Borrow Now, Pay Even Later: A Quantitative Analysis of Student Debt Payment Plans

Michael Boutros Nuno Clara Francisco Gomes*

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Abstract

In the U.S. student debt currently represents the second largest component of consumer debt, just after mortgage loans. Repayment of those loans reduces disposable income early in their life cycle when marginal utility is particularly high, and limits households' ability to build a buffer stock of wealth to insure against background risks. In this paper we study alternative student debt contracts, which offer a 10-year deferral period. During this period individuals either make interest payments only (”Principal Payment Deferral”, PPD) or make no payments at all (”Full Payment Deferral”, FPD) with the missed interest payments added to the value of the debt outstanding. We first calibrate an equilibrium with the current contracts, and then solve for counterfactual equilibria with the PPD or FPD contracts. We find that both alternatives generate economically large welfare gains, which are robust to different assumptions about the behavior of the lenders and borrower preferences. We decompose the gains into the percentages resulting from loan repricing and from the deferral of debt repayments. We compare these alternative contracts with the current changes in income driven repayment plans being proposed by the current U.S. administration and show that they dominate such proposals.

*Boutros: Bank of Canada (michael.boutros@bankofcanada.ca), Clara: Duke University, Fuqua School of Business (nuno.clara@duke.edu), Gomes: London Business School and CEPR (fgomes@london.edu). We thank Aleksander Andonov, John Campbell, Jonathan Parker, and Constantine Yannelis for helpful comments. The presented views are those of the authors, not necessarily of the Bank of Canada.

1 Introduction

Student debt in the United States has more than tripled in the last 15 years, increasing from \$500 billion USD to almost \$1.8 trillion USD (Panel A of Figure 1). It currently represents 7% of GDP, increasing from 4% of GDP in the early 2000s (Panel B), and is now the largest non-mortgage component of consumer debt. This increase is driven by both the extensive and intensive margins of student borrowing; in particular, the average student borrower now owes approximately \$37,000, up from \$18,000 in 2008 (Panels C and D).

The increasing volume of debt and the repayment difficulties that many people now experience have opened a debate on whether public policy should further intervene in the student loan market. In this paper, we develop a quantitative dynamic model to evaluate the effects of alternative student debt repayment plans on consumption and saving over the life-cycle. We use the model to study both Standard Repayment Plans and the increasingly popular Income Driven Repayment Plans, and quantify welfare gains from a set of modified plans that we propose. Our analysis centers on the two standard channels through which student debt affects households, wealth effects and liquidity effects.

Student debt imposes a large wealth effect because, in addition to mechanically decreasing lifetime wealth, the presence of student debt on a household's balance sheet may preclude other leveraged purchases, such as real estate or vehicles, which further affects lifetime wealth. Young households (34 years and younger), who hold almost 40% of student debt, are especially sensitive to such large levels of debt. These households face "debt overhang" at a critical juncture in life, potentially causing them to restrict career choices or delay important decisions such as buying a house, entering the stock market, or starting a family (see Goodman et al. (2021), Folch and Mazzone (2022) or Hampole (2022)). Liquidity effects from student debt arise since payments begin shortly after graduation and draw upon liquidity, depressing both immediate consumption and saving for future consumption, especially for lower-income households. These loans can be difficult to repay or renegotiate and are essentially nondischargeable in bankruptcy.

Recent proposals by the federal government have centered around outright student debt forgiveness. These policies induce a large and positive wealth effect that is commensurately borne as a large fiscal cost. Ganong and Noel (2020) study a set of mortgage modification policies enacted during the Great Recession to isolate the wealth and liquidity effects that are fundamentally the same as in the context of student debt. They find that principal reductions, which increased wealth without affecting liquidity, had no impact on consumption or delinquency. It follows that if student forgiveness is indeed effective, it will be because forgiving the debt outright will also have a positive liquidity effect. However, Catherine and Yannelis (Forthcoming) estimate that student debt will be forgiven for many high income and likely very liquid households, muting the impact of the additional liquidity on consumption.

In contrast, the policies we consider defer payments to later in the life-cycle, offering concessions to borrowers only early in the life of the loan. This induces a large and positive liquidity effect early in life and, in some cases, a relatively small negative wealth effect. In principle, the deferrals are similar to maturity extensions, which Ganong and Noel (2020) find had a large and positive effect on consumption and delinquencies for mortgage borrowers during the Great Recession. These policies are also similar to the student debt payment pause program included in the 2020 CARES Act, which Dinerstein et al. (2023) document led to increased consumption and fewer delinquencies for holders of loans with paused payments. Importantly, the plans have near-zero fiscal cost since they are still fully repaid, and in fact may generate more profit to the lender over the life of the loan.

The model serves to carefully quantify the welfare gains from increasing liquidity via deferring loan payments. Current student debt contracts impose a repayment schedule that starts (almost) after graduation. At this stage of the life-cycle, agents have lower income and the marginal utility of consumption is particularly high. Furthermore, they have been not yet been able to accumulate significant savings, and the requirement to make debt repayments further prevents them from accumulating much wealth early in life. In addition to reducing consumption overall, this makes households less able to smooth consumption and much more vulnerable to income shocks. For these reasons, it makes sense to defer debt repayments until later in the life-cycle, when agents typically have higher income and have had an opportunity to accumulate significant savings.

We start by calibrating a life-cycle model of consumption and savings behavior where households are endowed with an initial level of student debt that must be repaid under the current rules: standard repayment play (SRP) schedule with the option to enrol in a income-driven repayment play (IDRP). Under the IDRP agents total debt repayments are capped at a fraction of their disposable income, which can be particularly valuable for low-income individuals. Unsurprisingly this option is mostly taken early in life. We show that the model matches well the empirical fraction of individuals on SRP, IDRP and in default. In addition it also replicates the empirical patterns of income, debt outstanding, debt to income and net wealth across these three scenarios.

We then use the calibrated the model to solve for counter-factual equilibria where we introduce alternative student debt contracts. Under the first alternative contract ”Principal Payment Deferral” (PPD) during the first 10 years of the loan agents only have to make interest payments. Principal repayments only start in the 11th year. Under the second alternative contract, ”Full Payment Deferral” (FPD) agents are not required to make any payments at all during the first 10 years of loan. During this period interest payments are simply added to the value of the loan, which therefore grows every year at the interest rate on the loan.

For each of these alternative contracts we solve for a new equilibrium where lenders reprice the loans and households re-optimize subject to these new contracts. We evaluate these policies along several dimensions, including their impact on borrower consumption and welfare, but also default rates and cash-flows to the lender(s). We find that under these alternative contracts individuals are better able to smooth consumption over time and insure against income shocks, leading to economically significant welfare gains: yearly certainty equivalent consumption gain of 1.35% for PPD contracts, and 2.36% for FPD contracts.[1] We decompose these gains into the fraction that arises from the re-pricing of the loans and the fraction resulting from the deferral of debt repayments. For the FPD contract, the gains are almost exclusively driven by the later. By contrast, for the PPD contract, a significant component arises from a reduction in the loan interest rate.

We also compare our certainty equivalent gains with those obtained under a simple 10-year contract extension. We find that, while extending the maturity of existing contract is welfare improving, the corresponding gains are only 29% (51%) of those obtained under the FPD (PPD) modification. This confirms the intuition that the welfare gains are largely coming from the reduction of debt burden early in life. Replicating those gains with a simple maturity extension would require a much longer extension period than 10 years.

In addition to improving household welfare by postponing (most) debt repayments until later in the life-cycle when agents have higher income and more wealth, these new contracts also imply substantially lower default rates. Relative to the current equilibrium, defaults decrease by 1/3 in an economy with PPD contracts, and by 1/2 in an economy with FPD contracts. In our analysis we, conservatively, ignore the potential impact of these lower default rates on the risk premia associated with the loan contracts. Any further reduction in

[1]For comparison, there are similar to welfare gains from stock market participation, computed in similar life-cycle models, e.g., Cocco et al. (2005).

loan interest rates due to this channel would lead to even larger welfare gains.

For tractability, our baseline model abstracts from other features that could increase the welfare gains even further, such as a housing decision, family planning, job search, and stock market participation. To the extent that individuals are forced to delay stock market participation or a housing purchase because they are required to repay their student debt early in life, the benefits of our proposed contracts would be even larger.[2] Similarly, the additional pressure to secure an income stream limits their job search and forces them into a sub-optimal match, as shown by Hampole (2022) and Folch and Mazzone (2022). Therefore, the welfare gains that we are measuring are likely a (fairly conservative) lower bound relative to their full potential benefit for households. Student loans also have an impact on individual credit scores. Making regular payments on their student loans can help households build a credit score early in life. On the other hand, defaulting on their payments will trigger important negative credit events. Since both FPD and PPD contracts significantly reduce default rates, this constitutes an additional source of welfare gains that is not captured in our analysis.[3]

We also use our model to understand the welfare benefits of the current U.S. administration proposals to change IDRP plans. Two main changes are being proposed by the current administration: (i) change the time to forgiveness on IDRP plans from 25 years to 10 years and (ii) change the payment formula of the IDRP plan. We show that the first proposal has tiny welfare benefits for students whereas the second proposal is similar in nature to our PPD/FPD proposals and has welfare gains that are larger than our PPD proposal but smaller than the FPD.

Our paper contributes to the large literature studying student debt, surveyed in Avery and Turner (2012), Amromin et al. (2016), Bleemer et al. (2017), and Athreya et al. (2021). Student debt is unique from other forms of leverage for two key reasons. First, its unique to household balance sheets because student debt cannot be discharged in bankruptcy, nor can human capital financed by student debt be seized during bankruptcy. Second, relative to how firms or governments finance their spending with long or infinite horizons, consumption and savings decisions depend heavily on the household's age, i.e., its position in the

[2] An extension with an endogenous participation decision yields welfare gains that are around 20% higher than in the baseline model, even though we impose an exogenous portfolio allocation.

[3] Under the FPD contracts agents are not required to make loan payments early in life, so both the potential credit score benefits (from not defaulting) and costs (from defaulting) are absent. But under the PPD contract, the payments still exist but they are only reduced early in life.

life-cycle. The deferral policies we consider are welfare-improving because of the upward sloping income profile and other age-related expenses early in the life-cycle.

From a market perspective, the demand for student debt has increased as both the returns and costs of education have increased over the last several decades, while the supply side of the market has responded with the expansion of government programs and growing private lending sector (Sun and Yannelis, 2016; Ionescu and Simpson, 2016; Amromin et al., 2017; Lucca et al., 2019; Gallagher et al., 2022; Yannelis and Looney, 2022). For many, the decision to invest in higher education and accumulate human capital is closely linked to the ability to obtain student loans (Lochner and Monge-Naranjo, 2011; Gary-Bobo and Trannoy, 2015; Palacios, 2015; Abbott et al., 2019; Athreya et al., 2020). In this paper, we abstract from these larger forces that drive households to acquire student debt, and analyze the behavior of households who enter the workforce with student debt after completing their education.

Our main focus is on the specific payment plans that student borrowers use to pay down their debt. We quantitatively compare the standard repayment plan to income-driven repayment plans. Whereas there are a number of empirical papers looking into income-driven repayment plans, to the best of our knowledge we are the first to model the endogenous choice to enroll in an income-driven repayment plans. Karamcheva et al. (2020) document that although the majority of borrowers enrol in the default standard repayment plan, income-driven plans have gained popularity in recent years. The evidence suggests that directly offering the income-driven plans to borrowers an alternative to the default plan increases enrolment (Abraham et al., 2020; Cox et al., 2020; Mueller and Yannelis, 2022), in line with similar behavior on interest-free student loans documented by Cadena and Keys (2013). Maggio et al. (2020) find large benefits from the discharge of student debt in a natural experiment. Focusing on repayment plans specifically, Britton and Gruber (2019) find no evidence that income-driven repayment plans negatively affect labor supply and Herbst (Forthcoming) finds income-driven repayment plans reduce delinquencies, decrease outstanding balances, and have a positive effect on long-run measures of financial health. Goodman et al. (2021) show that increasing liquidity for student borrowers, which our modified plans do by adjusting the timing of payments to accumulate wealth for a period of time before paying down their student debt, has large welfare benefits for borrowers.

The rest of paper is organized as follows. Section 2 presents the model. Sections 3 and 4 discuss the calibration of the baseline economy and the baseline results, respectively. In Section 5 we introduce the alternative contracts, solve for the new equilibrium and compute our welfare measures. We conclude in Section 6.

2 Model

2.1 Environment

We consider an overlapping generations model with T generations of households and a single lender (the federal government) which provides student loans. We only model the loan market, and otherwise take a partial equilibrium approach.[4]

We model households as having just completed their education and beginning their working life with an initial endowment of student debt. In each period, in addition to plans for consuming and saving, each household makes a decision regarding its student debt payment. They can make a payment according to the default standard repayment plan (SRP), pay a cost to enroll in the income-driven repayment plan (IDRP), or default and pay a corresponding penalty. Each household lives for T periods. In the first K periods, the household receives stochastic labor income and faces borrowing constraints, and during the R retirement periods it receives a pension income.

Student loans are issued at time zero by the single lender, the Federal government. For our purposes, it would be equivalent to assume a continuum of ex-ante identical and perfectly competitive lenders. In the baseline model we calibrate the interest on student loans from the data. When considering alternative debt contracts we assume compute the lender's NPV associated with that particular interest rate, and use that to re-price all other contracts. We discuss these calculations in detail in section 5.

The default debt contract is a standard repayment plan (SRP). This is a constant-payment loan with a fixed payment schedule and maturity date. Alternatively households can opt into an income-driven repayment plan (IDRP), by paying a switching cost.[5] Under an IDRP the payments are a function of their income, and therefore the maturity of the loan is variable. Payments in the IDRP are capped at those of the standard plan. Because of this cap, the maturity date of the SRP is a lower bound for the maturity in the IDRP, but typically the debt is paid off over a longer period of time. The IDRP loans have a maximum maturity of 25 years, and at this time any remaining debt is discharged without penalty.

[4]We only consider households with student loans, so we are not modelling all consumers/savers.

[5]In practice this is a largely a time cost, associated with submitting the necessary paperwork, hence we model it as a utility cost.

2.2 Debt Contracts

Student debt starts under the terms of a standard repayment plan (SRP), which are described below. However, households who qualify, can apply for payments under an alternative Income-driven repayment plan (IDRP). Under the IDRP debt repayments are a function of income, and are capped at the value of the SRP. Therefore, low-income households have an incentive to switch. However, as a consequence of delaying their repayments, the maturity of the loan is extended.

The SRP structures payments using a standard amortization schedule common across many loan types, while the IDRP is designed to assist recent graduates as they enter the workforce and anticipate increasing income profiles. Under most circumstances, students are given a six- or nine-month grace period between graduation and their first debt payment, so student debt payments in our model begin in period two.

We denote the interest rate on the loans as $r_s \equiv r_f + \varphi^{Baseline}$, where $\varphi^{Baseline}$ is the student loan premium over the risk-free rate (r_f). Interest rate on student loans is tax-deductible at the income tax rate τ.

2.2.1 Standard Repayment Plan

In the standard repayment plan, the loan is amortized over N_{SRP} periods (in absence of default). In each period, principal (P_t^{SRP}) and interest payments (I_t^{SRP}) sum to a constant total payment, given by the standard formula:

$$P_t^{SRP} + I_t^{SRP} = \left[\frac{1-(1+r_s)^{-N_{SRP}}}{r_s}\right]^{-1} S_0, \tag{1}$$

where S_0 is the initial balance of the loan and r_s is the interest rate on the loan. The fraction of the total payment allocated towards principal and interest varies in each period according to the level of outstanding debt:

$$I_t^{SRP} = r_s S_t, \tag{2}$$

$$P_t^{SRP} = \left[\frac{1-(1+r_s)^{-N_{SRP}}}{r_s}\right]^{-1} S_0 - r_s S_t. \tag{3}$$

As with all constant repayment loans, payments early in the amortization schedule are tilted more towards interest than principal, with the pattern reversing as the loan reaches maturity.

2.2.2 Income-Driven Repayment Plan

Under an Income-Driven Repayment Plan (IDRP), the student loan payment in each period takes into account the household's income. Payments are reassessed annually depending on changes in the household's tax filings, which corresponds to the yearly frequency in the model.

A crucial feature of the IDRP is that the payment is capped at alternative the payment under the standard repayment plan. Specifically, payments in the IDRP are equal to the lesser between 10% of discretionary income or the standard payment:

$$P_t^{IDRP} + I_t^{IDRP} = \min\{P_t^{SRP} + I_t^{SRP}, 0.1 \cdot \mathrm{DI}_t\} \tag{4}$$

Discretionary income is equal to total income minus 100% of the federal poverty level (FPL), which depends on household size.

The income driven payment plan has a maximum maturity of $N_{IDRP}(> N_{SRP})$ years, after which any remaining principal is discharged with no penalty.[6] As before, interest is calculated using the outstanding level of debt, and the principal payment is the remainder:

$$I_t^{IDRP} = r_s S_t, \tag{5}$$

$$P_t^{IDRP} = \min\{P_t^{SRP} + I_t^{SRP}, 0.1 \cdot \mathrm{DI}_t\} - I_t^{IDRP}. \tag{6}$$

Note that since the total payment on the loan is capped at 10% of discretionary income (equation (4)), it is possible that this is not enough to cover the interest payments, i.e. we might have

$$0.1 \cdot \mathrm{DI}_t \ < r_s S_t \tag{7}$$

Under such a scenario, equation (6) implies that the amortization of the principal is actually negative, and therefore the total principal increases between periods. We note that this occurs despite the fact that the household has not defaulted on the loan nor deviated from its schedule of payments in any way.

2.2.3 Transitions between IDRP and SRP

If an agent switches from SRP to IDRP she is subject to the rules describe above. Likewise, if she later reverts back to the SRP then the loan terms are the standard SRP terms. However,

[6] If the household's income is sufficiently large such that the payments are always equal to those under the standard plan, then the entire student loan is paid off in N_{SRP} periods. For intermediate levels of income and payments, debt may be fully paid off between N_{SRP} and N_{IDRP} periods.

since under the IDRP the loan amortization has been lower, i.e. lower than the value implied by equation (3), then the overall maturity of the loan will typically be higher than N_{SRP}. Making principal payments under equation (3) is not going to deliver a zero balance at $t = N_{SRP}$ because the current outstanding balance is higher than it would have been if the agent had remained in the SRP throughout.

2.2.4 Default

In any given year the household may choose to default on its student debt, in which case it pays a default penalty, ξ^D. Under default, the household makes no payment towards either principal or interest, but accrues the missed interest onto its existing balance:

$$P_t^D = -I_t^D. \tag{8}$$

and therefore the debt balance grows by the interest rate,

$$S_{t+1} = (1 + r_s)S_t. \tag{9}$$

Default lasts for one period, and the household has access to the same menu of choices in the next period, including to the option default again.

2.3 Households

2.3.1 Budget Constraint

Households start each year with an initial endowment of wealth (W_t) and a stock of student debt (S_t), which could be zero if it was already fully repaid. During the year they receive receive labor income (or pension income if retired, Y_t) and make their choices regarding how much to consume (C_t), and how to repay their debt (under SRP, IDRP or to default). Household savings are invested in a riskless rate, that earns a deterministic return r_f.

Wealth therefore, evolves according to the following dynamic budget constraint

$$W_{t+1} = (1 + r_f)(W_t - C_t^j - P_t^j - I_t^j) + (1 - h_{t+1} - \tau)Y_{t+1}, \tag{10}$$

where h_t, is the fraction of gross income on housing-related expenditures and τ is the income tax rate.[7] Net income is then given by $(1 - h_t - \tau)Y_t$. Switching costs (for the agents who

[7] We do not model an explicit housing decision and instead incorporate housing expenditures in a reduced-form approach, following Gomes and Michaelides (2005).

enroll in the IDRP), or default costs (for the agents who choose to default), are modelled as utility costs, so they do not enter the budget constraint.

Student debt, S_t, is measured at the beginning of the period. P_t^j and I_t^j denote principal and interest payments, respectively, on student debt under each option $j \in \{\text{SRP}, \text{IDRP}, \text{D}\}$. If there is no default then student debt evolves according to principal payments:

$$S_{t+1} = S_t - P_t^j. \tag{11}$$

where P_t^j is given by equation (3) or equation (6), depending on the plan type. In the event of default S_{t+1} is given by equation (9).

2.3.2 Income Process

Income during the household's working life is modeled following Guvenen et al. (2021). In period t of household i's working life, income is given by:

$$Y_t^i = (1 - \nu_t^i) \exp(g(t) + \alpha^i + z_t^i + \epsilon_t^i), \tag{12}$$

where $g(t)$ captures the age profile of earnings and α is a household fixed effect calibrated to match average earnings. The unemployment shock ν_t generates a large decrease in income when the household is unemployed, while the stochastic processes z_t and ϵ_t capture, respectively, persistent and transitory income shocks for employed households.

The persistent income process, z_t^i, follows an AR(1),

$$z_t^i = \rho z_{t-1}^i + \eta_t^i, \tag{13}$$

with innovations drawn from a mixture of normal distributions. The persistent shock η_i^t is $\mathcal{N}(\mu_{\eta,1}, \sigma_{\eta,1})$ with probability p_z and $\mathcal{N}(\mu_{\eta,2}, \sigma_{\eta,2})$ otherwise.

The transitory shock, ϵ_t^i, is also a mixture of normal distributions, drawn from $\mathcal{N}(\mu_{\epsilon,1}, \sigma_{\epsilon,1})$ with probability p_ϵ and $\mathcal{N}(\mu_{\epsilon,2}, \sigma_{\epsilon,2})$ otherwise. In both cases, the expected value of the mixed distribution is zero.

The unemployment shock, $1 - \nu_t^i$, is given by:

$$1 - \nu_t^i = \begin{cases} 1 & \text{with prob. } 1 - p_\nu(t, z_t^i), \\ \lambda & \text{with prob. } p_\nu(t, z_t^i), \end{cases} \tag{14}$$

where

$$p_\nu^i(t, z_t) = \frac{\exp(a_\nu + b_\nu t + c_\nu z_t^i + d_\nu z_t^i t)}{1 + \exp(a_\nu + b_\nu t + c_\nu z_t^i + d_\nu z_t^i t)}. \tag{15}$$

This shock depends on household's age and the persistent component of the income process. When the unemployment shock is realized, the household's income is scaled down by a constant fraction, λ.

As described in section 2.2, the debt repyaments under the IDRP are a function of household discretionary income. In the model, for tractability, the measure of discretionary income only includes the lifecycle component, the individual fixed-effect, and the persistent component of income:

$$\mathrm{DI}_t = \exp(g(t) + \alpha + z_t) - 1.5 \times \mathrm{FPL}. \tag{16}$$

Following Cocco et al. (2005), retired households receive a deterministic fraction, ω, of their income in the last period of its working life. More precisely, for retired household i in period t, income is given by:

$$Y_t^i = \omega \cdot \exp(g(K) + \alpha^i + z_K^i) \tag{17}$$

where K is the final working period.

2.3.3 Preferences and Individual Optimization Problem

The individual optimization problem has three state variables: wealth, W_t, the level of student debt outstanding, S_t and the persistent labor income income z_t. We assume that households have Epstein-Zin preferences over consumption as specified below.

In each period, in which the household has student debt outstanding, it will decide between making payments under a SRP, an IDRP, or become delinquent on its student debt obligation. Payments under the IDRP can be lower, if household income is sufficiently low, but switching involves a cost (ξ^{IRDP}). Debt payments can be fully avoided by defaulting, but this is associated with a default penalty (ξ^D). We therefore can write the household's value function as the maximum of the values associated with these three alternative choices:

$$V_t(W_t, S_t, z_t) = \max\{V_t^{SRP}(W_t, S_t, z_t), V_t^{IDRP}(W_t, S_t, z_t), V_t^D(W_t, S_t, z_t)\}. \tag{18}$$

where V_t^j denotes the auxiliary value function associated with each possible option $j \in \{\mathrm{SRP}, \mathrm{IDRP}, \mathrm{D}\}$. The auxiliary value functions associated with each of three possible debt repayment decisions are given by

$$V_t^j(W_t, S_t, z_t) = \max_{C_t^j(\cdot)}\{(1-\beta)[C_t^j(W_t, S_t, z_t) - \xi^j]^{1-1/\psi} + \beta E_t[V_{t+1}(W_{t+1}, S_{t+1}, z_{t+1})^{1-\gamma}]^{\frac{1-1/\psi}{1-\gamma}}\}^{\frac{1}{1-1/\psi}}, \tag{19}$$

where ψ is the elasticity of intertemporal substitution, β is the subjective discount factor and γ is the coefficient of relative risk aversion. The utility cost of enrolling in each payment plan or defaulting is given by ξ^j.[8]

For all j, the continuation value on the right-hand-side of equation (19) is the unconditional value function, V_{t+1}, since in the next period, the household can again choose between both plans or to default.

3 Calibration

3.1 Income Process

We calibrate the income process (equations (12) to (15)) using the estimates in Guvenen et al. (2021) and Cocco et al. (2005). We use the estimates of the Gaussian mixture parameters and unemployment shock function from Guvenen et al. (2021). To ensure that the expected value of each mixture is zero, they set the mean of the second component to zero (without loss) and estimate the mean of the first component. We report the full set of parameters in Table 1.

[INSERT TABLE 1 HERE]

We calibrate the parameter, α_i, to match the median income conditional on having student debt. Income and student debt data are taken from the 2019 wave of the Survey of Consumer Finances.

For the life-cycle component of earnings, $g(t)$ and the retirement income replacement rate, we take the estimates in Cocco et al. (2005) for college-educated households. We calibrate the housing expenditures from Gomes and Michaelides (2005).

3.2 Student Debt

We calibrate the different moments and parameters for the student debt variables using data from the Survey of Consumer Finance (SCF).

[8] So ξ^{SRP}=0 since that is the initial plan, ξ^{IRDP} is the cost of transitioning to the IDRP plan, and ξ^D is the default penalty.

We calibrate initial student debt loan amount to match the median initial amount borrowed by households in the 2019 wave of the SCF (29 thousand US dollars). The loan premium for the standard repayment plan with the IDRP option ($\varphi^{Baseline}$), is calibrated using the average rate in the SCF: 3.5%. The utility penalty for missing a payment (ξ^{D}) is set to match the delinquency probability in the SCF: 18.0% of loans were under delinquency in 2019.[9]. We calibrate the utility cost of enrolling on IDRP (ξ^{IDRP}) to match the average IDRP enrollment level in the SCF data (31%). Table 2 reports the model parameters related to the student debt calibration.

[INSERT TABLE 2 HERE]

3.3 Preferences and Other Parameters

In our baseline calibration we set the coefficient of risk aversion, γ, to 2 and the elasticity of intertemporal substitution ψ to 0.5. Conditional on these, we then calibrate the discount factor, δ to 0.95, to match the median financial wealth of agents at the beginning of the life cycle (age 25-34) conditional on having student debt. We use data from the 2019 wave of the Survey of Consumer Finances to compute financial wealth. Financial assets include transaction accounts, CD's, savings bonds, bonds, stocks, non-money market mutual funds, retirement accounts, cash value of life insurance, other managed assets and other financial assets. In the robustness section we report results for additional values of the preference parameters. They all deliver very similar conclusions with regards to the welfare gains from introducing the alternative student debt contracts. Finally we set the riskfree rate to 1% and the income tax rate to 20%.

4 Baseline Results

In this section we present results for the baseline model where we consider the current contract structure for student debt: standard repayment plan with an option to enroll in an income driven repayment plan. The specific details of each of these, and the implications

[9]We use the same definition of delinquency as Athreya et al. (2021) A loan is delinquent if the household reports that she is not making payments on the loan either for affordability reasons or because the loan is in forbearance.

of default, were presented in section 2.2. In the next section we study the equilibrium and welfare implications of alternative debt contracts.

4.1 Income, Debt and Wealth under SRP, IDRP or Default

Table 3 shows the main moments generated by the model (Panel A) and their empirical counterparts from the SCF (Panel B). The first row of each panel shows the fraction of household/year observations where the household is making a student debt payment under a SRP, a IDRP or choosing to default. For each of these three we report the median loan balance outstanding, income, debt-to-income and net wealth. All the statistics are conditional on households having debt outstanding.

[INSERT TABLE 3 HERE]

In the model, around 55% of the time households make the scheduled payment according to the standard plan. 29% of the time agents enroll in the income driven repayment plan and 16% of the time they default. These percentages are very close to their empirical counterparts, respectively 51%, 31% and 18%.

Naturally agents tend to make payments under the IDRP when their income is lower, such that they can benefit from the corresponding payment reductions. Since there is switching cost, they also have a greater incentive to use the IDRP when their debt balance is particularly higher. If income is very low and/or loan balances are particularly high, then households choose to default. In the model income and loan balance outstanding are the only drivers of the default decision, while in reality households might default for other reasons, or might not make a fully rational default decision. This explains why, although the results are qualitatively the same in both, the differences in median loan balance and median income in the default states are more pronounced in the model than in the data. Finally, median net wealth is positive for households making repayments under the SRP but negative for those using the IDRP and even more negative for those in default. This is the case both in the model and in the data.

4.2 Life-Cycle Profiles

In table 4 we provide more detailed summary statistics from our baseline results, and further include a break-down by age groups: 25-30, 31-35 36-40 and 41-65.[10] Panel A reports statistics for households using the SRP, while the corresponding values for those using the IDRP or choosing to default are presented in panels B and C, respectively. All the statistics (except for row 2) are conditional on households having debt outstanding.

[INSERT TABLE 4 HERE]

4.2.1 Income, Consumption and Leverage

The first row of table 4 show the fraction of households enrolling in either payment plan or defaulting, conditional on having student debt outstanding (as in table 3). These numbers add to 1 across the three panels: households with debt outstanding must make repayments under one of the two plans, or default. In the second row we report the percentage of households in each category, relative to the initial population, i.e. those who had student debt at age 25. This allows us to track down the fraction of households that fully repay their loans over time. For example, if we sum the percentages in the three categories for the age group 41-65 we obtain 6.2%, thus indicating that 93.8% of households have fully repaid their student debt by age 41.

The next two rows of table 4 show the average income and average income growth. Income grows over the life-cycle, particularly early in life, hence its growth rate is therefore very high for the age group 25-30 and decreases for the others. This pattern is not visible for households who choose to default (Panel C), for whom we instead observe negative or close to zero growth rates (for all age groups). This is because individuals are naturally more likely to default after suffering a negative income shock. Despite the positive growth rates for all age groups (in panels A and B), average income is actually flat or even decreasing already from age 36. This is because we are conditioning on households who have student debt outstanding. Those with higher income growth are more likely to remain under the SRP throughout and repay their loans more quickly. As a result, they do not appear in the next age group of ”this sample”. Rows 5 and 6 of table 4 report mean consumption and

[10] since the maturity of the student loan is either 10 (under the SRP) or a maximum of 25 years (under the IDRP) few households still have debt outstanding after age 40, which is we consider them all as one group.

mean consumption growth, which follow the same patterns as their income counterparts, due to the presence of the borrowing constraints.

Younger agents, below 31 years old, are more likely to use IDRP (46.2% compared with 43.1% for the SRP). This is because income at the start of life-cycle is low, and the debt outstanding is still high, thus making it more beneficial for them to pay the switching cost and enroll in the IDRP. As income grows, and the debt is being gradually repaid, households are more likely to remain under the SRP: 65.4% and 69.3%, respectively at the age groups 31-35 and 36-40.

Although the percentage of households enrolled in the IDRP is lower in the 31-35 and 36-40 age groups (23.6% and 13.6%, respectively) it increases again for the age 41-65 cohorts. This increase is largely due to selection. As shown in row 2, while 53.7% of households still had student debt at age 36 (across all 3 groups), the number falls to 6.2% at age 41. Households who have not yet paid their student loans when they reach their forties, are likely to have low income and very high balances outstanding. Indeed, their income is even lower than for those in the age group 36-40, even though average income is growing, as confirmed by the growth rates numbers (row 4). This selection is particularly visible when we look at the debt outstanding numbers (row 7), which are in fact substantially higher for the 41-65 age group than for the age 36-40 cohorts. Although the debt balance can increase due to the negative amortization possibility described in section 2.2, most households in the 36-40 age group are under the SRP (under which negative amortization is not possible).[11] They are also more likely to have defaulted earlier on the life-cycle. Recall that student debt is non-dischargeable and interest accrues for missed payments, thus contributing to their high debt balances.

4.2.2 Default Rates and Debt Repayments

The previously discussed selection process also helps to explain the behavior of the default rates over the life-cycle (panel C). Default rates initially are very stable (comparing the age groups 25-30 and 31-35): early in life debt balances are higher, while both income and savings are lower, thus leading to more default events. However, default rates rise again later on, and are particularly high for the age group 41-65, reflecting the relatively lower income and higher debt balances of households who have not yet repaid their student loans by age 41. Those who have been particularly unfortunate in their income shock realizations

[11] We describe the negative amortization events below.

likely also have low wealth (negative net wealth) and are therefore highly likely to default (again).[12]

The last four rows of 4, report average total debt payments, principal payments, interest payments and the ratio of debt payments to income.[13] As expected, total payments are typically lower under the IDRP relative to the SRP. The 36-40 age group is an exception, but that is because the majority of agents in this group are close to paying off their debt, and as such have very low outstanding balances. In fact, the ratio of total debt payments to debt outstanding is 74.5% for those using the SRP, but only 20.8% for those using the IDRP. This pattern of lower payments is particularly useful for agents earlier on in their life-cycle when their income is tends to be lower. In fact, the ratio of total payments to income is actually higher for those using the IDRP, reflecting the lower income of households who opt for this payment plan.

A closer examination reveals that the lower total payments under the IDRP result from substantially lower loan amortization: between 30% to 50% lower than under the SRP. By contrast, interest expenses are in fact higher under the IDRP, as we would expect since the loan balance is also larger, on average.

4.3 Understanding Debt Repayments

In this section we study the debt repayment decisions in more detail. Table 5 shows the different debt payments statistics for agents using a SRP (column 2), a IDRP or in default (columun 5). It further separates IDRP repayments with positive or negative amortization (respectively, columns 3 and 4). Note that a default choice leads to negative amortization, since the unpaid interest is added to the outstanding balance. The first row shows the probability of each event.[14]

[INSERT TABLE 5 HERE]

Consistent with the previous results, agents choose to make payments under a SRP when they have low debt to income ratios. As this ratio increases they are more likely to choose

[12]We discussed the persistence of default rates later in the paper.

[13]In the default state no payment occurs, as shown in rows 9 and 12. Since the debt accrues with interest this is technically equivalent to a negative principal repayment and a positive interest payment of equal value, hence the non-zero values in rows 10 and 11.

[14]The probabilities on table 5 are slightly different than the probabilities on table 3 since we are conditioning on a positive/negative amortization and we lose one period when doing so)

the IDRP, or even to default. Comparing the actual payments with those that would have happened under the SRP plan (rows 4 and 5 versus rows 6 and 7) we see that switching to an IDRP provides substantial yearly savings. Even for those agents that have positive loan amortization (column 3), the total payment (principal plus interest) is on average 35% smaller.[15]

Negative amortizations under the IDRP tend to take place when debt to income is particularly high. Low individual income imposes a tighter cap on total payments, and a high level of debt implies a higher interest charge. As a result, there is a high probably that the interest expense will excess the cap leading to negative amortization. Interestingly, we see that those events are not very frequent. In only 1% of the cases are households achieving negative amortization within an IDRP. Even as a fraction of the households that use this plan, that still represents only 3.4% of the total.

Table 6 shows the persistence in agent's decisions. The rows report the time t choices, and the columns show the decisions at time $t+1$.

[INSERT TABLE 6 HERE]

We see that these decisions are very persistent. If an agent is making payments under a standard repayment plan at time t with 94% probability she will again choose to make a payment under the standard plan at time $t+1$. With 5% probability she will decide to use an income driven plan and with 1% probability she will default. For a household who is enrolled in IDRP the degree of persistence is not as extreme but still, with 62% probability she will make the same decision next period. With 28% probability she will move to a standard repayment plan and with 11% probability she will default. Unsurprisingly default at $t+1$ is more likely for agents that were previously in the IDRP versus those that had remained in the SRP. But the difference in conditional probabilities is quite large: 11% versus 1%.

Finally, there is also substantial persistence in default rates. An agent who is defaulting at time t has a 76.2% probability of defaulting again at time $t+1$. This helps to explain why certain individuals still have very high debt balances later in life with a significant portion of them still defaulting at this stage of the life-cycle, as shown in table 4: within the group of 41-60 year old with positive student debt, 44.4% of those choose to default in any given year.

[15]This results exclusively from a reduction in the principal repayment, since the agent must always make the full interest payment otherwise she is in default.

5 Modified Debt Contracts

In this section, we consider two payment plan modifications motivated by the patterns described in the previous section, especially as they relate to the timing of student debt repayment debt over the life-cycle. In both the standard repayment plan with an option to opt to IDRP, households start repaying their loans right early in their life-cycle. From a consumption smoothing perspective this is highly sub-optimal because this is when their marginal utility of consumption is particularly high, due to the combination of an increasing income profile and borrowing constraints. Therefore, it would be optimal to (partially) defer these payments to a future date. Building on this intuition, we now consider alternative student debt contracts with payment plan modifications designed to deliver a shift in repayments over the life-cycle.

In our baseline calculations, we re-price the loans under each of the proposed modifications, such that the expected NPV for the lender remains unchanged. However, we also report results for two alternative scenarios. In one of them lenders require a higher NPV on the new loans, while in the other we keep the interest rate constant at the current value. Those results will simultaneously allow us to decompose the sources of the welfare gains, and provide robustness evidence for our conclusions.

Although our model assumes a given initial level of student debt, we later show that our conclusions are robust to a scenario where households adjust their student loan size in response to the introduction of these policies.

5.1 Contract Terms

In this subsection we present the terms of the two proposed student debt contracts. In the next subsection we discuss the equilibrium pricing of these contracts and in the next sections we study the new equilibrium and its welfare implications.

5.1.1 Principal Payment Deferral (PPD)

The first alternative contract (Principal Payment Deferral, PPD) shifts the original amortization schedule of the loan forward by N_{PPD} periods. In those N_{PPD} periods the household is still required to make interest payments, which are simply the student loan interest rate multiplied by the initial loan amount. Since interest is being paid, the balance of the loan does not increase over time (in absence of default). So, for $t \leq N_{PPD}$ we have:

$$I_t^{PPD} = r_s^{PPD} S_t \tag{20}$$

$$P_t^{PPD} = 0 \tag{21}$$

where r_s^{PPD} is the interest rate on student loans under the PPD contract.

After the initial interest-only periods, the household can choose to make principal and interest payments under a standard repayment plan (equations (1) to (3)) or to pay the switching cost (ξ^{IRDP}) and enroll in an income driven plan (equations (4) to (6)), i.e. the contract reverts back to current one. As before, in case of default the loan balance increases by the value of missed interest payments (equation (9)). In our analysis below we set $N_{PPD} = 10$.

5.1.2 Full Payment Deferral (FPD)

The second alternative contract (Full Payment Deferral (FPD)), defers both principal and interest payments for N_{FDP} periods. The initial interest payments are not forgiven, they are just deferred. In these periods, the household is still charged an interest payment, as in the "Principal-Payment Deferral" contract. However, these are not actually paid, they are instead added to the principal of the loan. So, for $t \leq N_{FPD}$ we have:

$$I_t^{FPD} = r_s^{FPD} S_t \tag{22}$$

$$P_t^{FPD} = -I_t^{FPD} \tag{23}$$

where r_s^{FPD} is the interest rate on student loans under the FPD contract.

As a result, after the initial N_{FPD} deferred-payment periods, the new loan balance becomes the initial balance multiplied by $(1 + r_s)^{N_{FPD}}$:

$$S_{N_{FPD}}^{FPD} = (1 + r_s^{FPD})^{N_{FPD}} S_0 \tag{24}$$

At this point the payment scheduled is re-calculated using the new loan balance, and the debt contract reverts back to the current set-up: principal and interest payments according to a standard repayment plan (equations (1) to (3)) with the option to pay the switching cost (ξ^{IRDP}) and enroll in an income driven plan (equations (4) to (6)). If the agent chooses to default the loan balance increases by the value of missed interest payments (equation (9)). In our analysis below we set $N_{FPD} = 10$.

5.2 Equilibrium Loan Premia

In this section we describe how we compute the loan premium for each of the modified contracts, PPD and FPD, (respectively, φ^{PPD} and φ^{FPD}).

We assume that the lender is risk-neutral, or can fully diversify the cash-flow risk (namely default risk) associated with the different repayment schedules. Therefore we discount all cash-flows at the riskless rate. We make this assumption because the lender is typically the Federal Government which is much better able to diversify this risk than private lenders. If we incorporate a risk-premium in our calculations then the welfare gain from the introduction of the new contracts would be even higher, since they imply lower default rates as discussed below.

5.2.1 Baseline Case

In our baseline case we price the new debt contracts such that they deliver the same net present value (NPV) as the SRP/IDRP contract. We take this NPV as the normal level of revenue that the lender, typically the federal government, requires to cover the costs of originating and administrating these loans. Therefore, we impose that the contracts must generate the same level of revenue. Under this assumption, we compute the equilibrium loan rates for each new contract using the following fixed point algorithm:

(i) Compute the implied average NPV on those loans ($NPV^{Baseline}$) by simulating the model under the SRP/IDRP plan, and discounting the cash-flows at the risk-free.

(ii) For each of the two new equilibria, i.e. with the PPD and with the FPD contracts, simulate the economy using the same premia as in the baseline economy (φ^{FPD})), and compute the implied NPV for the lender: $NPV^i(\varphi^{Baseline})$, for $i \in \{\text{PPD}, \text{FPD}\}$

(iii) If the resulting NPV ($NPV^i(\varphi^{Baseline})$) is lower (higher) than the target ($NPV^{Baseline}$), construct a sparse 10 point loan premia grid with higher (lower) loan premia.

(iv) Compute the NPV of the loans for each of the 10 new values for the loan premia and pick the premia that delivers the closest NPV to the target.

(v) Repeat (iii) and (iv) until convergence.

Table 7 shows the equilibrium loan premia for each of the 2 new contracts, PPD and FPD.

[INSERT TABLE 7 HERE]

For both policies under consideration the equilibrium premia is lower than under the baseline contract. This is because loans are outstanding for longer and, as a result, they accrue higher total interest payments. The reduction in interest-rates is more significant under the FPD contract because, under this scenario, during the deferral period the loan balances are increasing at a rate (the loan premium) that is higher that the discount rate. As a result of this premium, extending the maturity leads to a higher NPV. Therefore, the same NPV can be obtained with a lower loan interest rate.

The decreases in interest rate are economically large, ranging from 1.77% for the PPD contract to 2.00% for the FPD, but it is important to highlight that the welfare gains reported below are only partially driven by this re-pricing of the loans. In fact, if we fix the interest rate at the baseline level, the majority of the utility gains remains.

5.2.2 Alternative Cases

As discussed above, in our baseline calculations we assume that the lender has a target level of revenue that corresponds to the one obtained under the baseline contract ($NPV^{Baseline}$), and therefore all alternative contracts must deliver the same expected discounted cash-flow. However, there are three potential considerations that might imply a different assumption. We discuss these next.

First, there might be differences in cash-flow risk, and in particular default risk, in the economies with the different contracts. If the lender cannot fully diversify this risk, then we should not match NPVs discounted at the riskless rate. However, as we show below, the new contracts actually deliver lower default rates so, if we were to include a risk premium in the discount rate they would deliver a higher NPV than the baseline case. Therefore the fixed point algorithm would imply an even larger difference between the equilibrium loan rate for the new contracts and the baseline rate, leading to even larger welfare gains.

Second, under the new contracts the loans remain in existence for a longer period, and this might increase the administrative costs for the lender.

Third, since the loans are (on average) paid off over a longer period, the discount rate should increase to reflect an additional term premium.[16]

[16] It is important to note that, although a 10 year extension is significant, the maturity of the loans in the baseline contract is already between 10 (under the SRP) and 25 years (under the IDRP). So, with the 10 year

To take the last two considerations into account, we consider a case where the required NPV on the new contracts is 10% higher than the corresponding NPV in the baseline economy ($NPV^{Baseline}$).

Finally, we also report results for an extreme case where we keep the interest rate on the loans constant at baseline level ($r_f + \varphi^{Baseline}$). This will serve both as a maximum conservative assumption on the pricing of the new loans, and it will allow us to decompose the sources of the welfare gains.

5.3 Results

We now present the results in the two alternative economies: the one with the principal payment deferred (PPD) debt contracts (hereafter PPD-economy), and the one with the full payment deferred (FPD) debt contracts (hereafter FPD-economy). Under PPD the loan amortization schedule is shifted for $N_{PPD} = 10$ years. During those first 10 years households are only required to pay interest. In the FPD scheme agents defer both loan interest and principal payments for $N_{FPD} = 10$ years. During this period debt outstanding increases over time as the "missing" interest payments are being added.

Table 8 shows statistics conditional on agents having student debt outstanding, as in the previous sections. We present results for the full life-cycle, later on. To facilitate the comparison across the different scenarios, panel A shows the corresponding statistics for the baseline case. Panel B reports the results for the economy with PPD contracts while panel C presents the results for the economy with FPD contracts. Within each panel we report the average across all ages, and results for 3 different age groups that capture important stages of the life cycle in the different economies. The first group covers the ages 26-35, the period during which agents in the PPD and FPD economies enjoy the (partial) deferral of debt payments. In the second group, ages 36 to 40, agents are making substantial debt repayments in all economies. Finally, after age 40, most individuals in the Baseline economy have already repaid their student loans, but those in the PPD and FPD economies have not yet, due to the initial deferral period.

[INSERT TABLE 8 HERE]

deferral, this is now being extended to between 20 and 35 years. The term structure of interest rates at these very high maturities is relatively flat as shown in Augustin et al. (2021), for example.

5.3.1 Debt Repayments

Under the baseline economy most households have repaid their debt by age 41, as previously discussed. By contrast, under PPD and FPD contracts younger agents are spared from making (large) repayments, and therefore we have much larger fraction of the population with debt outstanding still after age 40. Usage of the IDRP option is much less common under the alternative contracts: it falls from 28.5% in the baseline case to 10.0% and 10.9%, in the PPD and FPD economies, respectively. This is due to the fact that when households are no longer required to make large debt payments early in life, when their income is still low. We saw in table 4 that, in the baseline economy, the IDRP option is mostly used by the 26-30 age group (46.2%), and much less after that. Under the alternative contracts those agents are enjoying the deferral period, and as such only have make either (much smaller) interest payments (PPD economy) or no debt payments at all (FPD). During the first 10 years of the life-cycle, under PPD debt contracts, agents are only making interest payments and therefore choose never o enroll on IDRP.[17]

5.3.2 Net Wealth

Since (the main) debt repayments in the PPD and FPD economies take place later life, they happen both when individuals have higher income and after they have had time to accumulate a more substantial level of wealth. Not only is wealth accumulation typically higher late in life but, since agents have not been forced to make (large) debt repayments early on, they were able to save more in the two alternative economies. As a result net wealth is substantially higher for age groups 36-40 and 41-65 under the PPD and FPD economies, even though debt outstanding is also higher (as expected since it is only being repaid now).

5.3.3 Default Rates

The combination of higher income and higher wealth when the principal repayments are due leads to substantial lower default rates with the alternative contracts: defaults fall by about $1/3$ in the PPD economy, and by about $1/2$ in the FPD economy. The large reductions in default rates represent important benefits, for both borrowers and lenders, from the two alternative contracts.[18]. These lower default rates also suggest that, the equilibrium loan

[17]Under FPD contracts they do not make any payments at all before age 35.

[18]We report explicit welfare gains later in the paper

premium on these contracts might even be lower than what we have assumed by imposing the same NPV as for the baseline contract.

5.3.4 Debt Outstanding

Under the baseline contract leverage falls quite rapidly early on as agents repaid their loans, and it increases again for the last age group (41-65) because of the previously-discussed sample selection: the few individuals who still have debt after age 40 are mostly those who have defaulted (or negatively amortized) in the past. By contrast, under the PPD contracts leverage will remain largely constant until age 35, only increasing slightly due to the occasional default events.[19]. After age 35, the repayments start and we observe a gradual reduction of the loan amount outstanding, until retirement. In the economy with FPD contracts leverage is actually increasing until age 35, as the accrued interest is being added to the principal.[20]. As a result the loan amount outstanding is still higher betwen ages 36-40, and only decreases after that.

As previously discussed, in the baseline economy, the average loan amounts for individuals with debt outstanding actually increase substantially for the age group 41-65. Interestingly, this does not happen in either the PPD or the FPD economies. Likewise, although the default rates for this age group increases in all 3 scenarios, they are 57% and 65% lower with PPD and FPD contracts, respectively. In these two economies we don't have the same strong selection as in the baseline case, where only agents with past defaults and/or low income reach age 41 with student debt still outstanding. For the same reason, in the alternative economies, we have a much smaller fraction of agents using IDRP contracts at this stage of the life-cycle.

5.3.5 Consumption

In both the PPD and FPD economies, agents have much higher average consumption while their student debt is outstanding: 23% and 32% higher consumption in the PPD and FPD economies, respectively. The qualitative pattern was expected since, earlier in the life-cycle they either make no payments at all (deferred payments) or make only interest payments (interest only). Also, since the loans extended for a longer period, the statistics for the PPD

[19]The principal payments are slightly negative, reflecting the few defaults that occur during this period.

[20]The principal payments are negative and equal, in absolute value, to the interest payments

and FPD economies are also capturing households later in life, when their income is on average higher. Even when we condition on age the differences in consumption remain very large, but we are only considering agents with positive student debt here. In the next section we provide a more direct comparison of the full consumption profiles in the different economies.

5.4 Welfare Analysis

5.4.1 Consumption Over the Life-cycle

The PPD and FPD contracts benefit individuals early in life by deferring (most of) their student debt repayments. Relative to the baseline contract this will allow them to increase consumption early in life, but should be reflected in lower consumption late in life when debt is finally being amortized. In the previous section we reported statistics for households with positive debt balances only, in this section we track all households through their life-cycle to capture this important trade-off. More precisely table 9 reports consumption, net wealth and debt outstanding over the life cycle, without conditioning on positive debt balances.

[INSERT TABLE 9 HERE]

Table 9 confirms that, under the PPD and FPD contracts households are better able to smooth consumption over the life-cycle by increasing it early in life at expense of lower consumption late in life. The gains early in life are quite substantial, under both alternative contracts. There is 6.1% (4.2%) increase in average consumption at ages 26-30 under the FPD (PPD) debt contract. For the age group 31-35 these gains are again quite sizeable: 2.2% and 1.5%. By comparison, the reductions in average consumption later in life are much smaller. From age 36 to age 65 the differences in consumption relative to the baseline case are between 0.2% and 1.0% under the PPD contracts, and between 0.4% and 1.2% with the FPD contracts. Crucially, these decreases in consumption late life are less important in marginal utility terms since average consumption is now much higher than it was before age 35.

Differences in wealth accumulation for retirement are also quite small. Relative to the baseline economy, average wealth in the 61-65 age group we see that, is only 1.7% lower wealth in the PPD. economy, and only 2.6% lower in the FPD economy. The implied differences in consumption at retirement are even smaller, 0.04% and 0.06% lower respectively, since it is also being financed by the social security payments.

In addition to ignoring the differences in marginal utility of consumption at different ages, these comparisons also ignore risk. By reducing (or even eliminating) debt payments early in life, the PPD and FPD contracts allow agents to better smooth income shocks, exactly at the stage of their life cycle during which they are more vulnerable to such shocks, since they haven't yet had the opportunity to build a significant buffer stock of wealth. In the next section we explicitly take these into account by measuring the certainty equivalents associated with each debt contract.

5.4.2 Welfare Gains

As shown in table 9, the PPD and FPD contracts allow agents to increase consumption early in life, when marginal utility is highest, at expense of lower consumption late in life, when marginal utility is lower. In addition, they allow for better consumption smooth against income shocks, since younger agents have less wealth and are therefore more vulnerable to those shocks.

In this section we formal quantify the utility gains of the alternative debt contracts by measuring the certainty equivalent consumption level associated with each of them and comparing with the certainty equivalent consumption level obtained under the baseline economy. The corresponding percentage gains are reported in table 10. To shed light on the source of the welfare gains, we report results both with the contracts priced under the equilibrium loan premium in each economy (see table 7), and with the loan premium fixed at the value in the baseline economy. Furthermore, we also report welfare gains resulting from a simple 10-year maturity extension of the existing contract.

[INSERT TABLE 10 HERE]

The welfare gains from the proposed contract modifications are economically large. The certainty equivalent consumption gain from moving to an economy with PPD debt contracts is 0.62% per year. The gain from moving to an economy with FPD contracts is even larger 1.78% per year. For comparison, these values are similar to the welfare gains obtained for stock market participation in the context of similar life-cycle models (see Cocco et al. (2005)).

As shown in table 7, the PPD and FPD economies are characterized by lower interest rate premia on student loans. It is therefore important to understand how much of the welfare gains result from having these lower interest rates versus the deferral of repayments. To answer this question, the first column of table 10 reports welfare gains for households in a counterfactual economy where the interest rate is kept at the (higher) baseline value.[21]

Without the interest rate reduction, the gains in the PPD economy are smaller: 0.63% versus 1.35%. On the other hand, the welfare gains from switching to FPD contracts are barely affected: 1.96% versus 2.35%. These results highlight the importance of shifting debt repayments from the early stage of life-cycle to later in life, when agents have higher income and have accumulated more wealth. Under the FPD contracts all payments are deferred. As a result the total welfare gains are 3 times larger, and the reduction in loan interest rate is largely irrelevant. With the PPD contracts the total gains are still sizeable but, since the agent is still making interest payments early in life, the reduction in the loan interest rate plays a much more important role.

Finally, we can also compare the welfare gains of the PPD and FPD contracts, to those obtained when extended the contract maturity by 10-years but keep all other features unchanged.[22] This maturity extension allows individuals to delay full debt repayments until 35 years later, as in our proposed modifications. However, repayment of both principal and interest start in year 1 as under the current contract. As we can see in Table 10, although extending the maturity of the loans is welfare improving, the gains are only 51% (29%) of those obtained under the PPD (FPD). If wish to replicate the certainty equivalent gains of those two contracts, we would have to provide individuals with a much more substantial maturity extension.

5.5 Robustness

In this section we show that our conclusions, regarding the welfare gains from the PPD and FPD contracts, are robust to alternative assumptions about the required NPV of the lenders or the preference parameters of the borrowers. We also show that the gains are larger if we augment the model to include an endogenous stock market participation decision.

[21]The higher interest rate in this counterfactual economy is reflected in larger profits for lenders, which is why we emphasize that we are now comparing household welfare only.

[22]We also re-price these loans, and the corresponding equilibrium interest rate 2.02%.

5.5.1 Relaxing the NPV Assumptions

In our previous analysis we computed the equilibrium loan premium for each proposed modification (φ^{PPD}) and (φ^{FPD}), by imposing the condition that the NPV of the loan remains the same as under the original contract formulation ($NPV^{Baseline}$). However, as discussed in section 5.2.2, it is possible that, the new debt contracts might be associated a different equilibrium NPV.

The positive NPV on the loans is presumably compensation for the costs associated with the loan provision and subsequent maintenance.[23] The costs of loan origination should remain unchanged, but the maintenance costs might increase given that we are extending the duration of loan. in addition it is possible that lenders might require a higher term premium as compensation for higher loan maturity. Both of these arguments would suggest higher NPV requirements for the PPD and FPD loans, hence a higher loan premia. On the other hand, as shown in section 5.3, the new contracts are associated with significantly lower default rates implied by the new contracts. This in turn would imply lower equilibrium loan premia.

As a conservative robustness exercise, we consider the case in which the impact of the increased costs dominates the reduction in risk and therefore lenders require a higher NPV to originate the loans. More precisely we assume that the new NPV must be 10% higher than the one in the baseline economy. With this assumption we recompute the calculation of the equilibrium loan premium for the PPD and FPD economies using the algorithm described in 5.2.1 but, with the target in step iii) now set at $1.1 * NPV^{Baseline}$. Panel A from table 11 reports the corresponding endogenous loan premia in each of the two economies.

[INSERT TABLE 11 HERE]

With the new equilibrium loan premia, we can again study the outcomes in the corresponding PPD and FPD economies. In particular, we are interested in the corresponding welfare gains, which we report in panel B of table 11. As before we can decompose the welfare gains in two sources: (i) a welfare gain coming from the deferral of of payments and (ii) a welfare gain coming from the endogenous change in interest rate.

Compared to the values reported in table 10 the overall welfare gains are naturally smaller, but the differences are minimal. For the PPD contract the yearly certainty equivalent con-

[23]Could also result from market power, if these are provided by private lenders and not the Federal Government.

sumption gain falls from 1.35% to 1.30%. For the FPD contract the welfare gain falls slightly less from 2.36% to 2.33%. This is consistent the previous result showing that the welfare gains of this contract are almost exclusively due to the deferral of payments, rather than the reduction in loan interest rate.

5.5.2 Alternative Preference Parameters

We have shown that the welfare gains from introducing the new contracts are largely driven by the ability to shift payments over the life-cycle. Therefore, these gains should vary across agents with different discount factors, or different elasticities of intertemporal substitution. Table 12 shows the welfare gains for different values of those two parameters.

[INSERT TABLE 12 HERE]

In all cases that we consider, the welfare gains from both the PPD, and especially the FPD contracts, remain economically large.

Compared to the baseline calibration, the welfare gains of the policies increase (decrease) when households are more (less) impatient, i.e. when they have a lower (higher) subjective discount factor. More impatient households value consumption today relatively more than consumption tomorrow. Therefore, policies such as the PPD and the FPD that allow them to have higher consumption earlier in the life-cycle bring larger welfare gains.

When agents have lower EIS they are less willing to substitute consumption across time, so policies in this scenario have higher welfare gains compared to the baseline. In contrast, with a higher EIS, households are happier with having lower consumption today (and lower utility) to guarantee a higher consumption tomorrow. In this scenario policies that allow agents to defer consumption are less beneficial.

5.5.3 Different levels of student debt

Even though we do not model the households' endogenous education choice, our model can still help in understanding the effects of our policies for different values of the loan-to-income ratio. These different initial values of wealth proxy for households' different major choices, different lifetime earnings, or differential levels of financial help from their families. This analysis therefore serves two purposes. First it documents which groups of households will benefit more/less from these alternative contracts. Second, it show robustness of the welfare gains in a scenario where households might change their initial level of debt in response to the introduction of such contracts.

We solve our model for different levels of initial debt, while keeping all other parameters unchanged. In particular, we solve the model for a 25% lower and a 25% higher initial level of debt. Table 13 reports the welfare gains of the two policies we consider (PPD and FPD) for the different levels of initial debt. The welfare gains are monotonically increasing with the initial level of debt. Households with higher initial balances have greater benefits from having the option of deferring principal payments or all the payments whereas households with lower initial balances have the lowest. Therefore these type of policies are particularly helpful for students with no financial help from their family who are likely to have higher balances and students who enroll in majors with lower lifetime earnings and thus start their working life with higher loan to income ratios.

Furthermore the gains remain economically large in all cases, ranging from 1.13% to 1.44% for the PPD and from 1.83% to 2.64% for the FPD. This confirms that, even if household's respond to these policies by taking on different initial levels of debt, they will still benefit substantially from their introduction.

5.5.4 Stock Market Participation

High student debt payments early on the life-cycle of agents may delay some important decisions such as the decision of buying a house or enter the stock market. In the section we extend the model to consider an endogenous stock market participation decision. As in Gomes and Michaelides (2008) we assume that households must pay an entry cost to invest in stocks for the first time. Following their calibration we set the cost to 5% of average annual income.

To avoid introducing one additional choice variable in the model we abstract from the optimal portfolio choice, and endow agents with a $60\%/40\%$ stock/bond portfolio throughout their working life. Naturally if we allowed agents to choose their optimal portfolio every year the benefits from stock market participation would be even larger. [24].

The risky asset has a gross return r_t^{stock}, and its excess return is given by:

$$r_{t+1}^{stock} - r_f = \mu^{stock} + \sigma^{stock}\epsilon_{t+1} \tag{25}$$

[24]During retirement we assume agents only hold bonds. This is also a conservative assumption since it reduces the benefits of stock market participation.

where r_f is the risk-free rate, μ^{stock} is the excess average stock market return, that we calibrate to be 6%, σ^{stock} is the volatility of the stock market return, that we calibrate to be 15.7% and ϵ_{t+1} is the period $t+1$ innovation to excess returns, which we assume to be independently and identically distributed (i.i.d.) over time, and distributed as $N(0,1)$.

Table 14 reports the results. Under the PPD/FPD contracts households start participating in the stock market almost a year earlier. Their lower commitments to debt repayments allow them to accumulate more wealth early in life, and therefore pay the entry cost sooner. They also enter the stock market at higher levels of leverage and lower levels of income and net wealth. Finally, the welfare gains when we allow for stock market participation are even higher than on the base model. The PPD contract yields a welfare gain of 1.65% (vs 1.35% under the base model) and the FPD policy contract provides a welfare gain of 2.36% (vs 2.71% under the base model).

5.5.5 The current Biden Administration's Proposal

Our model setup can also help us understand the welfare benefits of the current U.S. government proposals for student loan repayment plans. In January 2023 the Biden administration proposed to change student loan plans allowing borrowers to make lower payments and have remaining loans forgiven sooner than under current plans. Two main changes are being proposed by the current administration: (i) change the time to forgiveness of loans from 25 years to 10 years and (ii) change the proportion of discretionary income that defines the minimum IDRP payment from 10% to 5% and discretionary income above which payments need to be made from 100% of the federal poverty level to 225%.

We analyze each of these proposed changes one at time, which allows us to understand the welfare benefits of each proposal when we keep the federal government budget unchanged (i.e. we reprice the loans such that they deliver the same NPVs).

The first change proposed by the federal government is to decrease the number of years to forgiveness from 25 to 10 years. This means that after 10 years households that still have outstanding student debt can have it discharged a no cost. This change has a significant cost on the profitability of the loans and thus the interest rate on student loans would have to increase to 9.7% to ensure that the loans have the same profitability. Overall, such a policy would have a welfare gain of 0.31%, so much lower than the welfare gains of our proposed policies PPD and FPD which have welfare gains of 1.35% and 2.36% respectively.

The second proposal changes the minimum payments that have to be made under an

IDRP significantly. This proposal is much closer to our proposed PPD and FPD. After repricing the loans, this proposal yields a welfare gain of 1.94% which lies between the welfare gains of our PPD and FPD proposals.

6 Conclusions

We build a quantitative life-cycle model of consumption and saving to study the impact of student debt repayment plans. We calibrate the model to generate behavior consistent with observed patterns on enrolment in the standard and income-driven repayment plans that are currently offered. We consider two modifications to each plan. The first, "Principal Payment Deferral" (PPD), defers principal payments for 10 years. The second, "Full Payment Deferral" (FPD), defers all payments for 10 years; during this time, the deferred interest is added to the principal.

These alternative plans lead to significant welfare gains of 1.30% in yearly certainty equivalent consumption for PPD contracts and 2.33% for FPD contracts. The gains come primarily from postponing payments early in the life-cycle, when margin utility is high, to later in the life-cycle, when the household has had the opportunity to accumulate wealth. Under the current plans, households make large payments early in life instead of accumulating wealth. Not only does this reduce consumption in each period, but it also reduces households' wealth accumulation and ability to smooth consumption across periods.

The welfare gains in our analysis likely understate the true gains since we abstract from job search and other financial decisions such as housing and family planning. Since student debt is difficult to renegotiate and is essentially nondischargeable in bankruptcy, student debt repayments crowd out these other financial decisions. Future work that better studies the adjustment along these additional dimensions will reveal the true benefits of the policies we propose.

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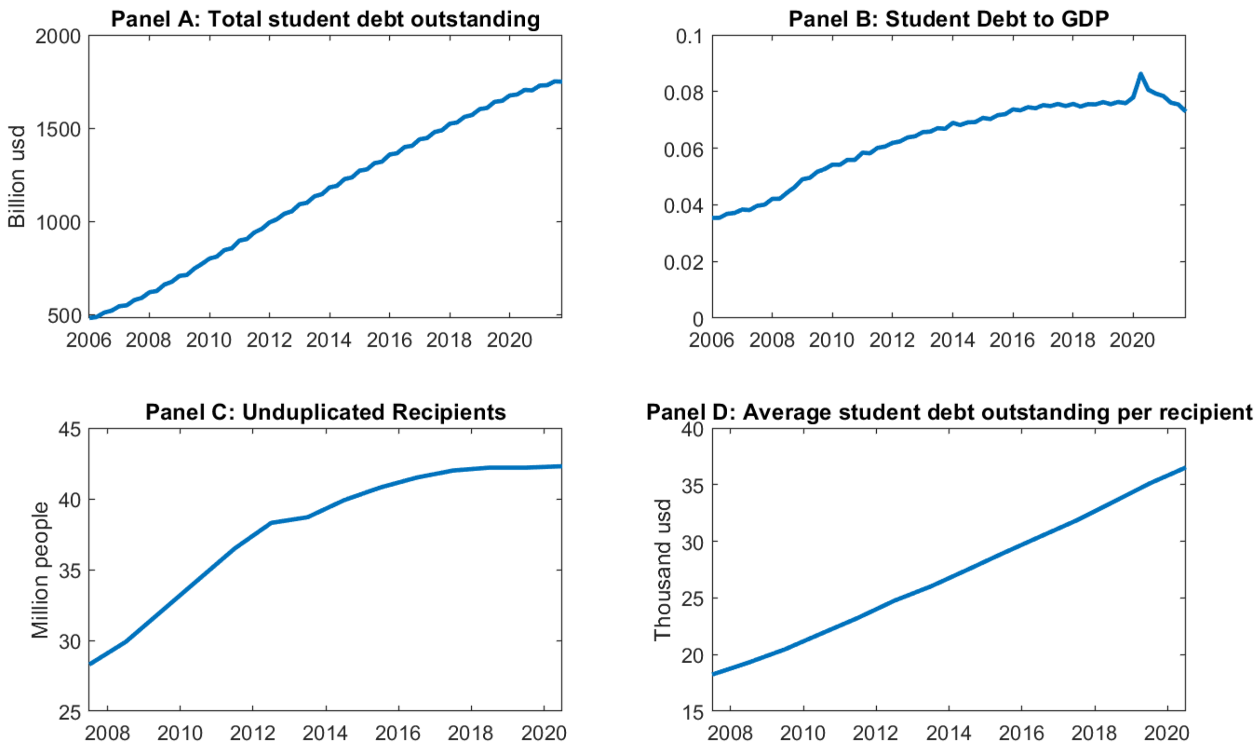
A Figures

Figure 1: Student debt

Panel A shows the total student debt outstanding in the US between Q1 2006 and Q4 2021. Panel B plots the ratio of student debt outstanding to nominal GDP. The Student Debt Data and GDP data are from the Federal Reserve Economic Data (FRED). Panel C plots the number of people with student debt outstanding and Panel D reports the average outstanding balance per recipient. The data comes from the Office of Federal Student Aid (FSA).



B Tables

Table 1: Income Process Parameters

This table shows parameters governing the income process detailed in Section **??**. Panel (a) contains parameters for the deterministic components of income: the household fixed effect, the lifecycle age profile, and the retirement replacement rate. Panel (b) contains parameters for the unemployment shock, such as the replacement rate. Panels (c) and (d) contain parameters for the persistent and transitory shocks, respectively. The income process and parameters follow closely Guvenen et al. (2021) for the working life and Cocco et al. (2005) during retirement. Over the working life, the variance of the persistent income process is scaled down to match that in Cocco et al. (2005).

(a) Deterministic Type & Lifecycle Components

Parameter	Value
α_i	0.99
a_0	-2.0317
a_1	0.3194
a_2	$-0.0577/10$
a_3	$-0.0033/100$
ω	0.94

(b) Unemployment Shock

Parameter	Value
λ	0.52
a_ν	-2.495
b_ν	-1.037
c_ν	-5.051
d_ν	-1.087

(c) Persistent Process

Parameter	Value
ρ	0.991
p_z	0.176
$\mu_{\eta,1}$	-0.524
$\sigma_{\eta,1}$	0.113
$\sigma_{\eta,2}$	0.046
κ_η	0.470

(d) Transitory Shock

Parameter	Value
p_ϵ	0.044
$\mu_{\epsilon,1}$	0.134
$\sigma_{\epsilon,1}$	0.762
$\sigma_{\epsilon,2}$	0.055

Table 2: Student Debt calibration

This table shows parameters related to student debt. The student debt premium over the risk free rate is taken directly from the Survey of Consumer Finances (SCF), while the delinquency utility penalty is calibrated to match the delinquency property in the SCF. The student debt maturity is chosen to reflect the actual lengths in the US for the standard and income-driven repayment plans. The interest only and deferred payment periods are the alternative policies studied in Section **??**.

Parameter	Value	Source/Target
Student debt premium ($\varphi^{Baseline}$)	0.035	Average SCF loan premium
Delinquency utility penalty (ξ^{D})	0.0059	Match delinquency probability SCF (16%)
Cost of enrolling in IDRP (ξ^{IDRP})	0.0000	Match proportion of IDRP from SCF (31%)
Student debt maturity (N_{SRP} and N_{IDRP})	10 if standard 25 if IDRP	

Table 3: Model and Data

Panel A from this table shows model moments. The first row shows the proportion of agents that are making payments under SRP (first column), under IDRP (second column) or not making payments (last column). The second rows show average loan balances, average income, debt to income and net wealth. Panel B from the table shows the data counterparts. The data is from SCF (sidenote: debt-2-income on the bottom panel is student debt to income, net wealth is the overall net wealth of the household as per SCF definition).

Model

	SRP	IDRP	Default
Fraction of Households	0.555	0.285	0.160
Median Loan Balance	14.626	26.855	32.604
Median Income	81.135	45.821	17.869
Median Debt-to-Income Ratio	0.172	0.580	1.859
Median Net wealth	7.473	-17.015	-29.453

Data - SCF 2019

	SRP	IDRP	Default
Fraction of households	0.507	0.313	0.180
Median Loan Balance	14.000	22.000	24.000
Median Income	76.359	55.996	30.544
Median Debt-to-Income Ratio	0.179	0.426	0.655
Median Net Wealth	10.480	-3.790	-10.470

Table 4: Standard Repayment plan vs Income driven repayment plan during the life-cycle

This table shows average income, income growth, consumption, consumption growth, probability of being enrolled in SRP/IDRP/Default, average debt outstanding, average debt payments, average net wealth and average debt payments to income for households during their working age over the life-cycle. Panel A report the statistics when agents choose a standard repayment plan, panel B report the same when agents choose an income driven repayment plan and the last panel when agents default. All statistics are conditional on the agent having debt outstanding (with the exception of the second line of the table). On the second line we report the probability that agents choose SRP, enroll in IDRP or default conditional on having debt outstanding at age 25.

	Panel A: Choosing keep on SRP				Panel B: Choosing to enroll on IDRP				Panel C: Choosing to default			
	26-30	31-35	36-40	41-65	26-30	31-35	36-40	41-65	26-30	31-35	36-40	41-65
Probability	0.431	0.654	0.693	0.316	0.462	0.236	0.136	0.240	0.107	0.109	0.171	0.444
Probability (as a fraction of age 25)	0.431	0.654	0.372	0.020	0.462	0.236	0.073	0.015	0.107	0.109	0.092	0.027
Income	75.476	96.288	92.928	80.958	44.441	46.990	42.068	41.270	17.395	19.522	20.966	20.890
Income growth	0.134	0.080	0.049	0.063	0.118	0.030	0.011	-0.008	-0.313	-0.063	0.005	0.005
Consumption	44.742	55.824	52.775	43.955	25.275	26.508	23.770	24.015	13.874	14.010	14.408	14.102
Consumption growth	0.123	0.077	0.049	0.068	0.056	0.016	0.004	-0.005	-0.172	-0.028	0.009	0.005
Leverage outstanding	25.285	14.298	6.868	17.027	27.805	21.951	19.996	32.147	29.311	30.583	34.365	44.288
Net wealth	-16.079	13.064	39.738	55.048	-19.385	-7.993	3.952	9.281	-28.061	-28.087	-29.738	-35.146
Total payments	3.697	3.697	3.135	3.285	2.900	3.205	3.202	2.925	0.000	0.000	0.000	0.000
Principal payments	2.560	3.054	2.826	2.518	1.649	2.217	2.302	1.478	-1.319	-1.376	-1.546	-1.993
Interest payments	1.138	0.643	0.309	0.766	1.251	0.988	0.900	1.447	1.319	1.376	1.546	1.993
Debt payments to debt outstanding	0.148	0.294	0.745	0.461	0.106	0.158	0.208	0.179	0.000	0.000	0.000	0.000
Debt payments to income	0.052	0.044	0.043	0.047	0.068	0.074	0.087	0.081	0.000	0.000	0.000	0.000

Table 5: Determinants of debt repayments

This table shows the determinants of debt repayments. The two left columns show agent's choices that lead to positive amortization of debt (either payments under SRP or IDRP) whereas the two right columns show agent's choices that lead to negative amortization (either IDRP or default). The first row shows the probability. The second and third rows show debt-to-income and debt payments to income. The fourth, fifth and sixth row shows age, income and net wealth respectively. The last four rows show principal and interest payments (realized and counterfactual payments under a SRP).

	Positive Amortization ($\Delta S_{t+1} > 0$)		Negative Amortization ($\Delta S_{t+1} < 0$)	
	SRP	IDRP	IDRP	Default
Probability	0.555	0.276	0.009	0.160
Debt-to-income	0.204	0.651	2.093	2.067
Debt payments to income	0.046	0.074	0.051	0.000
Principal payment	2.845	1.952	-0.558	-1.601
Interest payment	0.683	1.144	1.468	1.601
Comparable Principal payment under SRP	2.843	3.762	2.230	2.096
Comparable Interest payment under SRP	0.683	1.144	1.468	1.601

Table 6: Persistence in debt repayment decisions

This table shows the persistence in agent's debt repayment choices. The columns of the table show the probability of agents choosing SRP, IDRP or default at time $t+1$ conditional on what they chose at time t (rows). Therefore each row of the table sums up to one.

Transition probabilities

	SRP_{t+1}	IDRP_{t+1}	Default_{t+1}
SRP_t	0.940	0.054	0.007
IDRP_t	0.278	0.618	0.105
Default_t	0.018	0.220	0.762

Table 7: Loan Premia

This table reports the endogenous loan premia for each student debt repayment plan under consideration. We calibrate the loan premia on the SRP/IDRP to the average student loan interest rate in the data. The loan premia on the other two contracts (PPD and FDP) are set to equalize average student loan NPVs across all plans. We give details of the fixed point iteration price in section 5.2. The bottom row reports the difference in the interest rate obtained for each loan modification (interest-only or deferred) relative to the same basecase (SRP/IDRP)

.

	Baseline (SRP/IDRP)	PPD	FPD
Loan Premia	3.50%	1.73%	1.50%
Difference		-1.77%	-2.00%

Table 8: Debt repayment, wealth, income and consumption in the 3 different economies

This table shows average probabilty of agents being enrolled in SRP/IDRP/Default conditional on having debt outstanding (first three rows) and conditional on taking a loan at age 25 (fourth to sixth rows), income, consumption, average debt outstanding, average net wealth, average debt payments, average debt payments to debt outstanding and average debt payments to income for households during their working age over the life-cycle. Panel A shows the statistics for the baseline case and Panels B and C for the two student debt restructuring policies under analysis PPD and FPD, respectively. For the first 10 years of the life-cycle agents only make interest payments under the PPD policy (Panel B) or defer payments for 10 years under a FPD policy (Panel C).

	Panel A: Baseline				Panel B: PPD				Panel C: FPD			
	Overall	26-35	36-40	41-65	Overall	26-35	36-40	41-65	Overall	26-35	36-40	41-65
Pct of agents on SRP	0.555	0.555	0.693	0.316	0.798	0.962	0.752	0.621	0.807	1.000	0.752	0.660
Pct of agents on IDRP	0.285	0.337	0.136	0.240	0.100	0.000	0.156	0.188	0.109	0.000	0.150	0.187
Pct of agents default	0.160	0.109	0.171	0.444	0.102	0.038	0.092	0.191	0.084	0.000	0.098	0.152
Pct of agents on SRP (fraction of age 25)	0.188	0.555	0.372	0.020	0.430	0.962	0.752	0.174	0.495	1.000	0.752	0.262
Pct of agents on IDRP (fraction of age 25)	0.097	0.337	0.073	0.015	0.054	0.000	0.156	0.053	0.067	0.000	0.150	0.074
Pct of agents default (fraction of age 25)	0.054	0.109	0.092	0.027	0.055	0.038	0.092	0.054	0.051	0.000	0.098	0.060
Income	65.597	66.759	73.706	44.769	81.130	66.759	96.431	88.677	85.560	66.759	96.431	97.141
Consumption	38.160	39.040	42.269	25.918	47.407	40.080	54.738	51.591	50.416	40.533	54.673	57.239
Leverage outstanding	21.425	21.885	13.352	32.756	24.233	29.379	24.987	17.078	27.155	32.356	32.290	19.846
Net wealth	0.786	-6.403	22.997	4.031	33.100	-9.877	44.280	80.363	46.455	-12.159	39.725	103.038
Payments	2.819	3.068	2.609	1.741	1.898	0.771	3.026	2.539	1.723	0.000	2.976	2.655
Principal payments	1.855	2.083	2.008	0.267	1.235	-0.032	2.343	2.073	1.045	-0.808	2.170	2.160
Interest payments	0.964	0.985	0.601	1.474	0.662	0.803	0.683	0.467	0.678	0.808	0.806	0.495
Debt payments to debt outstanding	0.254	0.178	0.545	0.189	0.156	0.026	0.128	0.344	0.137	0.000	0.095	0.282
Debt payments to income	0.046	0.050	0.041	0.034	0.028	0.015	0.039	0.036	0.023	0.000	0.038	0.036

Table 9: Consumption, Net wealth and Debt outstanding over the life cycle

This table shows average average consumption, net wealth and debt outstanding over the life-cycle. The first three columns show the statistics for the baseline case, the middle three columns for the PPD policy and the last three columns for the FPD policy.

	Baseline			Principal Payment Deferral (PPD)			Full Payment Deferral (FPD)		
Age	Cons.	Net wealth	Debt outs.	Cons.	Net wealth	Debt outs.	Cons.	Net wealth	Debt outs.
26-30	31.343	-19.562	27.305	32.680	-20.825	29.241	33.267	-21.848	30.097
31-35	44.327	3.590	17.887	44.997	-1.539	29.441	45.321	-4.720	33.943
36-40	55.238	53.164	7.174	54.738	44.280	24.987	54.673	39.725	32.290
41-45	63.954	119.532	4.748	63.429	111.090	12.542	63.200	106.886	20.853
46-50	71.046	180.190	4.476	70.663	176.310	3.856	70.430	170.832	8.490
51-55	77.379	214.845	0.920	77.064	209.111	3.475	76.871	205.894	4.728
56-60	84.736	200.817	0.000	84.449	195.073	3.369	84.285	192.576	4.425
61-65	94.004	123.664	0.000	93.742	121.520	0.672	93.594	120.466	0.869
>66	75.793	3.986	0.000	75.764	3.931	0.000	75.748	3.899	0.000
Entire life-cycle average	70.172	60.276	4.167	70.141	57.502	7.172	70.125	55.807	9.046

Table 10: Welfare gains decomposition

This table reports the welfare gains of the two policies under analysis (PPD and FPD) relative to the baseline case (with the baseline loan premium, $\varphi^{Baseline} = 3.5\%$) as well as the welfare gains of a contract with the same features as the baseline contract but with longer maturity (LM). The different columns report results for different values of the loan premium in the PPD, FPD and LM economies. In column 2 the loan premium is set the at the value obtained in the baseline economy ($\varphi^{Baseline}$), while columns 3, 4 and 5 report results with the equilibrium loan premium of the PPD, FPD and LM economies respectively.

Loan Premium (φ)	$\varphi^{Baseline}$	φ^{PPD}	φ^{FPD}	φ^{LM}
Principal Payment Deferral (PPD)	0.63%	**1.35%**		
Full Payment Deferral (FPD)	1.96%		**2.36%**	
Longer Maturity (LM)	0.26%			**0.63%**

Table 11: Loan premia and welfare gains

This table reports loan premia and welfare gains for the two policies under consideration (PPD and FPD) when we require that average loan NPVs are 10% higher than in the baseline. Panel A reports the endogenous loan premia for each student debt repayment plan under consideration. Panel B reports the welfare gains.

Panel A: Loan premia			
	Baseline	PPD	FPD
Loan Premia	3.50%	1.87%	1.59%
Difference		-1.63%	-1.91%

Panel B: Welfare gains			
Loan Premium (φ)	$\varphi^{Baseline}$	φ^{PPD}	φ^{FPD}
PPD	0.63%	**1.30%**	
FPD	1.96%		**2.33%**

Table 12: Welfare gains: different preference parameters

This table reports welfare gains for the two policies under consideration Principal Payment Deferral (PPD) and Full Payment Deferral (FPD) for different preference parameters. The first column shows the welfare gains for our baseline calibration. The second and third column show the welfare gains for a lower and higher subjective discount factor, respectively. The last two columns show the welfare gains for a lower and higher elasticity of intertemporal substitution.

	Baseline	Lower Beta $\beta = 0.93$	Higher Beta $\beta = 0.97$	Lower EIS $\psi = 0.45$	Higher EIS $\psi = 0.55$
PPD	1.35%	1.85%	0.88%	1.48%	1.21%
FPD	2.36%	3.14%	1.59%	2.59%	2.06%

Table 13: Welfare gains - different initial levels of debt

This table report welfare gains of the PPD and FPD policies when households take lower and higher levels of debt. In particular, under the lower debt scenario (second row) households start their working life with 25% lower debt whereas under the higher debt scenario (last row) households start their working life with 25% higher debt.

	PPD	FPD
Baseline	1.35%	2.33%
Lower debt	1.13%	1.83%
Higher debt	1.44%	2.64%

Table 14: Welfare gains with stock market participation decision

This table report moments of the model when agents can endogenously decide to participate in the stock market. The first row of this table reports the welfare gain. The bottom four rows report age, debt outstanding, income and net wealth on the period agents decide to enter the stock market.

	Baseline	PPD	FPD
Welfare gain	n/a	1.65%	2.71%
Decision to participate:			
Age	31.622	30.734	30.566
Debt outstanding	23.484	29.069	31.232
Income	78.651	72.659	71.689
Net wealth	-3.080	-9.559	-12.073