1.1)	-0.002 (0.007)	-0.022* (0.009)	-0.005 (0.007)
Tenure 25 to 30	0.029** (0.003)	0.011** (0.002)	-0.1 (1.2)	0.002 (0.008)	-0.014 (0.009)	-0.002 (0.007)
Tenure 31 to 36	0.034** (0.004)	0.013** (0.003)	-0.8 (1.2)	0.004 (0.009)	-0.010 (0.009)	-0.003 (0.007)
Tenure 37 to 42	0.040** (0.004)	0.016** (0.003)	-0.2 (1.3)	0.008 (0.009)	-0.011 (0.009)	-0.001 (0.007)
Tenure 43 to 48	0.046** (0.005)	0.018** (0.004)	-0.5 (1.3)	0.004 (0.010)	-0.015 (0.009)	0.002 (0.007)
Tenure 49 to 53	0.051** (0.006)	0.021** (0.005)	0.7 (1.5)	-0.004 (0.011)	-0.011 (0.010)	-0.003 (0.008)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	No	No	Yes	Yes	No	No
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	344,208	344,208	478,067	574,313	282,623	282,623

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

Appendix Table C6. Effect of automatic enrollment on credit delinquency:
Constant sample of employees who remain at least 43-48 months

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). The dependent variables capturing debt amounts are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The sample contains only people who remain employed at 43-48 months of tenure.

	Has late balances	Amount of late balances	Has derogatory balances	Amount of derogatory balances	Has balances in collection	Amount of balances in collection
Tenure ≤ -18	0.008	0.000	-0.003	0.001	-0.006	-0.001
	(0.005)	(0.001)	(0.004)	(0.002)	(0.005)	(0.001)
Tenure -17 to -12	0.005	0.000	0.002	-0.002	-0.004	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure -11 to -6	0.001	0.000	-0.001	-0.001	-0.002	0.000
	(0.003)	(0.001)	(0.004)	(0.001)	(0.003)	(0.000)
Tenure 1 to 6	-0.003	0.000	-0.008*	-0.001	0.002	0.000
	(0.004)	(0.001)	(0.004)	(0.001)	(0.003)	(0.000)
Tenure 7 to 12	-0.001	0.000	-0.006	-0.002	-0.001	0.000
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure 13 to 18	-0.002	0.000	-0.004	0.000	0.000	0.000
	(0.005)	(0.001)	(0.005)	(0.001)	(0.005)	(0.001)
Tenure 19 to 24	-0.003	0.000	-0.007	0.000	0.002	0.000
	(0.005)	(0.001)	(0.005)	(0.002)	(0.005)	(0.001)
Tenure 25 to 30	0.006	0.000	-0.008	0.000	0.000	0.000
	(0.005)	(0.001)	(0.005)	(0.001)	(0.006)	(0.001)
Tenure 31 to 36	0.004	0.001	-0.009	-0.001	-0.004	0.000
	(0.005)	(0.001)	(0.005)	(0.002)	(0.006)	(0.001)
Tenure 37 to 42	0.000	0.000	-0.005	0.000	-0.001	-0.001
	(0.005)	(0.001)	(0.005)	(0.002)	(0.006)	(0.001)
Tenure 43 to 48	-0.003	0.001	-0.005	-0.001	0.000	-0.001
	(0.005)	(0.001)	(0.005)	(0.002)	(0.007)	(0.001)
Tenure 49 to 53	-0.006	0.000	-0.003	-0.002	0.000	0.000
	(0.006)	(0.001)	(0.006)	(0.002)	(0.007)	(0.001)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	574,313	574,313	574,313	574,313	574,313	574,313

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

Appendix Table C7. Effect of automatic enrollment on auto debt, first mortgage debt, auto loan delinquency, first mortgage delinquency, and first mortgage foreclosure: Constant sample of employees who remain at least 43-48 months

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). All dependent variables except for indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The sample contains only people who remain employed at 43-48 months of tenure.

	Auto debt	First mortgage debt	Most recent auto loan delinquent, last 6 months	Most recent first mortgage delinquent, last 6 months	Has foreclosed first mortgage	Balances on foreclosed first mortgages
Tenure ≤ -18	-0.005 (0.004)	0.010 (0.026)	0.003 (0.003)	0.005 (0.003)	0.000 (0.001)	0.004 (0.006)
Tenure -17 to -12	-0.005 (0.003)	-0.025 (0.020)	0.001 (0.003)	0.005 (0.003)	0.000 (0.001)	-0.002 (0.005)
Tenure -11 to -6	-0.001 (0.002)	-0.011 (0.014)	0.001 (0.002)	0.002 (0.002)	0.000 (0.001)	0.000 (0.004)
Tenure 1 to 6	0.001 (0.002)	0.031* (0.015)	0.000 (0.002)	0.001 (0.002)	-0.001 (0.001)	-0.004 (0.005)
Tenure 7 to 12	0.003 (0.004)	0.021 (0.023)	0.002 (0.003)	0.003 (0.003)	0.001 (0.001)	0.002 (0.006)
Tenure 13 to 18	0.005 (0.005)	0.037 (0.028)	0.001 (0.003)	0.003 (0.003)	0.000 (0.001)	0.000 (0.007)
Tenure 19 to 24	0.003 (0.005)	0.000 (0.031)	0.000 (0.003)	0.004 (0.003)	0.000 (0.002)	0.000 (0.007)
Tenure 25 to 30	0.003 (0.006)	0.008 (0.034)	0.000 (0.004)	0.004 (0.004)	0.001 (0.002)	0.006 (0.007)
Tenure 31 to 36	0.004 (0.006)	0.028 (0.036)	0.002 (0.004)	0.004 (0.004)	0.001 (0.002)	0.006 (0.007)
Tenure 37 to 42	0.006 (0.006)	0.027 (0.039)	-0.001 (0.004)	0.006 (0.004)	0.002 (0.002)	0.008 (0.007)
Tenure 43 to 48	0.007 (0.007)	0.038 (0.041)	-0.002 (0.004)	0.005 (0.004)	0.002 (0.002)	0.007 (0.007)
Tenure 49 to 53	0.004 (0.008)	0.043 (0.047)	-0.002 (0.004)	0.005 (0.004)	-0.001 (0.002)	-0.003 (0.008)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	574,313	574,313	574,313	574,313	574,313	574,313

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

Appendix Table C8. Effect of automatic enrollment on cumulative TSP contributions,
Vantage credit score outcomes, and debt excluding auto and first mortgages:
Constant sample of employees who were ever hired

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. Regressions where the dependent variable is contributions or an indicator for a credit score drop are estimated according to equation (2), and the other regressions are estimated according to equation (4). All dependent variables except for Vantage credit score and indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The constant sample contains all employees who were ever hired, setting their contribution flows to zero after separation.

	Cumulative total TSP contributions	Cumulative employee TSP contributions	Vantage credit score	Debt excluding auto, first mortgage	Vantage score dropped ≥25 points	Vantage score dropped ≥50 points
Tenure ≤ -18	--	--	-0.5 (0.8)	0.003 (0.006)	--	--
Tenure -17 to -12	--	--	0.0 (0.6)	-0.003 (0.004)	--	--
Tenure -11 to -6	--	--	-0.1 (0.4)	-0.003 (0.003)	--	--
Tenure 1 to 6	0.005** (0.000)	0.002** (0.000)	0.3 (0.5)	-0.001 (0.003)	-0.001 (0.005)	0.000 (0.003)
Tenure 7 to 12	0.010** (0.001)	0.004** (0.001)	0.1 (0.6)	-0.006 (0.004)	-0.005 (0.006)	0.000 (0.005)
Tenure 13 to 18	0.015** (0.001)	0.005** (0.001)	0.4 (0.8)	-0.008 (0.005)	-0.006 (0.007)	0.000 (0.005)
Tenure 19 to 24	0.021** (0.002)	0.008** (0.001)	0.3 (0.9)	-0.014* (0.006)	-0.006 (0.007)	-0.001 (0.005)
Tenure 25 to 30	0.027** (0.002)	0.010** (0.002)	0.4 (0.9)	-0.014* (0.006)	-0.003 (0.007)	0.002 (0.005)
Tenure 31 to 36	0.031** (0.003)	0.012** (0.002)	-0.1 (1.0)	-0.017* (0.007)	-0.002 (0.007)	0.000 (0.006)
Tenure 37 to 42	0.036** (0.003)	0.014** (0.002)	0.4 (1.0)	-0.018* (0.008)	-0.003 (0.007)	(0.002 (0.006)
Tenure 43 to 48	0.041** (0.004)	0.016** (0.003)	-0.1 (1.1)	-0.023** (0.008)	-0.004 (0.007)	0.003 (0.006)
Tenure 49 to 53	0.046** (0.004)	0.018** (0.003)	0.3 (1.2)	-0.029** (0.009)	-0.001 (0.007)	0.000 (0.006)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	No	No	Yes	Yes	No	No
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	560,223	560,223	779,283	941,984	482,835	482,835

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

Appendix Table C9. Effect of automatic enrollment on credit delinquency:
Constant sample of employees who were ever hired

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). The dependent variables capturing debt amounts are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The constant sample contains all employees who were ever hired.

	Has late balances	Amount of late balances	Has derogatory balances	Amount of derogatory balances	Has balances in collection	Amount of balances in collection
Tenure ≤ -18	0.003	-0.001	-0.004	0.001	-0.004	-0.001
	(0.004)	(0.001)	(0.003)	(0.002)	(0.004)	(0.001)
Tenure -17 to -12	0.001	-0.002*	0.001	0.000	-0.004	-0.001
	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
Tenure -11 to -6	-0.003	-0.001	0.000	0.000	-0.002	-0.001*
	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)	(0.000)
Tenure 1 to 6	-0.002	-0.001**	0.000	-0.001	0.002	0.000
	(0.003)	(0.001)	(0.003)	(0.001)	(0.002)	(0.000)
Tenure 7 to 12	-0.001	-0.001	0.001	0.000	0.000	0.000
	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
Tenure 13 to 18	-0.002	-0.001	-0.001	0.000	0.000	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure 19 to 24	-0.004	-0.001	-0.002	0.001	-0.001	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure 25 to 30	0.001	-0.002	-0.006	0.000	-0.002	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.001)
Tenure 31 to 36	0.001	-0.001	-0.007	-0.001	-0.005	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.005)	(0.001)
Tenure 37 to 42	-0.001	-0.001	-0.004	0.000	0.000	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.005)	(0.001)
Tenure 43 to 48	0.000	0.000	-0.005	-0.001	0.000	-0.001
	(0.004)	(0.001)	(0.004)	(0.001)	(0.005)	(0.001)
Tenure 49 to 53	0.000	0.001	-0.005	-0.001	-0.002	-0.001
	(0.005)	(0.001)	(0.005)	(0.001)	(0.006)	(0.001)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	941,984	941.984	941,984	941,984	941,984	941,984

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

Appendix Table C10. Effect of automatic enrollment on auto debt, first mortgage debt, auto loan delinquency, first mortgage delinquency, and first mortgage foreclosure: Constant sample of employees who were ever hired

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). All dependent variables except for indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression. The constant sample contains all employees who were ever hired.

	Auto debt	First mortgage debt	Most recent auto loan delinquent, last 6 months	Most recent first mortgage delinquent, last 6 months	Has foreclosed first mortgage	Balances on foreclosed first mortgages
Tenure ≤ -18	-0.001	0.021	0.000	0.001	0.001	0.007
	(0.003)	(0.020)	(0.003)	(0.002)	(0.001)	(0.005)
Tenure -17 to -12	-0.001	-0.008	0.000	0.002	0.001	0.006
	(0.003)	(0.016)	(0.002)	(0.002)	(0.001)	(0.005)
Tenure -11 to -6	0.000	-0.011	0.000	0.000	0.000	0.006
	(0.002)	(0.011)	(0.002)	(0.002)	(0.001)	(0.003)
Tenure 1 to 6	0.001	0.021	0.000	-0.001	0.000	0.000
	(0.002)	(0.012)	(0.002)	(0.002)	(0.001)	(0.004)
Tenure 7 to 12	0.000	0.006	0.003	0.000	0.003**	0.010
	(0.003)	(0.017)	(0.002)	(0.002)	(0.001)	(0.005)
Tenure 13 to 18	0.001	0.013	0.000	0.002	0.001	0.004
	(0.004)	(0.021)	(0.003)	(0.002)	(0.001)	(0.005)
Tenure 19 to 24	-0.001	-0.005	-0.002	0.000	0.001	0.005
	(0.004)	(0.024)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 25 to 30	0.001	-0.001	-0.003	0.000	0.002	0.007
	(0.005)	(0.026)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 31 to 36	0.002	-0.005	-0.002	0.000	0.002	0.004
	(0.005)	(0.029)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 37 to 42	0.004	-0.006	-0.003	0.001	0.003*	0.006
	(0.005)	(0.031)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 43 to 48	0.006	-0.002	-0.002	0.002	0.003*	0.004
	(0.005)	(0.033)	(0.003)	(0.003)	(0.001)	(0.006)
Tenure 49 to 53	0.002	0.010	0.000	0.004	0.001	0.001
	(0.006)	(0.037)	(0.003)	(0.003)	(0.001)	(0.007)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	941,984	941,984	941,984	941,984	941,984	941,984

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

Appendix Table C11. Effect of automatic enrollment on debt subcomponents

Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label. All regressions are estimated according to equation (4). All dependent variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression.

	HELOC revolving	Non-HELOC revolving	Other installment loans	Second mortgages	Student loans	External collections	Residual debt
Tenure ≤ -18	0.005 (0.003)	0.002 (0.002)	-0.003 (0.003)	0.004 (0.003)	-0.004 (0.003)	-0.001 (0.001)	0.001 (0.001)
Tenure -17 to -12	0.001 (0.002)	0.000 (0.001)	-0.003 (0.002)	0.000 (0.002)	-0.001 (0.002)	-0.001 (0.001)	0.000 (0.000)
Tenure -11 to -6	0.000 (0.001)	0.001 (0.001)	-0.003 (0.002)	-0.001 (0.001)	0.000 (0.001)	-0.001* (0.000)	0.000 (0.000)
Tenure 1 to 6	0.000 (0.001)	0.000 (0.001)	-0.003 (0.002)	0.002 (0.001)	0.001 (0.001)	0.000 (0.000)	0.000 (0.000)
Tenure 7 to 12	0.001 (0.002)	-0.001 (0.001)	-0.006* (0.003)	0.002 (0.002)	-0.001 (0.002)	0.000 (0.001)	0.001 (0.000)
Tenure 13 to 18	0.000 (0.002)	0.001 (0.002)	-0.006 (0.003)	0.002 (0.002)	-0.002 (0.002)	0.000 (0.001)	0.001 (0.001)
Tenure 19 to 24	-0.001 (0.002)	0.001 (0.002)	-0.006 (0.004)	0.000 (0.003)	-0.005 (0.003)	0.000 (0.001)	0.001 (0.001)
Tenure 25 to 30	-0.001 (0.003)	0.002 (0.003)	-0.005 (0.004)	0.002 (0.003)	-0.004 (0.003)	0.000 (0.001)	0.001* (0.001)
Tenure 31 to 36	-0.003 (0.003)	0.003 (0.003)	-0.003 (0.004)	0.002 (0.003)	-0.004 (0.004)	-0.001 (0.001)	0.001* (0.001)
Tenure 37 to 42	-0.001 (0.003)	0.003 (0.003)	-0.005 (0.004)	0.003 (0.004)	-0.003 (0.004)	-0.001 (0.001)	0.002* (0.001)
Tenure 43 to 48	-0.003 (0.004)	0.003 (0.003)	-0.004 (0.004)	0.002 (0.004)	-0.004 (0.005)	-0.001 (0.001)	0.002* (0.001)
Tenure 49 to 53	-0.002 (0.004)	0.000 (0.004)	-0.009 (0.005)	0.004 (0.004)	-0.008 (0.006)	0.000 (0.001)	0.001 (0.001)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	809,385	809,385	809,385	809,385	809,385	809,385	809,385

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

Appendix Table C12. The effect of automatic enrollment on single employees relative to other employees at 43-48 months of tenure

Each pair of cells contains estimates from its own separate regression. The left cell within a pair reports the treatment effect of automatic enrollment on the variable indicated in the row label at 43-48 months of tenure for employees not classified as single according to the method indicated in the column header. The right cell within a pair reports by how much the treatment effect in the left cell differs from the same treatment effect at 43-48 months of tenure for employees classified as single according to the method indicated in the column header. The contribution regressions and the regressions that have an indicator for a credit score drop as the outcome variable are estimated according to equation (2), modified to include the interactions of all explanatory variables with an indicator for being classified as single according to the method indicated in the column header. The other regressions are estimated according to equation (4), modified in the same way. All dependent variables except for Vantage credit score and indicator variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses.

	Single = always selected single health insurance		Single = single in last uniformed services record, with sample limited to employees who have such a record		Single = single in last uniformed services record, or always selected single health insurance if uniformed services record unavailable	
	Not classified as single	Single relative to others	Not classified as single	Single relative to others	Not classified as single	Single relative to others
Cumulative total TSP contributions	0.045** (0.004)	-0.024* (0.011)	0.052** (0.007)	0.001 (0.013)	0.044** (0.005)	-0.011 (0.009)
Cumulative employee TSP contributions	0.015** (0.004)	-0.007 (0.010)	0.020** (0.006)	0.003 (0.011)	0.015** (0.004)	-0.003 (0.008)
Vantage credit score	0.8 (1.3)	-4.9 (3.4)	3.0 (2.0)	-4.1 (4.3)	0.8 (1.4)	-3.0 (3.0)
Debt excl. auto and first mortgages	-0.005 (0.010)	-0.005 (0.024)	-0.026 (0.016)	0.085* (0.034)	-0.013 (0.010)	0.032 (0.022)
Vantage credit score dropped by ≥25 points	-0.009 (0.010)	-0.003 (0.025)	-0.007 (0.015)	0.001 0.032	-0.011 (0.010)	0.003 (0.022)
Vantage credit score dropped by ≥50 points	0.000 (0.008)	0.010 (0.020)	-0.003 (0.012)	0.019 (0.026)	-0.002 (0.008)	0.016 (0.018)
# of employees at 43-48 months not classified as single	31,400		11,860		28,388	
# of employees at 43-48 months classified as single	4,799		3,954		7,811	

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

Appendix Table C12 continued. The effect of automatic enrollment on single employees relative to other employees at 43-48 months of tenure

	Single = always selected single health insurance		Single = single in last uniformed services record, with sample limited to employees who have such a record		Single = single in last uniformed services record, or always selected single health insurance if uniformed services record unavailable	
	Not classified as single	Single relative to others	Not classified as single	Single relative to others	Not classified as single	Single relative to others
Has late balances	-0.003	-0.004	-0.005	-0.005	-0.005	0.003
	(0.005)	(0.012)	(0.009)	(0.019)	(0.005)	(0.012)
Amount of late balances	0.000	0.000	-0.002	0.001	0.000	0.000
	(0.001)	(0.002)	(0.002)	(0.004)	(0.001)	(0.002)
Has derogatory balances	-0.003	-0.010	0.007	-0.028	-0.001	-0.012
	(0.005)	(0.012)	(0.008)	(0.018)	(0.005)	(0.011)
Amount of derogatory balances	-0.002	0.005	-0.003	0.004	-0.002	0.004
	(0.002)	(0.003)	(0.003)	(0.005)	(0.002)	(0.003)
Has balances in collection	-0.002	-0.001	-0.003	-0.013	0.000	-0.007
	(0.006)	(0.016)	(0.011)	(0.023)	(0.007)	(0.015)
Amount of balances in collection	0.000	-0.006	0.000	-0.001	0.000	-0.004
	(0.001)	(0.003)	(0.002)	(0.004)	(0.001)	(0.003)
Auto debt	0.011	-0.005	0.011	-0.041	0.016*	-0.027
	(0.007)	(0.014)	(0.012)	(0.023)	(0.007)	(0.014)
First mortgage debt	0.007	0.084	-0.058	0.137	0.005	0.066
	(0.041)	(0.088)	(0.069)	(0.133)	(0.043)	(0.083)
Most recent auto loan delinquent, last 6 mos.	-0.003	0.000	-0.007	0.007	-0.004	0.003
	(0.004)	(0.008)	(0.007)	(0.015)	(0.004)	(0.009)
Most recent first mortg. delinquent, last 6 mos.	0.003	-0.002	-0.001	0.013	0.002	0.005
	(0.004)	(0.007)	(0.006)	(0.013)	(0.004)	(0.007)
Has foreclosed first mortgage	0.003	-0.003	0.001	0.004	0.002	0.001
	(0.002)	(0.003)	(0.003)	(0.006)	(0.002)	(0.003)
Balances on foreclosed first mortgages	0.011	0.001	-0.009	0.023	0.010	0.004
	(0.007)	(0.013)	(0.012)	(0.024)	(0.007)	(0.014)
# of employees at 43-48 months not classified as single	31,400		11,860		28,388	
# of employees at 43-48 months classified as single	4,799		3,954		7,811	

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

Appendix Table C13. Effect of automatic enrollment on joint and authorized user debt
Each column reports regression-adjusted effects of automatic enrollment on the dependent variable in the column heading as of the tenure months in the row label, estimated according to equation (4). The dependent variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in each regression.

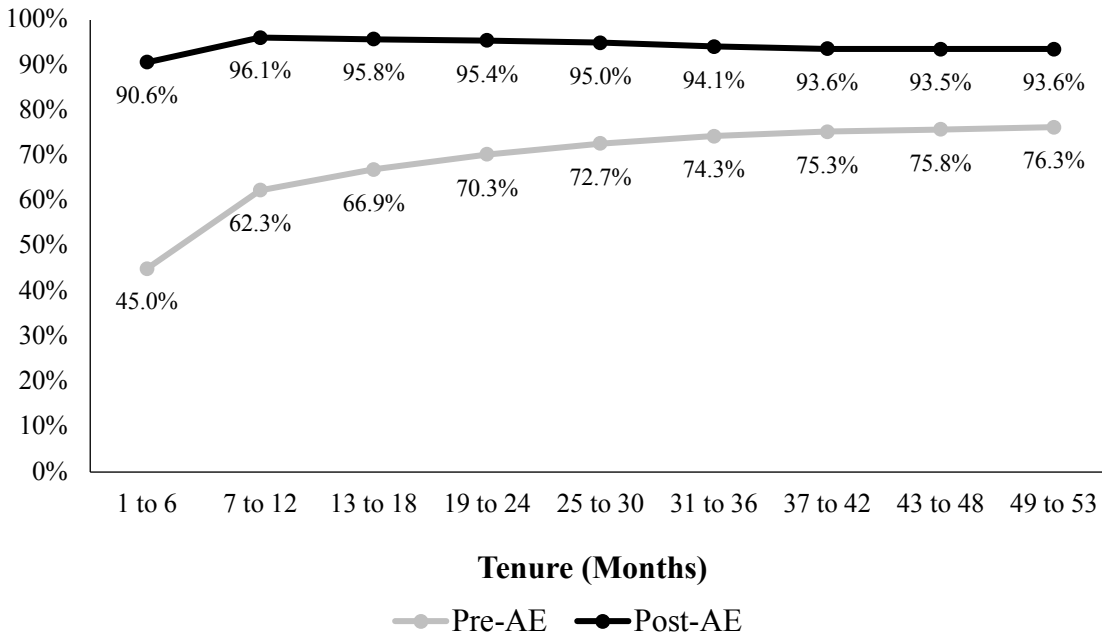|	Total joint debt	Joint mortgage debt	Joint non-mortgage installment debt	Joint revolving debt	Total authorized user debt	Authorized user bankcard and charge card debt
Tenure ≤ -18	0.014 (0.019)	0.019 (0.018)	-0.004 (0.004)	0.003 (0.002)	0.001 (0.001)	0.002* (0.001)
Tenure -17 to -12	-0.011 (0.015)	-0.005 (0.014)	-0.005 (0.003)	0.000 (0.002)	0.000 (0.001)	0.000 (0.001)
Tenure -11 to -6	-0.012 (0.010)	-0.009 (0.010)	-0.003 (0.002)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)
Tenure 1 to 6	0.023* (0.011)	0.022* (0.010)	0.001 (0.002)	-0.001 (0.001)	0.000 (0.000)	0.000 (0.000)
Tenure 7 to 12	0.012 (0.016)	0.009 (0.016)	0.003 (0.003)	-0.001 (0.001)	0.000 (0.001)	0.000 (0.001)
Tenure 13 to 18	0.023 (0.021)	0.018 (0.020)	0.005 (0.004)	-0.002 (0.002)	0.001 (0.001)	0.001 (0.001)
Tenure 19 to 24	0.014 (0.024)	0.006 (0.023)	0.007 (0.005)	-0.002 (0.002)	0.001 (0.001)	0.001 (0.001)
Tenure 25 to 30	0.023 (0.027)	0.013 (0.026)	0.009 (0.005)	-0.003 (0.002)	0.002* (0.001)	0.002* (0.001)
Tenure 31 to 36	0.035 (0.029)	0.024 (0.028)	0.012* (0.006)	-0.005 (0.003)	0.002 (0.001)	0.001 (0.001)
Tenure 37 to 42	0.031 (0.032)	0.023 (0.031)	0.008 (0.006)	-0.004 (0.003)	0.003* (0.001)	0.002* (0.001)
Tenure 43 to 48	0.027 (0.035)	0.018 (0.034)	0.009 (0.006)	-0.005 (0.003)	0.003* (0.001)	0.002* (0.001)
Tenure 49 to 53	0.036 (0.040)	0.028 (0.039)	0.007 (0.007)	-0.004 (0.003)	0.004* (0.002)	0.003* (0.001)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	809,385	809,385	809,385	809,385	809,385	809,385

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

Appendix Table C14. Effect of automatic enrollment on debt aggregates and cumulative TSP contributions net of debt aggregates

The first three columns report coefficients from regressions estimated according to equation (4), where the dependent variable is in the column heading. D1 is debt excluding auto loans and first mortgages, D2 is auto loans plus D1, and D3 is first mortgages plus D2. The last three columns report the estimated treatment effects on cumulative TSP contributions minus the D1, D2, or D3 effect estimates, where the contribution effect estimates are taken from the second column of Table 2. All dependent variables are normalized by first-year annualized salary. Standard errors clustered at the employee level are in parentheses. The last row shows the number of person-months in the debt regressions. The NET1-NET3 results are derived from the 809,385 person-months used in the debt regressions and the 427,624 person-months used in the contribution regressions.

|	D1	D2	D3	NET1	NET2	NET3
Tenure ≤ -18	0.003 (0.006)	0.003 (0.007)	0.027 (0.022)	--	--	--
Tenure -17 to -12	-0.003 (0.004)	-0.004 (0.005)	-0.011 (0.017)	--	--	--
Tenure -11 to -6	-0.003 (0.003)	-0.003 (0.003)	-0.013 (0.012)	--	--	--
Tenure 1 to 6	-0.001 (0.003)	0.000 (0.004)	0.022 (0.013)	0.005 (0.003)	0.004 (0.004)	-0.018 (0.013)
Tenure 7 to 12	-0.005 (0.004)	-0.003 (0.006)	0.001 (0.019)	0.014** (0.004)	0.013* (0.005)	0.008 (0.018)
Tenure 13 to 18	-0.006 (0.005)	-0.001 (0.007)	0.010 (0.024)	0.020** (0.005)	0.015* (0.007)	0.004 (0.024)
Tenure 19 to 24	-0.009 (0.006)	-0.005 (0.008)	-0.008 (0.027)	0.029** (0.006)	0.025** (0.008)	0.028 (0.027)
Tenure 25 to 30	-0.006 (0.007)	-0.001 (0.009)	0.003 (0.031)	0.032** (0.007)	0.027** (0.009)	0.023 (0.031)
Tenure 31 to 36	-0.005 (0.008)	0.004 (0.010)	0.023 (0.034)	0.036** (0.008)	0.027* (0.010)	0.008 (0.035)
Tenure 37 to 42	-0.003 (0.008)	0.006 (0.011)	0.025 (0.037)	0.039** (0.009)	0.030** (0.011)	0.011 (0.038)
Tenure 43 to 48	-0.006 (0.009)	0.005 (0.011)	0.027 (0.040)	0.047** (0.010)	0.036** (0.012)	0.014 (0.042)
Tenure 49 to 53	-0.013 (0.010)	-0.006 (0.013)	0.019 (0.046)	0.059** (0.012)	0.051** (0.014)	0.027 (0.047)
Calendar time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Person fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Demographic × tenure controls	Yes	Yes	Yes	Yes	Yes	Yes
# of obs. (N)	809,385	809,385	809,385	--	--	--

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

Appendix Figure C1. Participation rates in the TSP by cohort. Participation is defined as making a positive employee contribution to the TSP in the June or December when an individual reached the tenure level indicated on the horizontal axis. The pre-AE cohort consists of August 2009 – July 2010 hires, and the post-AE cohort consists of August 2010 – July 2011 hires. The sample at each tenure level consists of all civilians employed by the Army at that time, excluding re-hires. The participation rates do not exactly equal 100 minus the fraction contributing 0% in Figure 1 because the 0% bar in Figure 1 includes individuals making positive contributions that are less than 0.5% of their salary.
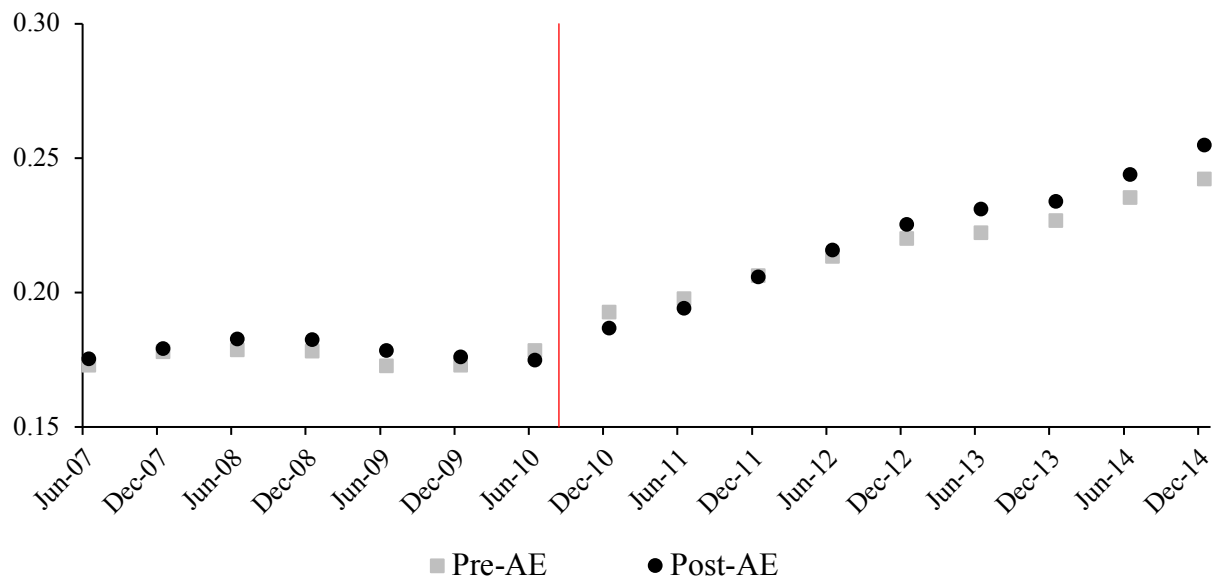
Appendix Figure C2. Average auto loan and lease balance normalized by annualized first-year pay at each calendar date. The pre-AE cohort consists of August 2009 – July 2010 hires, and the post-AE cohort consists of August 2010 – July 2011 hires. The vertical line indicates when automatic enrollment was introduced for new hires. Individuals are dropped from the sample once they have left Army employment.
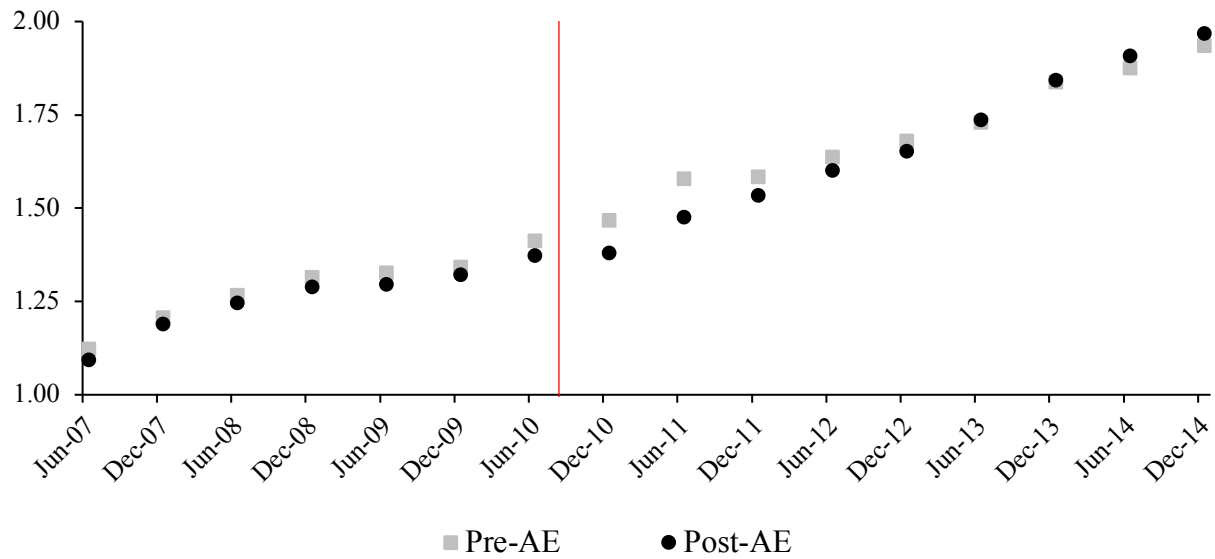
Appendix Figure C3. Average first mortgage balance normalized by annualized first-year pay at each calendar date. The pre-AE cohort consists of August 2009 – July 2010 hires, and the post-AE cohort consists of August 2010 – July 2011 hires. The vertical line indicates when automatic enrollment was introduced for new hires. Individuals are dropped from the sample once they have left Army employment.