Employer 401(k) Matches for Student Debt Repayment: Killing Two Birds with One Stone?

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Abstract

Almost 50 million Americans are burdened by the need to repay close to $2 trillion in student loan debt obligations, while at the same time saving in their employer-provided pension accounts. This article shows how workers can maximize their lifetime wellbeing by timing loan repayment and saving in tax-qualified retirement plans when these choices are shaped by employer-sponsored matching retirement contributions for qualifying student loan payments, as intended by the 2022 SECURE 2.0 Act. Our rich life cycle model predicts that, by age 50, employees will repay more debt but reduce own retirement plan contributions by almost half, offset by higher employer-matching contributions that take loan repayments into account. Accordingly, pre-retirement financial assets in and outside DC plans barely change; moreover, workers' optimal consumption rises by up to 3% prior to retirement, so that the reform will not lead to earlier loan discharges. Overall, 401(k) plan benefit payouts during retirement are not anticipated to change materially. Finally, our model predicts that anticipated additional employer costs due to the new matches will amount to around 2.4-4.3% of annual earnings for workers age 40-50, and expected federal income taxes paid over the lifetime would increase by about 1.8-2.5% (in present value).

Keywords: lifecycle saving; retirement plan; student loans; household finance
JEL codes: G11, G22, G53, D14, D91

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The SECURE 2.0 Act of 2022 contained numerous measures intended to enhance Americans' retirement security, one of which gives workers with outstanding student loans the opportunity to repay these loans and receive matching employer contributions in their tax-qualified retirement plans.[1] The growth in defined contribution (DC) plans, especially 401(k)s where employees can decide how much to contribute and often receive employer matching contributions, makes it increasingly important to recognize the fact that close to 50 million Americans owe close to $2 trillion in student loan debt, and most young workers start their work lives facing the heavy burden by of these obligations.[2] To mitigate the concern that indebted workers may be unable to save in their employer-provided pension accounts, this new policy is intended to let employees repay their loans more quickly without undermining the growth of their retirement accounts. Whether workers will achieve this goal is, as yet, unknown.

To address this question, our paper investigates how employees with student loans should optimally manage the choice between debt repayment and retirement saving in tax-qualified accounts. A life cycle model, calibrated using data from the Survey of Consumer Finances (SCF), informs our assessment of how these decisions will be influenced by employer-sponsored matching contributions to retirement plans when workers make such qualifying student loan payments. We show that, as intended, the reform will boost peoples' loan repayments, while own retirement plan contributions fall prior to about age 50and catch up after that. At retirement age, 401(k) assets are similar to those pre-reform, while non-retirement financial assets are slightly lower due to consuming more when young. Overall, we conclude that encouraging workers to discharge their student debts as soon as possible may not be optimal when their employers match loan repayments in their retirement saving plans.

This paper contributes to the rich literature on household finance (Gomes et al. 2021) and dynamic portfolio choice over the life cycle (Gomes 2020). Though some researchers in this field have considered household balance sheet debt, they focus mainly on mortgage loans used to purchase homes (e.g., Cocco 2005; Kraft and Munk 2018) rather than on education debt.[3] Nevertheless, mortgages

[1] Prior to the passage of this act, a few employers did offer matching contributions, but so-called "non-discrimination rules" made this difficult and costly (Correia 2023).

[2] See Safier and Harrison (2023); Lusardi and Mitchell (2017); Lusardi et al. (2018, 2020); and Mitchell and Lusardi (2020).

[3] Black et al. (2023) also investigate auto loan debt.

differ importantly from student loans, since one's home is an asset that serves as collateral, and mortgage loans may be discharged by transferring the house to the lender, even if the house value is less than the loan. Moreover, the mortgage amount can be reduced (extended) by selling the house (refinancing the mortgage). None of this is true for student loans.

Our paper also builds on a growing literature regarding the impact of student loans and educational loan subsidies (e.g., Black et al. 2023; Catherine and Yannelis 2023; Cornaggia and Xia 2024; Dynarski 2021; Dettling et al. 2022; Kargar and Mann 2023; Looney and Yannelis 2021), as well as empirical evidence on student loan borrowers (e.g., Goodman et al. 2021; Gopalan et al. 2023; Holder and Yannelis 2022). Nevertheless, that research focuses mainly on the distributional effects of student loans, along with adverse selection and moral hazard prompted by alternative loan financing arrangements. To date, few analysts have examined the interplay between repaying educational loans and saving for retirement; in a single exception, Paluszynski and Yu (2023) explored the case where policymakers seek to design optimal policy to induce present-biased workers to invest more in education. By contrast, our life cycle model incorporates both student loans and incentives for tax-qualified retirement saving in a rich and institutionally-realistic structure with forward-looking agents, as well as uncertain labor earnings, capital market returns, and lifetimes; we also integrate social security taxes and benefits and employer matching behavior, building on Horneff et al. (2023a). The model also incorporates US regulatory thresholds and limits, tax rules on contributions to and withdrawals from tax-qualified DC pension plans, and rules for student loan repayments.

Accordingly, our comprehensive structure enables us to undertake the first economic assessment of this important aspect of the SECURE 2.0 legislation, as well as to evaluate its impacts on saving and consumption, both prior to and during retirement. We document that this policy can enhance workers' optimal consumption prior to retirement by around 3%. We also predict that it will not lead to earlier loan discharge dates, particularly for women, and it will only slightly reduce non-retirement asset balances. In addition, we show that, until age 50, employees substantially reduce own DC plan contributions, but these reductions are almost fully compensated by higher employer matching contributions for worker loan repayments. Overall, retirement payouts are not predicted to change materially.

In what follows, we first provide a short overview of how student loans have operated in the US over the last few decades, along with a brief description of 401(k) plans. Next, we outline the methodological foundations of our life cycle model and describe model calibration. The subsequent section provides results on the anticipated impacts of the SECURE 2.0 Act reform on student loan repayment patterns, 401(k) contributions, and accumulated retirement plan wealth, as well as non-tax-qualified financial wealth, over the life cycle. Following a discussion of consumption changes, we discuss the potential impacts of the SECURE Act 2.0 reform on employer costs due to the new matching contributions, as well as on federal income tax revenues. A final section concludes.

I. Overview on Student Loans and Tax-Qualified Retirement Plans in the United States

The US student loan market plays a crucial role in enabling individuals to pursue higher education, but, for many borrowers, it also leads to substantial debt. Around half of US college students rely on such loans (Black et al. 2023). The majority (90%) of these are federal loans backed by the government,[4] with the remainder offered by private lenders (Dettling et al. 2022). As reported by Catherine and Yannelis (2023), federal student loan interest rates and borrowing limits are set by Congress; interest rates, which are typically lower than on private loans, do not vary with borrowers' creditworthiness. The loans are designed to provide access to education financing, though they do have repayment requirements and consequences for those who fail to meet their repayment obligations. In particular, student loans cannot generally be discharged through bankruptcy.

There are two ways that people can repay their student loans (FSA 2023a): the standard repayment plan, and the income-driven repayment plan (IDR). The former is similar to a 10-year mortgage: borrowers typically make fixed monthly payments until the student loans are repaid. There are, however, numerous exceptions that allow borrowers to extend their loan maturity, permitting them to make lower regular monthly payments over longer than a decade. For example, under an extended or consolidated loan program, the repayment period depends on the total amount of student loans, and it varies from 10 years (for loans up to $10,000) to 30 years (for loans of $60,000 or more). Additionally, under financial hardship or other conditions satisfactory to the lender, a borrower may temporarily suspend her loan for up to five years, during which time the interest continues to accrue (FSA 2023b). As a result, workers may continue making loan repayments until late in life. It is also possible to repay a student loan early, by making a one-time payment without incurring additional fees.

[4] The main two federal lending programs are the Federal Family Education Loan Program (FFEL) and the Federal Direct Loan Program (DL). The FFEL was using private lenders (such as banks) as intermediaries to provide student loans regulated and guaranteed by the government; this program was terminated in 2010. In the DL program, the US Department of Education is the main lender for student loans.

Hanson (2023) reports that the average student takes about 20 years to repay the loan, though there is much dispersion around the average, with some graduates taking over 45 years to repay.[5]

Introduced in 2009, income-driven repayment plans require borrowers to pay 15% (20%) of their discretionary income (defined as income over 150% of the poverty line); any unpaid balance after 25 (20) years is discharged.[6] Even though financial hardship situations are directly included in the repayment formula, temporary suspensions of repayments are also permitted under the IDR program. The importance of these repayment plans has increased significantly in recent years; about 10% of borrowers were in income-driven repayment plans in 2013, and a decade later, this number had increased to 32%. The rise of IDR plans is even more notable when measured by the amount of student debt involved: in 2013, 22% of student debt in repayment was in an income-driven repayment plan, but a decade later, it was almost 54%.

In what follows, we focus first on the traditional standard loans with fixed monthly repayments, since "[t]hroughout the history of the student loan program, most borrowers have enrolled in 10-year fixed-payment plans; … [and] most borrowers are enrolled automatically" (CBO 2020: 6). Moreover, as we describe below, the data we use for model calibration were collected in 2022, so most of the student loans observed were likely taken out before the rise of IDRs. Next, we turn to an assessment of how results differ for workers with IDR loans.

Our analyses implement the key features of tax-qualified retirement plans in the private sector. Federal regulation allows workers to contribute to these plans using pre-tax income up to certain limits, often with contribution rates set by default.[7] Currently two-thirds (67%) of the private sector workforce has access to DC plans (US BLS 2023), wherein employers frequently match employee contributions up to a legally-set limit, with the most prevalent pattern being dollar-for-dollar or $0.50 per dollar match rates (Vanguard 2020). Access to retirement plan assets is restricted and tax-penalized prior to specified ages, and there are also requirements regarding minimum distributions after retirement. To date, these plans have amassed $37 trillion in DC plans and Individual Retirement Accounts (ICI 2023).

Using the nationally representative Survey of Consumer Finances, a detailed cross-sectional dataset on income, assets, debt, and demographic characteristics of US families gathered by the Board

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[5] This analysis abstracts from the Biden Administration's efforts to enact student loan relief that met resistance from the US Supreme Court (Lobosco 2023).
[6] It should be noted that the total amount repaid under an IDR loan could exceed the amount that would have been paid under the standard plan, and a borrower could be required to pay income tax on amounts forgiven; see Gunn et al. (2021) and Herbst (2023).
[7] Under so-called Roth plans, employees contribute to the pension plan from their after-tax income, with no later tax on investment income or withdrawals. Our analysis does not focus on these accounts.

of Governors of the Federal Reserve System, we have computed the percent of college-educated respondents having access to retirement accounts as well as a student loan outstanding (see Table 1). Two thirds (62%) of the age 20-29 sample had student loans outstanding and held retirement accounts in 2019, and (54%) of those in their 30's. Loan prevalence does decline at older ages, though by their 50's, almost a quarter (24%) of the workers still held student loans alongside retirement accounts, and 11% in their 60's. Hence there is substantial potential for the SECURE 2.0 Act to improve both loan repayments and retirement wellbeing.

Table 1 here

II. Life-Cycle Model: Methodology

Our discrete-time dynamic portfolio and consumption model assumes a utility-maximizing college-educated worker who decides how much to consume and how much to invest in risky stocks, bonds, and a 401(k) plan over her lifetime, taking into account that the individual must make student loan repayments.[8] We posit that the individual's decision window runs from $t = 1$ (age 25) and ends at $T = 76$ (age 100); accordingly, each period corresponds to a year. The individual's lifetime can be divided into two phases: the work life from age 25-65 ($t = 1,,2,..,41$) and retirement from age 66 ($t = K = 42$) until death. The individual's utility depends on her consumption and bequests, while constraints include a realistic characterization of income profiles, income and social security taxes, and the opportunity to invest in risky stocks and riskless bonds in a DC tax-qualified retirement plan (up to a limit) as well as in a non-tax-qualified account. This framework additionally takes into account the Required Minimum Distribution (RMD) rules relevant to the US DC setting, as well as a realistic formulation of social security benefits and sex-specific mortality.[9]

Preferences and Labor Income

Preferences at time *t* are measured by a recursive *CRRA* utility function defined over current consumption, C_t, and level of bequest, Q_{t+1}, should the individual passes away at time $t + 1$. Formally, the value function of the individual is given by:

$$J_t = \frac{(C_t)^{1-\rho}}{1-\rho} + \beta \sum_i \Pi_{ij,t} \, E_t \left(p_t^s J_{t+1} + (1 - p_t^s) b \frac{(\phi + Q_{t+1}/b)^{1-\rho}}{1-\rho} \right), \tag{1}$$

[8] This paper does not examine which workers take out what kind of student loan; for additional discussion on that topic, see Herbst (2023) and Amromin and Eberly (2016).

[9] Throughout this paper, we work in real terms (e.g., for labor income and asset returns). This is justified since the social security bend points, brackets for income taxation, and maximum contribution limits to retirement plans are updated annually for inflation.

The parameter ρ represents the coefficient of relative risk aversion, and β is the subjective time preference rate on future utility. The preference weight on bequest, which consists of terminal financial assets minus any outstanding debt from student loans, is controlled by the parameters b and ϕ, with the latter denoting whether a bequest is a luxury good (Ameriks et al. 2011). Conditional on being alive at time *t*, the individual's subjective probability of survival to time $t + 1$ is denoted by p_t^s. Finally, $\Pi_{ij,t} = Prob(l_{t+1} = i | l_t = j)$ is a transition matrix representing the probability of moving from current (t) income level *j* to income level *i* one year later $(t + 1)$.

Following Horneff et al. (2023a), we model the exogenously determined labor income process for college-educated workers using a discrete Markov-switching income process, $Y_{t+1} = I_{t+1}^l \cdot U_{t+1}$. Here $I_t^l \in l_{t,1}, l_{t,2,} l_{t,3}$ represents the sex- and age-dependent permanent income levels which can switch between three states according to a matrix of transition probabilities $\Pi_{ij,t}$. Transitory shocks $U_t \sim LN(-\frac{\sigma_t^2}{2}, \sigma_t^2)$ are lognormally distributed with volatility parameters depending on the worker's age, sex, and permanent income level. The parameters of the income process are calibrated using data from the Panel Study of Income Dynamics (PSID) data.[10] In retirement, the individual receives lifelong social security benefits as determined by the Primary Insurance Amount (PIA), a function of average indexed lifetime earnings (AIME).[11] The fixed social security payments (Y_{t+1}) in retirement $(t \geq 42)$ are overlaid by a lognormally-distributed transitory shock $\varepsilon_t \sim \text{LN}(-0.5\sigma_\varepsilon^2, \sigma_\varepsilon^2)$ with a mean of one reflecting out-of-pocket medical and other expenditure shocks (Love 2010). Overall, the yearly labor income before and after retirement is given by:

$$Y_{t+1} = \begin{cases} I_{t+1}^l \cdot U_{t+1} & t < 42 \\ PIA_K^l \cdot \varepsilon_{t+1} & t \geq 42. \end{cases} \quad (2)$$

Student Loan Debt

After graduating from college, the individual starts to work at age 25 with a student loan of \$23,000, computed as the average loan size held by college-educated individuals with positive DC retirement savings in the SCF.[12] There are two ways to repay the loan. In the first case, we assume that

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[10] The Panel Study of Income Dynamics is a project of the National Institute on Aging, fielded at the University of Michigan (see Institute for Social Research, nd).

[11] The US Social Security benefit formula is a piece-wise linear function of the Average Indexed Monthly Earnings providing a replacement rate of 90% up to a first bend point, 32% between the first and a second bend point, and 15% above that.

[12] Specifically, this is the average student loan amount at that age for college-educated workers with a DC retirement account (or IRA) across SCF waves 2007-2022 (in \$2019).

the worker takes the *standard repayment plan* requiring a fixed annual regular repayment of 8% of the initial amount borrowed, determined using an assumed student loan annual interest rate of 5% plus an initial repayment amount of 3%. This is in line with an extended repayment period of about 25 years. In practice, borrowers may suspend loan repayments for several reasons, including financial hardship, unemployment, home purchase, or other reasons with permission from the lender. To take such a possibility into account, the model permits the worker to choose between regular repayments or suspension within the first five years of the loan, until she reaches age 30. Thereafter, suspension is permitted only if the worker's cash on hand falls below 150% of the federal poverty threshold, which (in 2019) was equal to $19,000. Any suspension results in the outstanding loan amount growing by the interest rate. Alternatively, if the worker has sufficient cash on hand (X_t), she could repay her remaining student debt (SLD_t) in full. In sum, depending on the worker's age and cash on hand, she can decide whether to suspend her repayment ($LR_t = 0$), make a regular repayment ($LR_t = RP$), or repay the loan in full ($LR_t = SLD_t$), as follows:

$$LR_t = \begin{cases} \text{suspend}, & X_t \leq RP \\ \text{suspend or regular}, & X_t \leq SLD_t \text{ and } X_t > RP \\ \text{suspend or full}, & X_t > SLD_t \text{ and } RP > SLD_t \\ \text{suspend or regular or full}, & X_t > SLD_t > RP \,, \end{cases} \qquad t \leq 5 \tag{3a}$$

and

$$LR_t = \begin{cases} \text{suspend}, & X_t \leq RP \\ \text{suspend or regular}, & X_t \leq SLD_t \text{ and } RP < X_t \leq 19K \\ \text{suspend or full}, & X_t \leq 19K \text{ and } X_t > SLD_t \text{ and } RP > SLD_t \\ \text{regular}, & 19K < X_t \leq SLD_t \\ \text{regular or full}, & X_t > 19K \text{ and } X_t > SLD_t \\ \text{suspend or regular or full}, & RP < SLD_t < X_t \leq 19K. \end{cases} \qquad t > 5 \tag{3b}$$

The repayment reduces the student loan debt SLD_t, hence, the development of the account is as follows:

$$SLD_{t+1} = (SLD_t - LR_t) * R_{sld}, \tag{4}$$

where R_{sld} denotes the yearly gross interest rate on the student loan debt.

In addition, we also model the *income driven repayment plan*; following Catherine and Yannelis (2023), we assume the following repayment formula ($5 < t \leq 30$) is applied after a five-year suspension phase:

$$LR_{t+1} = \min\,(0.1 \cdot max(Y_{t+1} - \$19{,}000;\ 0); LR^{max}\,; SLD_t \cdot (R_{SLD}\,)). \tag{5}$$

If the worker's income exceeds \$19,000 (about 150% of the federal poverty line), the repayment is set at 10% of the corresponding excess amount. If income falls below this threshold, the required repayment is zero. Also, the repayment is limited to the amount L^{max} that the worker would have to pay under the 10-year standard plan. Assuming an initial loan of \$23,000 and a 13% fixed repayment rate, the cap is equal to \$2,990. Again, we assume that the worker does not start repaying until five years after leaving college, so her first repayment occurs at age 30. Furthermore, the repayment amount may not exceed the respective residual debt $LR_{t+1} \leq SLD_t \cdot R_{SLD}$. Finally, all outstanding student loans are forgiven 25 years after the start of repayment.[13] Assuming that the repayments are made at the end of each year, the development of the student loan account is as follows:

$$SLD_{t+1} = \begin{cases} SLD_t * R_{SLD} - LR_{t+1} & if\ t \leq 30 \\ 0 & else. \end{cases} \tag{6}$$

Cash on Hand

Prior to retirement at age 66 ($t = K = 42$), the worker can allocate current cash on hand X_t to student loan repayment LR_t, for consumption C_t, investments in risky stocks $S_t \geq 0$, and riskless bonds $B_t \geq 0$. In addition, she may contribute ($A_t \geq 0$) to a tax-qualified DC retirement plan up to a yearly limit ($A_t \leq A_t^{max}$) until age 51, and extra retirement plan 'catch-up' contributions are permitted after age 51 (here we assume all workers have access to tax-qualified DC retirement plans). After retirement at age 66 ($t = 42$), no further contributions into 401(k) plans $A_t = 0$ ($t \geq 42$) are possible. Formally, cash on hand reduced by student loan repayments that year is given as follows:

$$X_t - LR_t = \begin{cases} C_t + S_t + B_t + A_t, & t < 42 \\ C_t + S_t + B_t, & t \geq 42. \end{cases} \tag{7}$$

In the following year, the individual's cash on hand consists of stocks having earned an uncertain gross return R_t, bonds plus the earned riskless return R_f, labor income (including social security benefits) Y_{t+1} reduced by age-dependent housing costs h_t (modeled as a percentage of labor income as in Love 2010), and withdrawals W_t from DC plans, minus taxes Tax_{t+1}:

$$X_{t+1} = S_t R_{t+1} + B_t R_f + Y_{t+1}(1 - h_t) + W_t - Tax_{t+1}. \tag{8}$$

In our model, individuals must pay three kind of taxes: $Tax_t = PayT_t + IT_t + PT_t$. Payroll taxes $PayT_t = 0.062 \cdot \max(Y_t, Y^{cap}) + 0.0545 \cdot Y_t$ reduce labor income proportionally during the work life ($t < K$) by social security contributions of 6.2% (up to a yearly limit of $Y_t^{cap} = \$132{,}900$),

[13] An alternative with a higher income-dependent repayment rate of 15% and loan forgiveness after 20 years is not considered here.

Medicare premiums (1.45%), and city/state taxes (4%). After retirement $(t \geq K)$, payroll taxes fall to $PayT_t = 0.0545 \cdot Y_t$, as social security contributions are no longer paid. In addition, the worker must pay income taxes (IT_{t+1}) according to US federal progressive tax system rules on taxable income. The latter includes income from work, social security benefits, financial assets, and 401(k) withdrawals, while own contributions into 401(k) plans reduce taxable income (for details, see Appendix A). Prior to retirement, the worker may save in a tax-qualified DC plan, while non-pension saving in bonds and stocks is allowed over the entire life cycle. In the event of early withdrawals from these tax-qualified retirement plans before age 60 ($t < 36$), a 10% penalty tax $PT_t = 0.1W_t$ is incurred. As of 2019, the US Treasury required DC participants to take required minimum withdrawals (RMDs) from their plans from age 70.5 onwards or pay a substantial tax penalty (50%); the withdrawal amount was determined as a specified age-dependent percentage (m_t) of plan assets. Therefore, to avoid the excise penalty, plan payouts in the model are such that $mL_t \leq W_t < L_t$ for $t \geq 46$ [14]

We assume that annual IDR repayments are made at the end of each year and all remaining loan debt is forgiven after age 54 ($t > 30$), so the budget equations for cash on hand are:

$$X_t = \begin{cases} C_t + S_t + B_t + A_t, & t < 42 \\ C_t + S_t + B_t, & t \geq 42 \end{cases} \tag{9}$$

where:

$$X_{t+1} = \begin{cases} S_t R_{t+1} + B_t R_f + Y_{t+1}(1 - h_t) + W_t - Tax_{t+1} - LR_{t+1}, & t \leq 30 \\ S_t R_{t+1} + B_t R_f + Y_{t+1}(1 - h_t) + W_t - Tax_{t+1}, & t > 30. \end{cases} \tag{10}$$

Tax-Qualified DC Plan

The tax-qualified DC retirement account evolves over time as follows:

$$L_{t+1} = \begin{cases} \omega_t^s (L_t - W_t + A_t + M_t) R_{t+1} + (1 - \omega_t^s)(L_t - W_t + A_t + M_t) R_f, & t < 42 \\ \omega_t^s (L_t - W_t) R_{t+1} + (1 - \omega_t^s)(L_t - W_t) R_f, & t \geq 42. \end{cases} \tag{11}$$

Prior to retirement, the worker's total value (L_{t+1}) of her DC assets at time $t+1$ is determined by her previous period's value, minus any withdrawals ($W_t \leq L_t$), plus additional own contributions (A_t), plus employer matching contributions (M_t) and returns from stocks and bonds.[15] After retirement, neither the employee nor the employer can make additional contributions into the retirement plan. Retirement plan assets are assumed to be invested in a Target Date Fund having a relative stock

[14] More recently, the SECURE 2.0 Act raised the RMD age to 73, which will increase to age 75 by 2033; in addition, the penalty tax was reduced to 25%.

[15] In case of the income driven repayment plan, we assume that matching contributions are paid at the end of the period (synchronized with the loan repayments). Therefore the first line of equation (11) modifies to $\omega_t^s(L_t - W_t + A_t)R_{t+1} + (1 - \omega_t^s)(L_t - W_t + A_t)R_f + M_t$.

exposure (ω_t^s) that declines according to age, following the popular "125-Age rule" ($\omega_t^s = (125 - Age)/100$).[16] Wealth dynamics for the DC account after retirement are given by the previous year's value L_t, withdrawals W_t, and investment returns on stocks and bonds.

To be considered as a 'safe harbor' DC plan and hence avoid complex non-discrimination testing, we assume that employers match 100% of employee contributions up to 5% of yearly labor income to a maximum compensation level of $\$M^{max}$ per year.[17] The matching amounts prior to the SECURE 2.0 reform, and afterwards, are then given by:

$$M_t = \begin{cases} \min(A_t, 0.05Y_t, M^{max}), & \text{pre reform} \\ \min(A_t + LR_t, 0.05Y_t, M^{max}) & \text{post reform.} \end{cases} \tag{12}$$

After retirement, no additional own or matching retirement plan contributions are possible ($A_t = M_t = 0$).

Numerical solution

We solve the optimization problem recursively via backward induction separately for four subgroups using discrete-time dynamic programming: the subgroups are workers with income profiles characteristic of college-educated males and females, with either the standard or income-driven repayment programs. The numerical procedure used to generate the optimal policy functions in each period assumes a five-dimensional discrete state space grid 40(X)×20(L)×20(SLD)×3(I^l)×76(t), with X being cash on hand, L referring to 401(k) assets, SLD Student Loan Debt, I^l income level, and t is time. The decision variables are consumption, student loan repayments (for standard repayment plans), investments in stocks and bonds, and contributions to/withdrawals from 401(k) accounts. Since the model uses non-linear functions for taxes, contribution matches, and other institutionally appropriate thresholds, it is not possible to reduce the dimensionality of the problem by normalization (as in Cocco et al. 2005). The expectations of the multivariate log-normally distributed random variables are computed using Gauss-Hermite quadrature with nine quadrature nodes per dimension. To evaluate the value function at points that do not lie on the grid, we use cubic spline inter- and extrapolation. The optimization procedure runs over the certainty equivalent of the corresponding CRRA utility function.

Model calibration

To calibrate model parameters, we adopt the conventional two-stage approach (e.g., Catherine 2022 or Love 2010, among others). First, we estimate and calibrate parameters related to labor and

[16] This approach satisfies the Qualified Default Investment Alternative (QDIA) rules as per US Department of Labor regulations (nd).
[17] See Willson (2019) and 401k Help Center (2017).

retirement income, housing costs, mortality rates, financial market returns, and institutional rules including tax and benefit regulations using U.S. data, as these can be identified without explicitly solving the model. Next, we structurally estimate preference parameters given the first-stage parameters using the simulated method of moments (SMM) approach with respect to our two empirical target variables, 401(k) wealth and outstanding student loans held by American college-educated workers at different ages.

First stage parameters: To calibrate the first stage, and consistent with previous life cycle models (e.g., Inkmann et al. 2011; Horneff et al. 2023a), we set financial market parameters of the risk-free interest rate at 2% and an equity risk premium at 5% with a return volatility of 18%, in line with a diversified stock portfolio. The interest rate on student loans is equal to 5%. In addition, we use data from the PSID data (1975–2019) to calibrate the labor income process, along with the (2019) institutional tax and benefit rules. Mortality rates by gender are taken from the US Population Life Table 2019 (Arias 2022) adjusted by a factor $\lambda = 0.94$ for male ($\lambda = 0.92$ for female) that reflects the more favorable mortality rates for college graduates compared to the general population (Krueger et al. 2015). Social security retirement benefits are based on the 35 best years of income and the bend points as of 2019 (US Social Security Administration, nd_a and nd_b).[18] The maximum labor income on which social security tax is levied is $Y_t^{cap} = \$132{,}900$. Housing cost parameters h_t are calibrated as in Love (2010). All dollar figures are reported in $2019.

The age-dependent percentages (m_t) for Required Minimum Distributions from DC plans are calculated as 1 divided by the retiree's remaining life expectancy, as per Internal Revenue Service rules (IRS 2019a). US federal income taxes are based on the household's taxable income, seven income tax brackets, and the corresponding marginal tax rates for each tax bracket (see Appendix A). According to IRS (2019b), the worker's maximum permitted own contribution to the DC account is $A_t^{max} = \$19{,}000$ to age 51, with additional retirement plan 'catch-up' contributions after the age of 51 (up to $6,000). The maximum employer matching contribution to the worker DC plan is $M^{max} = \$14{,}000.$

The labor income process during the work life is calibrated for college-educated females and males. Here we follow Horneff et al. (2023a) who used the 1975–2019 PSID to estimate a Markov-switching model generating labor income profiles with three income levels (I) and sex-specific transition matrices as well as the age-dependent transitory shocks. At age 66, the worker retires and

[18] Accordingly, the annual Primary Insurance Amount (or the unreduced Social Security benefit payment) equals 90 percent of (12 times) the first $926 of average indexed monthly earnings, plus 32 percent of average indexed monthly earnings over $ 926 and through $5,583, plus 15 percent of average indexed monthly earnings over $5,583 and through the cap $11,075. All dollar values are reported in $2019.

receives social security benefits and DC plan withdrawals. The variance of transitory shocks for college graduates during retirement is set equal to $\sigma_{\varepsilon}^{2} = 0.0767$ (as in Love 2010).

Second stage preference parameters: For the second stage analysis, values of the preference parameters for the four subgroups (males/females with standard/income-driven loan repayment programs) are selected so that the model generates student loan debt and DC wealth profiles consistent with empirical evidence. Specifically, we calibrate the model to the 2007-2022 waves of the SCF using average DC plan asset values and student loan debt for five age groups (20-29, 30-39, 40-49, 50-59, and 60-69). In the model, our population consists of four subgroups: college-educated men and women (male with a weight of 49.28%), having either a student loan with fixed repayments (weight 60%) or income-based repayments (weight 40%).

We fix the parameter for relative risk aversion at $\rho = 5$ and the discount rate $\beta = 0.98$, in line with the literature using comparable life cycle models (e.g., Cocco et al. 2005; Inkmann et al. 2011). Next, for each subgroup, we solve the model for various sets of preference parameters b and ϕ, generate 10,000 simulated independent optimal life cycles with respect to the exogenous random variables (stock returns, labor income), and calculate averages for retirement assets and student loans. We repeat this procedure to minimize the value of the distance function $\theta = \frac{1}{10}\sum_{j=1}^{10} \left| y_j^{model} - y_j^{data} \right| / y_j^{data}$, which is the average absolute deviation across the five age groups of the simulated DC assets ($j = 1,..,5$) and SLD ($j = 6,..,10$) from the model y_j^{model} minus that from the corresponding SCF data y_j^{data}.

We find that the bequest parameters b = 4 and ϕ = \$19,000 minimize the distance function (θ = 0.3718) within the range of preference parameters tested. These are consistent with the research cited above and they also closely match simulated model outcomes to empirical evidence. Figure 1 displays simulated and empirical data for the five age groups and confirms that our simulated outcomes, both for retirement assets and outstanding student loans, are remarkably close to the empirically observed values (for additional detail on lifecycle patterns, see Appendix B).

Figure 1 here

III. Results: Impact of the SECURE 2.0 Reform on Employee Behavior

The SECURE 2.0 reform of particular interest here gives workers with outstanding student loans the opportunity to receive employer matching contributions in their tax-qualified retirement plans, when they make qualified student loan repayments. The purpose of this policy is to enable employees to repay these loans more quickly, without undermining the growth of their retirement accounts. In what follows, we examine the potential effects of this reform on key financial variables over the life cycle. First, we focus on individuals having standard loans with fixed repayments. Specifically, we are interested in the repayment behavior of student loans, contributions to and asset accumulations in DC pension plans, other financial assets held outside of pension plans, and consumer spending patterns. Additionally, we compare these variables before versus after the reform for a simulated population of 10,000 workers making optimal decisions over their lifetimes.

Figure 2 displays the profiles of loan repayment behavior. Specifically, we illustrate the frequencies (y-axis) by age (x-axis) where workers pay the regular repayment amount (orange bars), suspend repayment (blue bars), or repay the student loan in full (black bars), with females (on the left) and males (on the right). In the pre-reform case, most people suspend student loan repayments within the first five years, and at age 29, only 4% (1%) of females (males) make regular repayments. From age 30, repayment suspension is only possible in the event of financial hardship, defined as having cash on hand $X_t < \$19{,}000$. However, due to the relatively high labor incomes received by the college-educated, this rarely occurs (in fewer than 1% of simulated cases); therefore, most workers make the regular fixed repayments. We also see that, as workers age, they increasingly select the option to pay off their remaining loans in one lump sum: only a few do so before age 30, but between ages 30-40, around 67% of women and 63% of men do so. On average, women repay their entire loans after 12.8 years, and men after 14.3 years. This can be explained by the fact that peoples' earnings rise rapidly from the age of 30, giving them the chance to repay their loans (with a relatively high interest rate) in full.

Figure 2 here

Post-reform, when workers can receive employer matching contributions in their 401(k) retirement plans while repaying their student loans, significantly fewer people suspend loan repayment early in their careers. That is, the proportion of 29-year-old women making regular repayments rises from 4% (pre-reform) to 85% (post-reform), and from 1% to 14% of men; the increase in regular repayments continues thereafter. In contrast to the pre-reform situation, many fewer repay their loans in one lump sum: almost none do so early on, and even by age 40, fewer than 2.5% of women and 0.5% of men repay their entire loans all at once. Loan periods are also much longer post-reform, by about 12 years: on average, women take 25 years to repay on average, and men take 26 years. Overall, therefore, after the reform people optimally repay their loans more regularly, but more slowly.

This pattern also shapes the outstanding student loan profile over the lifecycle. Figure 3 provides information about the average outstanding debt by age for men and women before (solid line) and after the reform (dashed line). Pre-reform, outstanding loan balances rise before age 30, as many workers suspend their student loan repayments resulting in compound interest effects increasing debt levels. This is also observed after the reform, although the increase in debt is significantly lower (especially for women), due to their more regular repayment pattern. From age 30 on, average debt levels pre-reform fall significantly, as suspensions are only possible in hardship situations and workers increasingly make use of one-time repayments. Post-reform, levels of outstanding student debt also fall from age 30, but far more slowly compared to before the reform. The explanation is that workers make significantly less use of one-time repayments.

Figure 3 here

Yet one might ask, why do employees post-reform have less incentive to repay their loans early and in full? To answer this question, we examine interactions with other financial assets, both inside and outside retirement accounts. After the reform, Panel A of Figure 4 shows lower own contributions in 401(k) plans until age 50; thereafter, they are very similar to the pre-reform case. At the same time, Panel B shows that 401(k) account balances are not significantly lower; indeed, in some cases, workers even have slightly more retirement assets around age 65 than pre-reform, despite having made lower own contributions. The explanation for this apparent contradiction lies in the generous employer matching contributions, displayed in Panel C of Figure 4. These are much higher after the reform, as employers now provide matching contributions on employees' relatively low own contributions as well as on workers' student loan repayments. The sum of both components implies that total contributions to retirement accounts are similar before and after the reform, which explains why 401(k) account balances differ very little, pre- and post-reform.

Figure 4 here

To illustrate with an example, before the reform, the average male employee age 41 contributed \$1,460 to his 401(k) account and received nearly the same employer matching contribution. Post-reform, employer matching contributions for the same individual would total about \$2,390 while the worker would contribute only around \$640 per year. The difference of matching and own contributions, \$1,750, is attributable to the worker's regular loan repayment (of \$1,990), which qualifies for matching contributions in addition to the employee's own contributions. In both instances, before and after the reform, the annual contribution of \$3,000 paid to the retirement account is roughly the same. The similar 401(k) asset accrual pattern over the life cycle also means that employees do not use the additional SECURE 2.0 option to build up more retirement savings. Furthermore, Figures 2 and 3 confirm that workers repay their student loans more regularly after the reform, but more slowly, overall.

Figure 5 depicts the development by age of average financial balances in workers' non-tax-qualified accounts. These assets (held in stocks and bonds) are neither tax-privileged nor subject to employer contributions, but they are liquid, since, unlike 401(k) assets, they can be used for consumption at any time without restrictions or penalties. Interestingly, it turns out that both men and women hold fewer liquid financial assets during their working lives in the post-reform case, compared to before the reform.

Figure 5 here

Since workers do not appear to be saving more in their retirement accounts, pay off their loans faster, or hold more liquid financial assets after the reform, one might ask what changes? Figure 6 provides an insight by comparing consumption profiles, reported as differences by age and sex for 10,000 simulated optimal lifecycles - based on the same exogenous shocks for each path - of college-educated employees post- versus pre-reform. The fan charts illustrate the probability distribution (90%; 10% quantiles) of the resulting consumption differences; darker areas represent higher probability mass and the solid white line represents the zero difference line. Entries below (above) the line indicate lower (higher) consumption levels after the reform. Panel A clearly documents that, during the work life, consumption levels until age 66 are higher in most cases. During the retirement phase, positive and negative deviations from the zero line are roughly balanced. This means that individuals taking advantage of the new opportunity to repay their student loans and receive 401(k) employer matching contributions can also boost their annual consumption prior to retirement.

Figure 6 here

This is due to the following consideration: although the 401(k) is financially very attractive due in large part to the employer matching contributions, it is still a comparatively illiquid asset during the work life. Early withdrawals are only possible in financial hardship situations and only up to maximum limits, and there are also penalty taxes on early withdrawals. This means that employees must wait until they attain age 60 before they can use their 401(k) money to cover consumption needs. At the same time, workers also need to pay off their student loans. Both factors reduce consumption options. Therefore, pre-reform, workers do not take full advantage of employer matching contributions and tax benefits through their own 401(k) contributions. After the reform, by contrast, loan repayments also generate employer matching contributions, thus "killing two birds with one stone." This new opportunity helps boost consumption among the younger workforce, with a noticeable impact on lifetime utility. For example, yearly consumption rises post-reform between age 30-50 by up to 3%.[19]

The same pattern pertains to the IDR plan, depicted in Panel B of Figure 6. Rather than contributing more to her 401(k) plan or accumulate more liquid financial assets post-reform, the worker instead consumes more at younger ages. Specifically, mean consumption differences are positive during the work life (dark area), and in most cases, higher than pre-reform. It is also worth noting that the chance that a student loan will be forgiven after 25 years is not altered much by the reform. That is, before and after the SECURE 2.0 change, many women (31% of the cases) still have a positive student loan after 25 years, while for men this is rarer (9% of cases) due mainly to their higher earnings.

IV. Implications for Employer Costs and Tax Revenue

The above analysis has shown that the SECURE Act 2.0 reform under consideration is likely to change employees' optimal behavior with respect to contributions paid into tax-qualified retirement plans and student loan repayments. This, in turn, can have spillover effects on employer costs and tax revenues. In this section, we use our life cycle model to examine both in quantitative terms, for standard repayment plans and income-driven repayment plans. To do so, we use 10,000 simulated optimal lifecycle profiles (males/females) for the two repayment plans and compute the difference between employer matching contributions and tax payments generated post- versus pre-SECURE 2.0 reform, for each individual i at each point in time t for the same exogenous shocks (capital markets, labor income).

The fan charts in Figure 7 illustrate the probability distribution of the difference in employer matching contributions $\Delta M_{i,t} = M_{i,t}^{post}$- $M_{i,t}^{pre}$ for workers age 25-65. Under both the standard repayment plan (Panel A) and the income-driven repayment plan (Panel B), employer matching contributions for workers age 30+ are higher post-reform in almost all simulation paths (and not only in expectation as shown in Figure 4C). This is because it is usually optimal for the employee to make higher student loan repayments in place of lower own 401(k) contributions, while receiving higher matching retirement plan contributions.[20]

Figure 7 here

[19] Bequests, the second component of the utility function, play an important role only in later life when mortality probabilities rise with age.

[20] The differences are less pronounced prior to age 30, since debt repayment suspension is generally permitted (and not only due to financial hardship, as in later years).

To illustrate the magnitude of the changes, we first focus on an age-30 worker. Pre-reform, average employer matching contributions for the worker are about \$ 1,040 lower than post-reform; hence post-reform, employee compensation rises by 2.14%. A similar finding applies to workers having an income driven repayment plan: the firm's annual matching contribution post-reform rises by about \$1,200 or 2.46% of employee compensation. As Table 2 shows, differences in average employer matching contributions post- versus pre-reform shrink with age, as the number of employees with outstanding student loans decreases and their own contributions to 401(k) plans are more similar across settings. Overall, we conclude that, *ceteris paribus*, this feature of the SECURE Act 2.0 reform will generate higher employer costs in the form of matching contributions for retirement plans.

Table 2 here

Calculating the tax revenue effects is somewhat more complex. On the one hand, changes in workers' taxable incomes alter the taxes they pay during the work life as well as in retirement. Additionally, penalty taxes for non-compliant early 401(k) withdrawals could change. On the other hand, payroll taxes do not change, as these are calculated based on earnings assumed not to change. We take all of these into account when quantifying the effects on tax revenue. Specifically, we compute the yearly differences in tax payments $\Delta Tax_{i,t} = (Tax_{i,t}^{post} - Tax_{i,t}^{pre})$ for each path of the 10,000 simulated optimal life cycles based on the same exogenous shock sequences. To reflect mortality risk, we multiply tax payments by an indicator variable $\mathbb{I}_{i,t}$ equal to 1 if the individual is alive at time t and zero otherwise. Transition probabilities of this indicator variable are derived from the relevant mortality tables for males and females. Next, we discount future tax payments by the risk-free interest rate of $R_f - 1 = 2\%$ and calculate the probability distribution of the present value of differences of all future tax payments. Formally, this present value is defined as:

$$PV(\Delta Tax_i) = \sum_{t=1}^{76} \frac{\mathbb{I}_{i,t} \cdot \Delta Tax_{i,t}}{(R_f)^t} . \qquad (13)$$

Using the probability distribution of the resulting present values for all simulated lifecycles, we calculate the mean, median, and the Q-75% and Q-25% quantiles of this difference; results appear in Table 3. Columns (1) and (2) contain the absolute differences (in \$000) for the standard and income-driven repayment plans, respectively. Columns (3) and (4) show the absolute differences as a percentage of the present value of tax income (both federal income and penalty taxes) prior to the reform. From this table, it is clear that the reform will generate higher tax revenues (in present value terms). Under the standard repayment plan, revenues are predicted to be around \$3,150 higher per employee, for an increase of around 1.8% in present value compared to pre-reform tax revenue. Even at the Q-25% quantile, the changes are still positive, while for the Q-75% quantile, revenue increases amount to 5.6%. Under the income driven repayment plan, revenue increases are slightly higher. The greater tax revenue post-reform is mainly due to workers making smaller tax-deductible own 401(k) contributions. In terms of timing, then, the tax revenue increase is most notable during for employed persons, as only slightly higher tax revenue results from the taxation of retirement plan withdrawals since the higher employer matching contributions helped generate comparable retirement assets.

Table 3 here

These tax revenue results must be interpreted with caution (Horneff et al. 2023b), as our microeconomic life cycle model does not account for potential macroeconomic effects of the rule change. For instance, we do not endogenize the possible impact of new employer matching rules on the labor, financial, or goods markets. Moreover, these calculations do not incorporate the possibility that higher employer matching contributions could reduce taxable corporate income. Our model also posits rational individual decision makers, even though in practice they sometimes are not; since there is little consensus regarding which behavioral aspects are most appropriate for normative models, we leave those extensions to future research. In any event, our results do shed light on how the SECURE Act change is likely to change student loan repayment and employer matching contribution patterns, as well as how these could affect federal revenues.

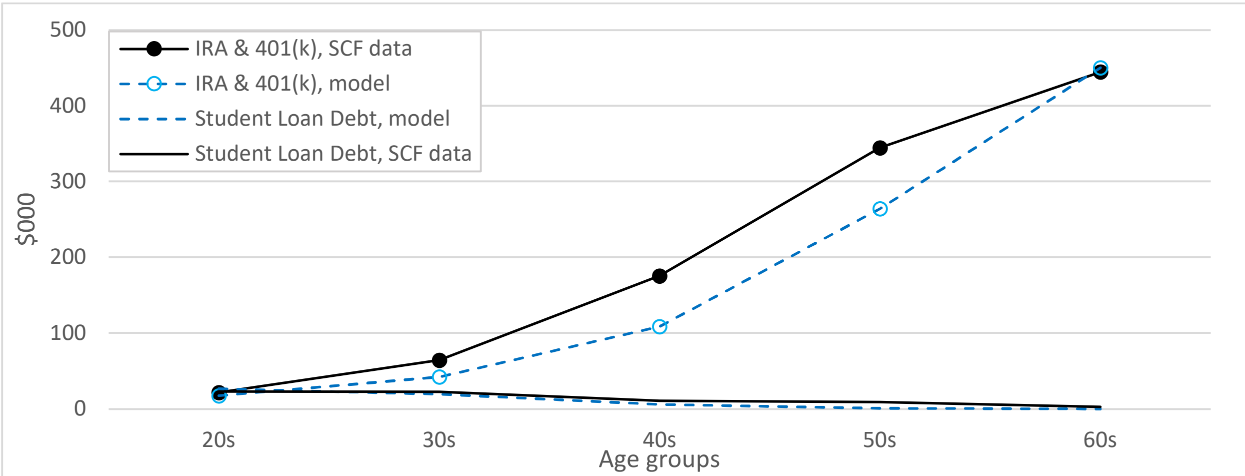
IV. Discussion and Conclusions

To help the 50 million American workers with student debt save in their employer-provided pension accounts, the SECURE 2.0 Act now permits employers to deposit matching contributions into their employees' DC retirement accounts when employees repay these student loans. Our paper offers the first economic assessment of this important aspect of the new legislation, focusing on how it will impact saving and consumption prior to and in retirement. Using a calibrated life cycle model that embodies multiple key aspects of US tax and benefit regulation, we predict that this policy will enhance workers' optimal consumption by up to 3% prior to retirement. Workers are predicted to curtail their own 401(k) plan contributions until the middle of their work lives by almost half, with these reductions compensated by higher employer matching contributions subsidizing loan repayments. We also expect that the reform will not lead to earlier loan discharge dates, particularly for women, and it will only slightly reduce non-retirement asset balances. Overall, benefit payouts in retirement are not predicted to change materially. Anticipated additional costs to employers due to these new matches will amount to around 2.4-4.3% of annual pay for workers age 40-50. Finally, our model predicts that median tax revenues would increase by around 1.8-2.5% (in present value terms), as employees are predicted to contribute less to their 401(k) plans and hence receive higher taxable earnings during their work lives.

This research will be of interest to a variety of stakeholders in the financial community. Numerous institutions are keenly interested in the savings behavior of Millennials and younger workers, many of whom cannot start saving for retirement early in life due to heavy debt burdens. Additionally, we emphasize that this is a voluntary benefit: employers have the option to match loan repayments, though they are not obliged to do so. These matching contributions will not be cost-free to plan sponsors, and DC plan service providers will also need to build new systems to make this feasible in practice (Correia 2023). Nevertheless, loan repayment matching could be an attractive employee benefit offering, since student debt is known to contribute to borrowers' financial distress and mental health problems shaping worker behavior on the job (Balloch et al. 2022; Bogan and Fertig 2013; Daniels and Kakar 2022). The policy could also help attract and retain workers given the tight US labor market and the relative dearth of young employees (Ellis 2023), as well as enhance opportunities for women and minority workers who tend to hold more student debt than their majority counterparts (Ceron 2023). Our research will also be useful to professional financial planners helping guide younger clients holding student debt, as they make saving and retirement decisions. In particular, we show that encouraging workers to discharge their student loans as soon as possible post-SECURE 2.0 may not be optimal, when their employers match their loan repayments in company-sponsored retirement saving plans.

Future work will evaluate the sensitivity of our results to different employer match policies, interest rates, and capital market returns. Finally, inasmuch as most employees having access to employer provided retirement plans are found in the higher income deciles (Bhutta et al. 2020), this regulatory change could contribute to an increase in the retirement wealth gap between the lower- and the more highly paid workforce.

Figure 1: Simulated results versus data: DC plan wealth and outstanding student loan balances

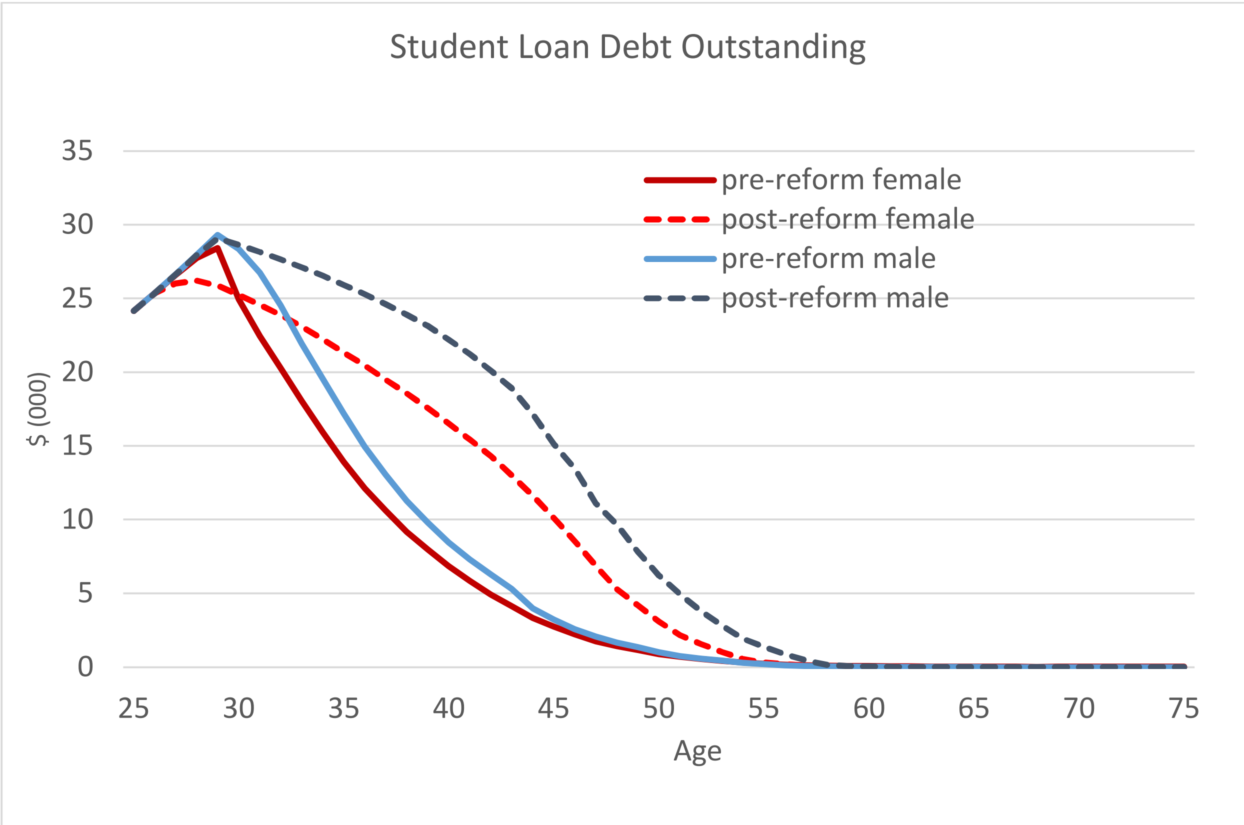


Note: The figure shows empirical DC tax-qualified account balances for college-educated individuals (black solid line with circle) and student loan debt (black solid line), by age group, computed for college-educated workers with a DC retirement account (or IRA) across all SCF waves 2007-2022. The dashed lines depict the same outcomes from our life-cycle model simulations based on average defined contribution asset levels and outstanding student loans, from simulated optimal lifecycles (weighted by sex and repayment program; see Section II above). Preference parameters: risk aversion $\rho = 5$, bequest strength $b = 4$, luxury bequest parameter $\phi = \$19{,}000$, time discount rate $\beta = 0.98$. Starting value of 401(k) assets in t = 0 is $12,000. Risk-free interest rate 2%; equity risk premium 5% with volatility of 18%; interest on student loans 5% see text. All values in $2019. Source: Authors' calculations.

Figure 2: Impact of the SECURE 2.0 reform on student loan repayment behavior: Post- versus pre-reform

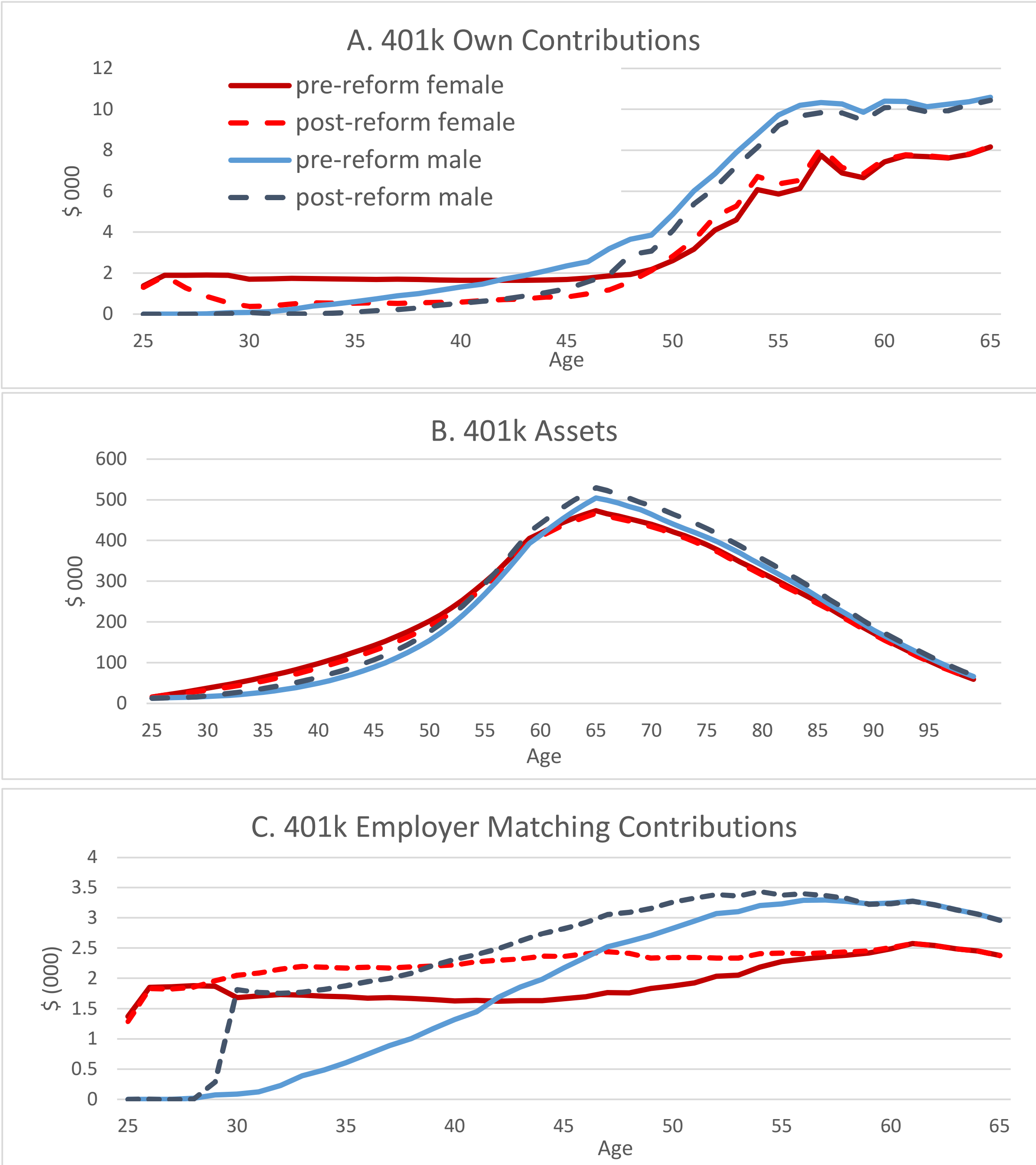
Note: This figure shows 10,000 simulated student loan repayment outcomes (suspend, regular fixed payment, or full repayment) for college-educated men and women in the standard repayment program with access to DC retirement accounts by age. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions. Source: Authors' calculations.

Figure 3: Impact of the SECURE 2.0 reform on average student loans outstanding: Post-versus pre-reform



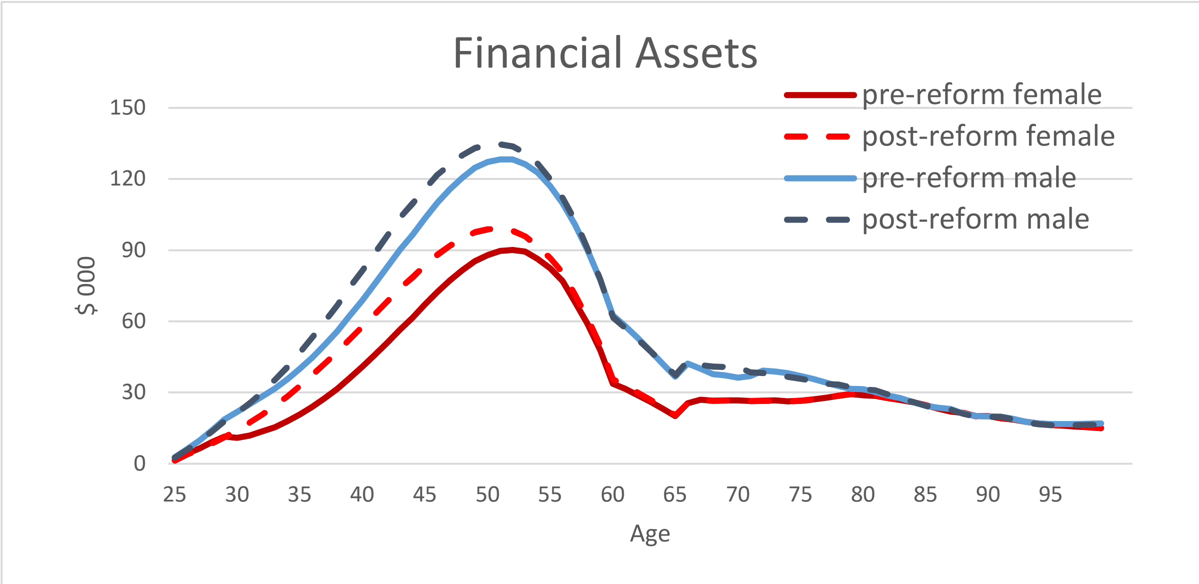
Note: This figure shows the average of 10,000 simulated outstanding student loans for college-educated men and women in the standard repayment program with access to DC retirement accounts by age. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.

Figure 4: Contributions to DC retirement accounts and accumulated assets in these accounts: Post- versus pre-SECURE 2.0 reform



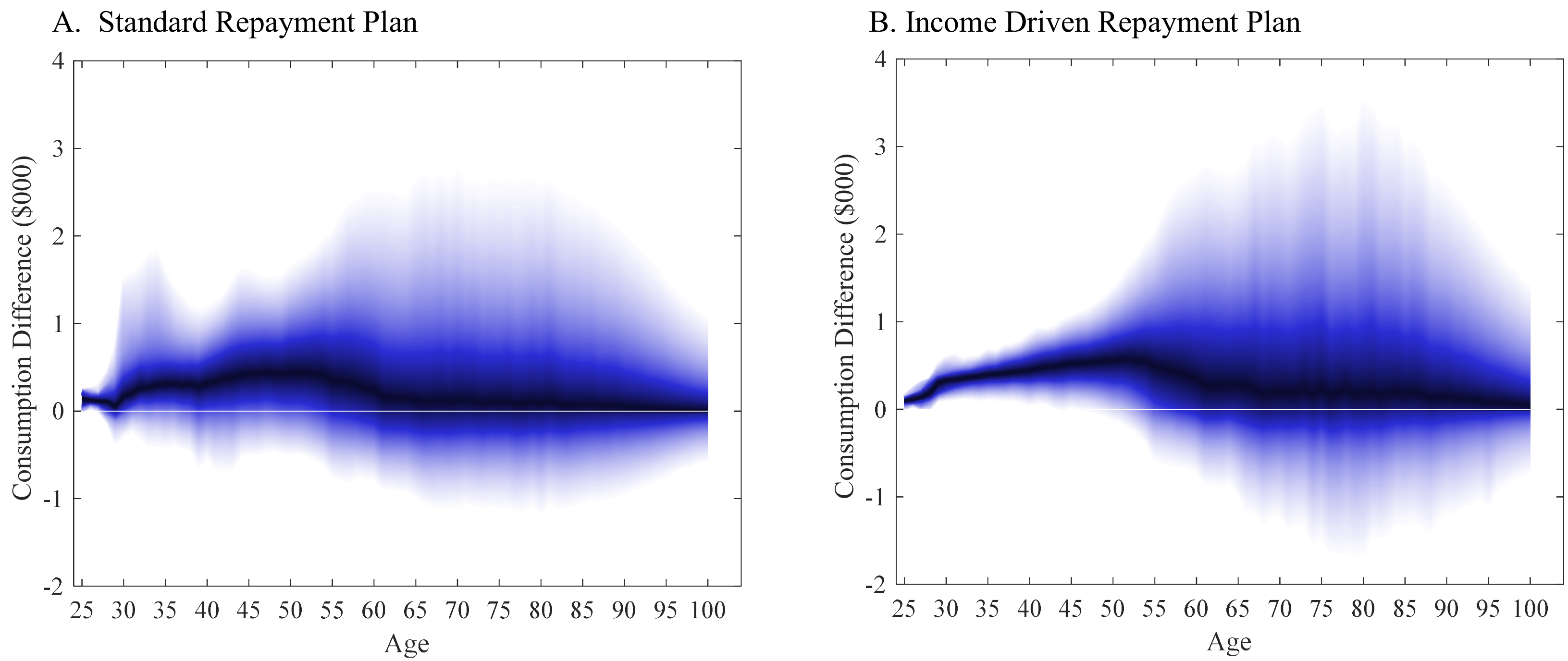
Note: For tax-qualified DC retirement accounts, this figure depicts average own contributions by the employee (Panel A), levels of accumulated assets (Panel B), and employer matching contributions (Panel C) for college-educated men and women holding student loans. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.

Figure ***5:*** **Financial assets outside tax-qualified DC retirement accounts: Post- versus pre-SECURE 2.0 reform**



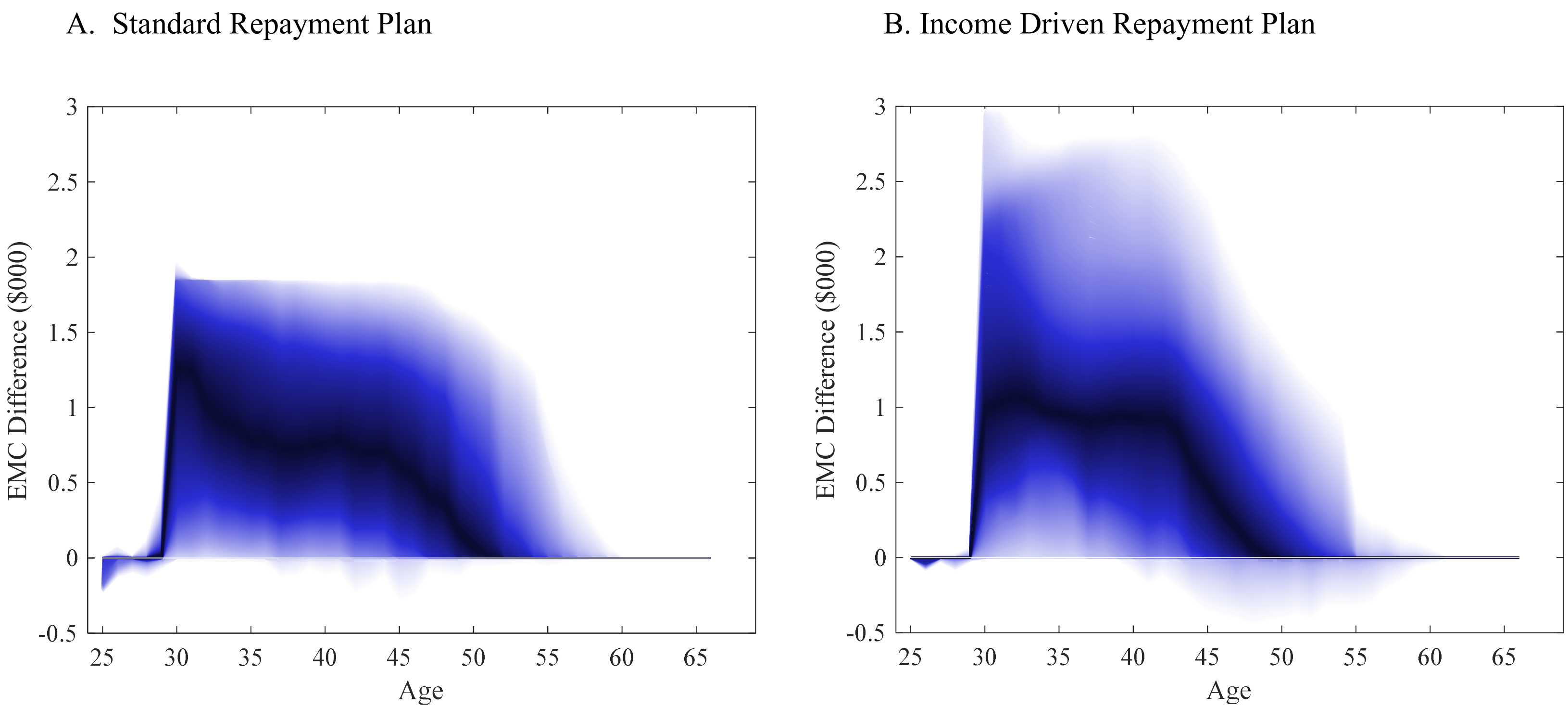
Note: This figure shows average financial wealth held in bonds and stocks outside tax-qualified retirement accounts for college-educated men and women holding student loans. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.

Figure 6: Differences in consumption: Post- versus pre-SECURE 2.0 reform



Note: This figure shows the probability distribution of consumption differences pre- versus post-reform for college-educated workers (male and female) holding student loans and with access to DC retirement accounts by age. The fan charts illustrate the probability distribution (90%; 10% quantiles) of differences in optimal consumption for the 10,000 simulated lifecycles weighted by sex (49.3% females); darker areas represent higher probability mass. The panel on the left (right) illustrates differences for workers with a standard (income driven) repayment plan. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.

Figure 7: Differences in employer matching contributions: Post- versus pre-SECURE 2.0 reform



Note: This figure shows the probability distribution of employer-matching contribution differences pre- versus post-reform for college-educated workers (male and female) holding student loans and with access to DC retirement accounts by age. The fan charts illustrate the probability distribution (90%; 10% quantiles) of differences in employer matching contributions for the 10,000 simulated lifecycles weighted by sex (49.3% females); darker areas represent higher probability mass. The panel on the left (right) illustrates differences for workers with a standard (income driven) repayment plan. Prior to the reform, loan repayments do not receive employer matching DC contributions, while after the reform, repayments are matched (to the legal limits) by employer DC contributions. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.

Table 1. Percent of college+ SCF respondents with access to retirement accounts and holding a student loan

Age	% w/ ret account	% w/ student loan	% w/ret account & student loan	*SCF sample size (N)*
20-29	57%	35%	62%	*484*
30-39	73%	39%	54%	*864*
40-49	77%	26%	35%	*971*
50-59	80%	19%	24%	*1,242*
60-69	72%	8%	11%	*1,218*
70+	62%	2%	4%	*983*
Total	71%	21%	30%	*5,762*

Note: Number of college-educated persons with retirement accounts and education loans reported in the 2019 SCF. Retirement accounts include both defined contribution and individual retirement accounts. Source: Authors' calculations using 2019 SCF data; % columns use sample weights.

Table 2. Differences in average annual employer matching contributions (EMC): Post- minus pre-reform

	EMC differences in $000		EMC differences in % of labor income	
age	Standard (1)	IDR (2)	Standard (3)	IDR (4)
30	1.04	1.20	2.14	2.46
40	0.79	1.04	1.29	1.69
50	0.46	0.28	0.72	0.48
60	0.01	0.05	0.01	0.10

Note: This table reports expected differences of employer-matching contribution post versus pre-reform for college-educated workers (male and female) holding student loans and with access to DC retirement accounts by age. Columns (1) and (2) show absolute differences ($000) for a standard and income driven (IDR) repayment plan. Columns (3) and (4) shows the differences as a percent of labor earnings. Differences are calculated for 10,000 simulated optimal lifecycles weighted by sex (49.3% females), with identical exogenous shocks and optimal feedback controls for individuals after and prior to the SECURE Act 2.0 reform. See Figure 1 for additional modelling assumptions; all dollar values in $2019.

Table 3. Present value differences of tax payments: Post- minus pre-reform

	PV tax payment differences in $000		PV tax payment differences in % of pre reform tax payments	
	Standard (1)	IDR (2)	Standard (3)	IDR (4)
Mean	3.15	4.12	1.82%	2.65%
Q-25%	0.18	1.58	0.14%	1.17%
Median	2.82	3.70	1.80%	2.45%
Q-75%	5.59	6.04	3.42%	3.91%

Note: This table reports summary statistics (mean, median, quantiles) for differences in the present value of paid income and penalty taxes for college educated workers (male and female) with a standard versus income driven (IDR) repayment plan. Columns (1) and (2) shows present value differences in ($000) and Columns (3) and (4) as a percent of the present value of tax payments pre-reform. Differences are calculated for 10,000 simulated lifecycles (weighted by sex, females 49.3%) with identical exogenous shocks and optimal feedback controls for individuals pre- and post-reform. Tax payments are weighted by (sex specific) survival probabilities and discounted to age 25 at the risk-free rate of 2%. See Figure 1 for additional modelling assumptions; all dollar values in $2019.

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Appendix A: Modeling income taxes

This section builds on Horneff et al. (2023a) with a few modifications. Specifically, we take into account the tax-relevant dimensions for student loans. We look at US-workers having access to a qualified tax-deferred retirement account (TDA) and who pay federal income taxes on taxable income. All values are in $2019 and relevant amounts are inflation adjusted yearly. Taxable income is a complex function of labor income (minus housing costs), Social Security benefits, and returns from investments in bonds and stocks. For simplicity, we assume that all investment earnings (if overall positive) in form of interest, dividends, and capital gains are part of taxable income. Contributions A_t (up to D_t = $19,000) to the TDA reduce and withdrawals W_t from the TDA increase taxable income. For taxation of Social Security (Y_{t+1}) benefits after retirement, we use the following rules: when the retiree's *combined income* is between $25,000 and $34,000 (over $34,000), 50% (85%) of benefits are part of taxable income**.** Combined income is sum of adjusted gross income and half of Social Security benefits (US SSA nd). Negative returns from equity investments held in non-tax-qualified accounts are offset against positive returns from bonds. Interest on student loans D_{t+1}^{SDL} can be deducted from taxable income up to $2,500 per year, if the individual makes repayments and her modified adjusted gross income, $MAGI_{t+1} = \max\big(S_t(R_{t+1}-1)+B_t(R_f-1),0\big)+Y_{t+1}+W_t$, is below $70,000. Therefore,

$$D_{t+1}^{SDL} = \begin{cases} min(SLD_t \cdot 0.05, \$2{,}500), & if\ LR_t > 0\ \&\ MAGI_{t+1} < \$70{,}000 \\ 0 & else. \end{cases} \tag{B1}$$

Finally, a general standardized deduction GD = $12,250 reduces the worker's taxable income, which is given by:

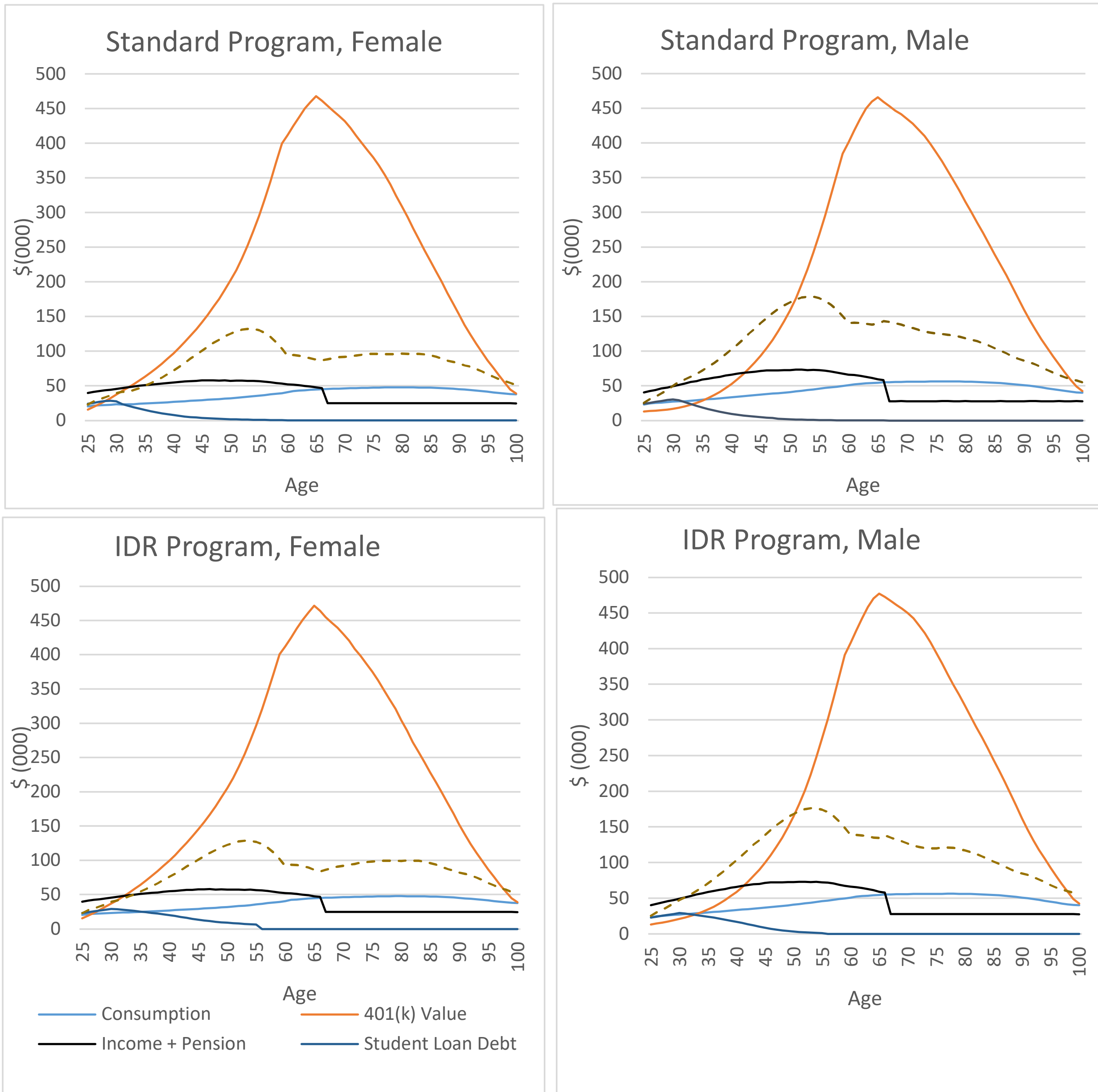
$$Y_{t+1}^{tax} = \max\big[\max\big(S_t(R_{t+1}-1)+B_t(R_f-1),0\big)+Y_{t+1}(1-h_t) - D_{t+1}^{SDL} + W_t - \min(A_t;D_t) - GD; 0\big]. \tag{B2}$$

The income tax has $i = 1, \dots, 7$ brackets (IRS 2019c) defined by a lower and an upper bound of taxable income $Y_{t+1}^{tax} \in [lb_i, ub_i]$ and a marginal tax rate r_i^{tax}. In 2019, the marginal taxes rates for a single household were 10% from $0 to $9,700, 12% from $9,701 to $39,475, 22% from $39,476 to $84,200, 24% from $84,201 to $160,725, 32% from $160,726 to $204,100 35% from $204,101 to $510,300 and 37% above $510,301 (see IRS 2019c). Based on these tax brackets, the dollar amount of income taxes payable is given by:

$$IT_{t+1} = \sum TB_i\,(Y_{t+1}^{tax}) \cdot r_i^{tax} \tag{B3}$$

Here $TB_i(Y_{t+1}^{tax})$ is the amount of taxable income that falls into the respective tax bracket (see Horneff et al 2023a).

Appendix B: Life cycle consumption, income, and other financial patterns



Note: Optimal lifecycle patterns for males and females in the standard repayment program and income driven repayment program. See Figure 1 for additional modelling assumptions; all dollar values in $2019. Source: Authors' calculations.