# Income-Driven Repayment Plans for Student Loans

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# Abstract

In February 2020, the Congressional Budget Office released a report on the budgetary effects of student loans repaid through income-driven plans. This paper provides additional information on the analysis the agency conducted on the characteristics of borrowers in those plans and the methods the agency used to project borrowers' earnings, repayment, and resulting forgiveness. The results show that income-driven repayment plans are heavily used by borrowers with large balances and low earnings. The typical borrower in income-driven repayment is negatively amortizing, and substantial forgiveness is projected for low-income borrowers in such plans. Overall, increased take-up of income-driven repayment and the negative amortization in those plans explain much of the decline in student loan repayment rates between 2008 and 2017.

# Contents

# I.    Introduction

In a February 2020 report, the Congressional Budget Office (CBO) estimated the budgetary costs of income-driven repayment plans for student loans.[1] Those budgetary estimates were informed by an analysis of the characteristics of borrowers in such plans and changes in enrollment and repayment over time. This paper enhances the transparency of CBO's work by offering details on that analysis and by providing a technical description of the empirical model the agency developed to forecast the earnings of borrowers in income-driven repayment plans. Because borrowers' payments in income-driven plans depend on their income, that empirical model is a key input into CBO's estimates of loan repayment and forgiveness in income-driven plans.

**Background**

The volume of outstanding student loans in the William D. Ford Federal Direct Loan Program grew considerably over the past decade as the number of borrowers and the amounts they borrowed increased. Enrollment in income-driven repayment plans, as opposed to fixed-payment plans, increased even more quickly. Both the share of borrowers and the share of loan volume in those plans increased rapidly between 2010 and 2017 as the plans became available to more borrowers and their terms became more favorable. In addition, during that period, the average rate at which borrowers repaid their loans slowed down. More recent cohorts of borrowers owe larger shares of their original loan balances at similar points in time after entering repayment than did older cohorts of borrowers.

Introduced as a way to make student loan repayment more manageable, income-driven repayment plans limit payments to a percentage of borrowers' income and allow for loan forgiveness after 20 or 25 years. The plans keep payments low for borrowers who earn little (or nothing) upon graduation, and they essentially insure borrowers against adverse labor market shocks by allowing required loan payments to drop if borrowers' earnings decline. Under the most popular income-driven plans, borrowers' student loan payments are 10 or 15 percent of their discretionary income, which is typically defined as income above 150 percent of the federal poverty guideline for a borrower's household size. Furthermore, most of the plans cap monthly payments at the amount borrowers would have paid, given their balance upon entering repayment, under a 10-year fixed-payment plan. The earnings and loan balances of borrowers in income-driven plans determine whether they will repay their loans in full or receive loan

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[1] Specifically, that report examined the budgetary costs of student loans disbursed between 2020 and 2029 and assessed several policy options that would change the availability of income-driven plans or parameters of those plans that determine borrowers' payment amounts. See CBO (2020). The estimates of budgetary costs in that report and the analysis presented in this paper do not account for changes to the nation's economic outlook and fiscal situation arising from the recent and rapidly evolving public health emergency related to the novel coronavirus.

forgiveness. Borrowers who have not paid off their loans by the end of the repayment period have their outstanding balance forgiven.

The effect of income-driven plans on overall loan repayment and the resulting cost of loans to the government is theoretically ambiguous. On the one hand, such plans typically require smaller payments and often allow for loan forgiveness at some point. Those factors would lead to fewer dollars collected. On the other hand, borrowers who make smaller payments accrue more unpaid interest, and the maturity of their loans increases. Those factors would lead to more dollars being collected. The net effect of those offsetting factors depends on how borrowers' post-graduation earnings relate to the size of their loans.

We use administrative data on a random sample of student borrowers from the National Student Loan Data System (NSLDS), the main administrative data source for federal student loan programs.[2] The use of the NSLDS allows us to construct nationally representative estimates of repayment patterns for borrowers from 1970 to the present day. We supplement those data with data from several other sources to develop an empirical model for imputing the lifetime earnings of borrowers in income-driven repayment plans, which allows us to project the overall repayment and forgiveness of loans repaid through those plans. The empirical model for imputing lifetime earnings builds upon the framework developed in the Congressional Budget Office Long-Term Model (CBOLT)—a model CBO uses to make long-term projections of the federal budget and economy and of the distribution of Social Security benefits and taxes.[3]

**Findings**
This paper focuses on three main findings:

- Income-driven plans are adversely selected: Borrowers who are most likely to enroll are those with large balances and low post-graduation earnings.

- The typical borrower in an income-driven repayment plan is negatively amortizing, which leads us to project substantial forgiveness for low-income borrowers in such plans.

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[2] The NSLDS is the Department of Education's central database for administering the federal student loan program.

[3] See CBO (2018).

■   Increased take-up of income-driven repayment and the negative amortization in those plans can account for almost all of the decline in student loan repayment rates over time.

**Adverse Selection.** Because the borrowers most likely to enroll in the plans have large loan balances and low earnings, they have smaller required payments than they would in a standard (10-year) fixed-payment plan. Among both graduate and undergraduate borrowers, there is a positive relationship between enrollment in an income-driven repayment plan and total borrowing and a negative relationship between enrollment in an income-driven plan and post-graduation earnings.[4]

**Negative Amortization and Loan Forgiveness.** Because most borrowers in income-driven repayment plans are not making payments large enough to cover accruing interest, they typically see their balance grow over time rather than being paid down. For example, the median balance of those who began repaying their loans in 2010 increased as a percentage of the original disbursement for eight years; by the end of 2017, over 75 percent of those borrowers owed more than they had originally borrowed. By contrast, the median balance among borrowers in fixed-payment plans decreased steadily.

Overall, as a result of negative amortization and slow repayment, borrowers who are currently in repayment are projected to receive considerable loan forgiveness. We estimate the value of expected forgiveness using an earnings projection model to forecast the future earnings of borrowers and the resulting repayment under income-driven repayment plans. For those who entered repayment between 2010 and 2017, total forgiven balances—expressed in present-value terms—are expected to average 5 percent of the total amount disbursed to undergraduate borrowers and 15 percent of the total amount disbursed to graduate borrowers. Moreover, forgiveness is concentrated among borrowers with large loan disbursements and low earnings. Among borrowers with the largest loan amounts and the lowest earnings, average forgiveness as a share of disbursed amounts is projected to be 17 percent for undergraduate borrowers and 36 percent for graduate borrowers. By contrast, among borrowers with the smallest loans and highest earnings, projected forgiveness is zero for both undergraduate and graduate borrowers.

**Repayment Rates.** Borrowers in the 2010–2017 repayment cohorts are also projected to make considerable payments toward their loans. The present value of their payments is expected to average 104 percent of the disbursed amount for undergraduate borrowers and 105 percent of the disbursed amount for graduate borrowers. However, overall repayment varies by type of

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[4] For the purposes of this analysis, undergraduate borrowers are defined as students who took out loans only for undergraduate studies. Graduate borrowers are defined as students who took out at least one loan for graduate studies and may also have borrowed at the undergraduate level.

repayment plan. For borrowers in income-driven repayment plans, average projected repayment is 101 percent of the disbursed amount for undergraduate borrowers and 97 percent of the disbursed amount for graduate borrowers. By contrast, for borrowers in fixed-payment plans, those rates are 105 and 113 percent, respectively.

Average repayment rates—measured as the ratio of a borrower's outstanding balance (at different points in time) to his or her balance upon entering repayment—have declined for student borrowers in more recent cohorts. Loan repayment is considerably slower for borrowers in income-driven plans than it is for borrowers in fixed-payment plans. Moreover, the increase in the share of borrowers using income-driven repayment plans can account for much of the decline in repayment rates over time for student borrowers overall.

**Relationship to Other Research**
The analysis and findings in this paper relate to several strands of academic literature. First, the paper relates to a body of literature in household finance on loan repayment and the consequences of default. A significant body of work has focused on the determinants of loan repayment—for example, Ronel et al. (2010), Ghent and Kudlyak (2011), and Guiso et al. (2013) studied the determinants of borrowers' default in the context of mortgage loans. Botsch et al. (2012) and Melzer (2017) explored the effect of mortgage debt overhang, documenting the decreased propensity to invest in a property that could be lost through default. More recent work has studied federal loan modification programs such as the Home Affordable Modification Program (Meyer et al., 2014; Agarwal et al., 2017) and found that they had large effects on alleviating default and increasing consumption. This paper studies an important alternative loan repayment option that sharply reduces the risk of default and does not exist under many private plans. Little work has focused on why such modifications do not arise in private contracts or why many private contracts do not have insurance provisions for borrowers. This paper fills that gap by providing details on an important and widely used federal loan modification program.

This study also relates to a literature on insurance in loan contracts. Previous work has studied the consumption smoothing versus insurance tradeoff inherent to bankruptcy protection. For example, Dobbie and Song (2015) found strong effects of bankruptcy on earnings, whereas Gross and Souleles (2002) showed that bankruptcy also affects consumption. Fay et al. (2002) and Guiso et al. (2013) examined the role of strategic behavior in bankruptcy. However, less empirical work has studied the provision of insurance directly through loan contracts or why that remains uncommon in private markets. This paper documents important selection patterns that are key to the functioning of markets (Rothschild and Stiglitz, 1976). We show that higher-cost borrowers—those with low earnings and large loan balances—are more likely to select income-driven repayment plans. The observed relationship between income and loan repayments also links to a growing literature on labor and finance by illuminating how loan repayment interacts with earnings and protection from shocks to earnings.

Finally, the paper links to a growing body of literature on student loans (reviewed by Avery and Turner, 2012; Bleemer et al., 2017; and Looney and Yannelis, 2019). Recent work has shown that, in the presence of strategic default behavior, incomplete insurance is optimal for borrowers investing in human capital (Gary-Bobo and Trannoy, 2015; Lochner and Monge-Naranjo, 2011). Ionescu (2011) and Chatterjee and Ionescu (2012) focused on the insurance value of bankruptcy protection in student loans, which they argued is significant. A handful of recent papers have focused on income-driven repayment. Mueller and Yannelis (2018) studied the insurance effect of income-driven repayment plans on loan default and found that such plans reduce default. Herbst (2018) studied the impact of income-driven repayment plans on credit outcomes and found that the plans increase consumption and liquidity. Mueller and Yannelis (2019) found that the complexity of applications for income-driven plans plays an important role in their take-up. This paper presents new facts about student loan repayment through income-driven plans in the United States and documents broad trends.

**Outline**
The remainder of this paper is organized as follows. Section II discusses the history and institutional details of income-driven repayment plans and the student loan market more broadly. Section III discusses the data. Section IV discusses borrowers' adverse selection into income-driven repayment plans. Section V presents recent trends in repayment rates and how they relate to income-driven repayment. Section VI shows how the take-up of income-driven repayment is expected to translate into loan forgiveness. Section VII concludes. Appendix A provides details on the empirical framework we use to model borrowers' post-graduation earnings. Appendix B contains some supplemental empirical results on repayment and forgiveness by borrowers' education level.

## II.    Income-Driven Repayment

Between 1965 and 2010, most student loans were issued by private lending institutions and guaranteed, or insured, by the federal government, but today, the federal government directly issues the vast majority of student loans. The volume of outstanding federal guaranteed and direct student loan debt has increased by 128 percent over the past 10 years. As of December 2018, outstanding federal student loan debt totaled $1.4 trillion.

There are three types of student loans: subsidized Stafford, unsubsidized Stafford, and PLUS. Subsidized Stafford loans are available only to undergraduate students with financial need and

do not accrue interest until payments are due (in other words, the government subsidizes the interest), whereas other loans begin to accrue interest after they are disbursed.[5]

Once borrowers begin repaying their loans, they are required to make payments each month. Borrowers may suspend their loan payments by requesting a deferment if, for example, they are enrolled in school, serving in the military, or experiencing economic hardship. If borrowers are not eligible for deferment, they may request forbearance, which also allows them to postpone or reduce their monthly payments, although interest still accrues. For borrowers with subsidized Stafford loans, interest accrual generally pauses during deferment.

Throughout the history of the student loan program, most borrowers entered 10-year fixed-payment plans, in which borrowers make fixed monthly payments under a schedule similar to that of a 10-year mortgage. Borrowers in fixed-payment plans who have larger balances can choose an extended term of repayment, up to 30 years. Borrowers can also select a graduated payment plan, under which payments are initially small and increase over time. If borrowers do not choose a repayment plan, they are enrolled automatically in the 10-year fixed-payment plan.

Income-driven repayment plans provide relief to borrowers by reducing their loan payments when they would be at higher risk of default or forgiving their balance if they have not fully repaid their loans by the end of the repayment term. Unlike fixed-payment plans, income-driven plans tie payments to borrowers' household income and allow for loan forgiveness. A number of income-driven repayment plans currently exist in the United States. The plans have slightly different parameters, as shown in Table 1, but all have the same basic features. Under these plans, borrowers pay between 10 and 20 percent of their discretionary income, which most plans define as income above 150 percent of the federal poverty guideline. Most borrowers today are in plans that were introduced after 2009, which allow for forgiveness after 20 to 25 years of qualifying payments. A qualifying payment is any monthly payment that is equal to or greater than the amount scheduled under the plan; for borrowers with no discretionary income, qualifying payments may be as low as $0.

Income-driven plans offer several advantages to borrowers. One advantage is that required payments are small if a borrower's income is low. Those smaller required payments can help borrowers avoid default—and, in turn, consequences such as garnished wages and barriers to future borrowing. Also, most plans limit required monthly payments to the amount borrowers

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[5] Unsubsidized Stafford loans are available to both undergraduate and graduate students irrespective of their financial need. PLUS loans are available to graduate students and the parents of undergraduate students. The various loans are also subject to different limits and have different interest rates. See CBO (2020) for details on the various types of student loans.

would owe under a 10-year fixed-payment plan, regardless of how much their income rises. Finally, because borrowers will have their outstanding debt forgiven as long as they make the required number of payments, some borrowers will not have to pay off the full principal or all of the interest that has accrued during the repayment period.

However, income-driven plans may also have disadvantages. Some borrowers may pay more interest over their repayment term than they would have in a fixed-payment plan, although borrowers can avoid accruing additional interest by paying more than their plan requires. Furthermore, borrowers who receive loan forgiveness may face a large tax liability if the forgiven balance is included in their taxable income.[6]

## III.  Data

Our main source for historical information on borrowers' loan balances and repayment plans is the NSLDS. That database contains detailed information on student borrowers compiled by schools and loan servicers, which are required to report new information within 30 to 120 days. That information includes borrowers' gender, age, school of attendance, loan disbursements, academic level, repayment history, and repayment plan, along with other borrower, loan, and school attributes. We analyze longitudinal data for a random 4 percent sample from that data set to track the same borrowers and loans over time.

To project the income of borrowers in income-driven repayment plans, we supplement the information from the NSLDS with data from several other sources. The information from those data sources is not merged directly to the individual records in the NSLDS. Rather, we use those sources to estimate statistical relationships on the basis of data on individual borrowers' characteristics that are present in the NSLDS and then use those model estimates to stochastically impute data that are not available in the NSLDS. Relationships between borrowers' demographic characteristics and their earnings, family size, and spouses' characteristics are estimated using data from the Current Population Survey. Changes in borrowers' marital status are modeled using data from the Survey of Income and Program Participation (SIPP). Student debt of borrowers' spouses is modeled using data from the Survey

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[6] In both fixed-payment and income-driven repayment plans, student loan interest is deductible in the tax year in which it is paid. In addition, borrowers in income-driven plans whose loans are forgiven have the unpaid balance included in their taxable income for that year (unless the loans are forgiven through the Public Service Loan Forgiveness program). For a discussion of the tax revenue implications of student loans, see CBO (2020).

of Consumer Finances. And finally, the relationship between the type of repayment plan and borrowers' earnings is modeled using imputed versions of tax records that had been matched to the NSLDS data.[7]

## IV.   Borrowers' Selection Into Income-Driven Plans

Borrowers have selected income-driven plans at higher rates as new and more generous plans have been introduced. Take-up has been higher for borrowers with large balances and low income, who receive greater benefits from the plans.

**Recent Trends in Enrollment and Repayment in Income-Driven Plans**

Both the number of borrowers and the volume of outstanding loans in the direct loan program grew considerably over the past decade. Enrollment in income-driven repayment plans, as opposed to fixed-payment plans, increased even more quickly. Both the share of borrowers and the share of loan volume in those plans increased steadily between 2010 and 2017 (see Figure 1) as the plans became available to more borrowers and their terms became more favorable. The growth began after the original income-based repayment (IBR) plan was introduced in 2009 and became particularly rapid after the Pay as You Earn (PAYE) plan was introduced in 2013.

Over the 2010–2017 period, the share of outstanding direct loan balances repaid through income-driven plans increased faster than the share of borrowers in those plans. For example, despite a marked increase in the number of borrowers repaying through income-driven plans—from 700,000 to 6.4 million—a clear minority of borrowers were in such plans in 2017 (the share increased from 10 to 27 percent; see Figure 1). By contrast, nearly half the volume of direct loan balances was being repaid through those plans. Loan balances in income-driven repayment increased from $24 billion to $384 billion, or from 12 percent to 45 percent. That increase was bigger for graduate loans than for undergraduate loans (see Table 2). Between 2010 and 2017, the share of outstanding undergraduate debt in income-driven repayment increased from 14 percent to 34 percent, whereas that of graduate debt increased from 10 percent to 56 percent.

The larger increase in the share of debt than the share of borrowers in income-driven plans reflects the fact that borrowers with large balances are more likely to enroll in those plans. One reason is that graduate borrowers, who have higher loan limits and tend to take out larger loans

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[7] The Department of Education provided CBO with information on a sample of borrowers from the NSLDS and their imputed tax-return information for 1996 through 2013. The imputed information was based on imputations of borrowers' income provided by the Department of the Treasury. We did not use the data to directly project borrowers' earnings over time. Instead, we used the data to model the relationship between borrowers' income and income-driven repayment. For a more detailed discussion of the Treasury data, see Appendix III in Government Accountability Office (2016).

than undergraduate borrowers, have enrolled in income-driven repayment plans at higher rates (see Figures B1 and B2 in Appendix B). Further, because recent loans to graduate students have had higher interest rates than loans to undergraduate students, graduate borrowers making small payments have accrued interest at a faster rate. Another reason balances are larger for borrowers in income-driven repayment plans is simply that many borrowers are not paying down their loans. Because of low income, many borrowers in such plans make payments that do not cover accrued interest. Those borrowers see their loans negatively amortize. We explore the prevalence of negative amortization in these plans further in section V.

**Selection of Borrowers Into Income-Driven Repayment**

In this section, we examine in more detail the characteristics of borrowers who choose income-driven plans. In particular, we analyze how borrowers' propensity to choose income-driven repayment plans relates to the size of their loan disbursement and their post-graduation earnings.

The findings we present serve two purposes. First, they shed light on the choices that went into building the empirical microsimulation model that CBO used to forecast the budgetary costs of income-driven plans (see CBO, 2020). Providing more details on the factors determining the take-up of income-driven repayment plans enhances the transparency of CBO's work and provides insight into the technical aspects of CBO's forecast. Second, the findings in this section contribute to the academic literature on insurance markets and offer insight into why income-driven repayment options for student loans are not offered in the private sector.

**The Relationship of Loan Disbursements and Post-Graduation Earnings to Enrollment in Income-Driven Plans.** We find that borrowers with larger loan balances are more likely to choose an income-driven repayment plan. We hypothesize that that occurs for two main reasons. First, their required monthly payments under such plans are typically smaller than they would be under the standard fixed-payment plan. Second, conditional on being in an income-driven plan, borrowers with larger loan balances are more likely to receive loan forgiveness. For similar reasons, enrollment in income-driven plans would probably be negatively correlated with borrowers' expected income after graduation.

We use data on past borrowers from the NSLDS to examine how enrollment in income-driven repayment plans relates to borrowers' loan disbursements. And because direct information on borrowers' post-graduation earnings or expected earnings is generally not available in the NSLDS, we rely on the imputed NSLDS-matched tax data to examine the relationship between enrollment in income-driven plans and borrowers' post-graduation earnings.

The NSLDS-matched tax data show that income-driven repayment plans are heavily adversely selected.[8] As shown in Figure 2, we find that enrollment in income-driven plans is higher among low-income borrowers. Moreover, among the low-income borrowers who qualify for such plans, enrollment is much higher among borrowers with large loan balances.

The two lines in the figure show how much borrowers in a single-person household would have to borrow and earn to pay the same amount under the PAYE plan or the original IBR plan, respectively, and a 10-year fixed-payment plan. (Because the updated IBR plan is very similar to the PAYE plan, we consider them together in our analysis.) Borrowers whose combination of earnings and loan disbursement amount fell below either line would pay less under the respective plan than they would under a 10-year fixed-payment plan—a condition they would have to meet to qualify for enrollment in the income-driven plans.[9] The break-even line for the PAYE plan lies above that for the IBR plan, capturing a bigger share of the distribution of borrowers, because the required payment under the PAYE plan (10 percent of a borrower's discretionary income) is smaller than the required payment under the IBR plan (15 percent of a borrower's discretionary income). As a result, some borrowers with earnings too high to qualify for the IBR plan may qualify for the PAYE plan. The Revised Pay as You Earn (REPAYE) plan, which does not limit payments, is available to all borrowers regardless of income.

The estimated relationship between borrowers' post-graduation earnings and their enrollment in income-driven repayment plans guides our projections of earnings for borrowers entering repayment between 2010 and 2017. (It likewise guided CBO's projections of earnings for borrowers taking out loans between 2020 and 2029; see CBO, 2020.) Appendix A provides details on the empirical model for projecting borrowers' earnings.

Overall, the model captures the observed relationships between enrollment in income-driven repayment plans and borrowers' earnings and loan balances. For example, for borrowers in the 2017 repayment cohort, the share of loans in income-driven plans increases with borrowers' loan amounts and decreases with borrowers' projected income (see Figure 3). For borrowers in the 2010–2017 repayment cohorts, the model projects a concentration of borrowers in income-driven

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[8] The most recent data available are for 2013. Conducting the same analysis using data only for more recent years—2010 to 2013 instead of the full period of 1996 to 2013—yields very similar results.

[9] Borrowers' eligibility for the IBR and PAYE plans is determined by whether they are in partial financial hardship. Borrowers are considered to have a partial financial hardship when their combined payment under the standard 10-year plan would be greater than 10 percent (for the PAYE and updated IBR plans) or 15 percent (for the original IBR plan) of their discretionary income.

repayment among those with low earnings and large balances, similar to the pattern observed in the NSLDS-matched tax data (see Figure A-4 in Appendix A).

Finally, using data on past borrowers from the NSLDS, we examine the relationship between loan disbursement amount and choice of repayment plan. CBO used estimates of that relationship to project enrollment in income-driven plans for borrowers taking out loans between 2020 and 2029 (CBO, 2020).

Table 3 presents coefficient estimates from a multinomial logit model of plan enrollment choice in 2017 for borrowers who entered repayment between 2013 and 2015. Each column shows the estimated coefficients for one type of repayment plan—extended (25 years of fixed payments), original IBR, PAYE or updated IBR, and REPAYE—with the standard 10-year fixed-payment plan as the base outcome. The results show that loan disbursement is positively associated with enrollment in an income-driven plan, and the effect is stronger for borrowers with higher levels of education. Borrowers who are eligible for the PAYE plan are more likely to choose that plan than others, including the IBR and REPAYE plans. Controlling for loan balance, however, we find that borrowers with more education are less likely to choose an income-driven plan and more likely to choose a fixed-payment plan. On average, female borrowers are more likely than male borrowers to pick an income-driven plan.

**Enrollment and Adverse Selection in Income-Driven Repayment Plans.** By making loan payments a function of borrower's income, income-driven plans provide borrowers with significant insurance against labor market shocks. For most households, labor income risk is a significant source of lifetime financial risk. Because required payments under income-driven plans are reduced if a borrower's income declines, the plans can help borrowers avoid default and, in turn, the consequences of default, such as garnished wages and barriers to future borrowing.

A natural question arises: If individuals value insurance against income risk, why do private loan contracts not offer income-contingent repayment options? One possibility is that information asymmetries prevent a functioning private market from arising.

For example, adverse selection could cause a private income-driven repayment program to unravel, as described by Rothschild and Stiglitz (1976). That threat stems from the ability of individuals to choose different plans and of lenders to offer both income-driven repayment and fixed-payment plans. If borrowers have private information about their future earnings, lower-income borrowers with larger loan balances would disproportionately select into income-driven repayment plans. If such borrowers—who would repay less under an income-driven repayment plan than a fixed-payment plan—are more likely to choose income-driven repayment plans, then lenders would have to charge a higher repayment rate as a fraction of income. That could make income-driven repayment plans less attractive relative to standard plans, causing even fewer

borrowers with lower balances and high earnings to enroll in the plans. In turn, lenders might charge even higher repayment rates, leading more high-income borrowers to instead select fixed-payment plans, in a cycle that would ultimately leave no borrowers in income-driven plans. Thus, the market would fail.

Conversely, the government's income-driven repayment plans would not unravel because they are being run not to earn a return on investment but to ease the debt burden on students. The government has the ability to provide the insurance at a loss and would face less pressure to increase the price in the presence of adverse selection.

Does the empirical relationship between loan size, earnings, and enrollment in income-driven repayment plans provide some insight into the question of information asymmetries between borrowers and lenders in the context of such plans? The results presented in Figure 2 and Table 3 show that borrowers do not select into income-driven repayment plans at identical rates regardless of loan size, and regardless of post-graduation earnings—suggesting that informational asymmetries might indeed be present. However, such positive correlation tests (recommended by Chiappori and Salanié, 2000) cannot in general distinguish between the effects of informational asymmetries related to adverse selection and differences in plan terms related to moral hazard.

## V.    Negative Amortization and Declining Repayment Rates

The selection patterns mentioned earlier help explain aggregate student loan repayment patterns. A salient fact is that student borrowers' rates of loan repayment have slowed over time (Looney and Yannelis, 2015). Among undergraduate borrowers who entered repayment in 2007, the average portion of debt repaid five years later was 25 percent (see Table 4). By contrast, among undergraduate borrowers who entered repayment in 2013, the average portion repaid five years later was only 15 percent. Understanding the factors behind the slowdown of loan repayment is important for CBO's projections of future loans' repayment and budgetary costs.

During the period when student loan repayment rates were slowing, the share of borrowers in income-driven repayment plans was increasing considerably. For example, as of 2017, only 5 percent of borrowers who entered repayment in 2007 were in income-driven plans, compared with 22 percent of borrowers who entered repayment in 2013.[10] In this section, we examine to what extent the increased use of income-driven plans can explain the overall decline in repayment rates.

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[10] Table B-1 in Appendix B contains more detailed information on repayment rates by cohort and education level.

Although the effect of income-driven plans on overall loan repayment is theoretically ambiguous, as we discuss below, in the short term, their increased use is expected to lead to slower repayment, as borrowers would typically make smaller monthly payments in those plans than under standard fixed-term plans. Indeed, using data from the NSLDS, we find that in the short term, borrowers are making smaller payments. What is more surprising is that the loan balance of a typical borrower in income-driven repayment grows over time rather than being paid down. That pattern is known as negative amortization, which occurs when a borrower's payments are too small to cover accruing interest. For example, as mentioned in section I, the median outstanding balance of borrowers in income-driven repayment who began repaying their loans in 2010 increased as a percentage of the original disbursement for eight years. By the end of 2017, over 75 percent of those borrowers owed more than they had originally borrowed. By contrast, borrowers in fixed-payment plans typically pay down their loans. The typical borrower in those plans who avoids default manages to make substantial progress in paying down his or her debt (see Figure 4).

The pattern of negative amortization seen among borrowers who entered repayment in 2010 is also observed among borrowers in other repayment cohorts (see Figure 5). The median ratio of outstanding balance to original loan disbursement increased for borrowers in income-driven repayment plans who began repaying their loans in 2008, 2010, 2012, and 2014. In each of those cohorts, typical borrowers saw their loans negatively amortize. By contrast, borrowers in the same repayment cohorts who did not enroll in income-driven plans made significant progress in paying down their loans and saw their ratio of outstanding loan balance to original disbursement decline over time. For those borrowers, we compare actual changes in their outstanding balance with changes scheduled under the standard 10-year fixed-payment plan. We observe that the actual balance is larger, on average, than the scheduled balance because many borrowers in standard plans miss payments through default, forbearance, or deferment. Further, borrowers with larger loan balances may have extended repayment terms, which lower required payments. However, typical borrowers in non-income-driven repayment plans do see their outstanding balance decline over time.

An analysis of the repayment rates of borrowers entering repayment in each year between 2007 and 2016 further confirms the results shown in Figure 5. Borrowers in income-driven repayment plans consistently saw negative amortization, whereas borrowers in other plans made progress in paying down their loans. Moreover, repayment rates by type of repayment plan are similar across borrowers in different repayment cohorts. Table 4 shows outstanding balances two, three, and five years into repayment by cohort, broken down by type of repayment plan. The similarity in repayment patterns by type of plan across various cohorts suggests that other factors (i.e., compositional changes), rather than changes in the repayment behavior of borrowers within the same plan type, are behind the overall decline in repayment rates.

A likely driver of the overall decline in repayment rates is the increase in the share of borrowers in income-driven plans. For example, the average ratio of borrowers' outstanding balance to their initial balance five years into repayment increased from 0.77 for borrowers in the 2007 repayment cohort to 0.84 for borrowers in the 2013 cohort (see Table 5). Within each type of repayment plan, however, the ratio was roughly the same for the 2007 and 2013 cohorts—1.12 and 1.11 for those in income-driven repayment plans and 0.74 and 0.76 for those in fixed-payment plans, respectively. By contrast, the share of borrowers who were in income-driven repayment plans was quite different for the two cohorts of borrowers—5 percent versus 22 percent. That difference in enrollment in income-driven plans explains much of the decline in average repayment rates across the cohorts.[11]

Although borrowers in income-driven repayment plans tend to make smaller payments and, at least in the short term, tend to see their loans negatively amortize, they are also less likely to default on their loans.[12] Examining cumulative default rates for borrowers who entered repayment in 2012, we find that both undergraduate and graduate students who enrolled in an income-driven plan by the end of 2013 were less likely to default than their counterparts in fixed-payment plans (see Figure 6). Five years into repayment, the average cumulative default rates of borrowers in income-driven plans were about half as high as those of borrowers in fixed-payment plans.

Borrowers in income-driven plans could be less likely to default for various reasons. For example, given that borrowers are automatically enrolled in a 10-year fixed-payment plan unless they select another plan, those who choose other options may have greater financial literacy and be more likely to manage their funds in a way that allows them to avoid default. Alternatively, borrowers in income-driven plans may be less likely to default because those plans keep payments at a more manageable level when borrowers have low income.

## VI.   Loan Repayment and Forgiveness

Although there is an ongoing academic and policy debate regarding student loan forgiveness, the student loan program currently has significant forgiveness built in through income-driven repayment plans. Under the rules of existing income-driven repayment plans, unpaid balances

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[11] A back-of-the-envelope counterfactual calculation shows that if borrowers in the 2013 cohort had been as likely as those in the 2007 cohort to enroll in income-driven plans, the two cohorts' repayment rates five years later would have been almost identical. The counterfactual calculated rate of 0.77 for the 2013 cohort ($1.1 \times 0.05 + 0.76 \times 0.95$) is very close to 0.77—the ratio of outstanding to initial loans five years into repayment for the 2007 cohort. Similarly, the counterfactual calculated rate of 0.82 for the 2007 cohort ($1.12 \times 0.22 + 0.74 \times 0.78$) is very close to 0.84—the ratio of outstanding to initial loans five years into repayment for the 2013 cohort.

[12] A loan is considered to be in default when payments are at least 270 days late.

are discharged after 20 or 25 years of payment. As a consequence, for borrowers with low income who make small payments under the plans, a substantial amount of debt may be forgiven.

Ex ante, the effect of income-driven repayment plans on budgetary costs is not obvious. On the one hand, the plans allow borrowers to pay off their loans more slowly and allow unpaid balances to be forgiven. That would lead a smaller portion of loans to be repaid in total, increasing budgetary costs. On the other hand, because borrowers in income-driven plans experience negative amortization, they may pay more than they would under the standard fixed-payment plan if their income rises as they age. That would effectively extend the maturity of their loans, decreasing budgetary costs.

The difficulty that arises in projecting forgiveness is that future income paths are uncertain. To address that challenge, we use a microsimulation model that projects borrowers' household earnings and resulting loan payments over time. That model aims to generate realistic earnings profiles that not only reflect relationships between borrowers' observable characteristics and earnings but also accommodate borrower heterogeneity and earnings variability. The model uses information from several data sources and estimates from a range of regression equations that model the relationships between earnings and demographic characteristics. The microsimulation method also allows us to model the relationships between enrollment in income-driven repayment plans and borrowers' post-graduation earnings and original loan balances that we observed in the NSLDS-matched tax data, as described in section IV. Further details are provided in Appendix A.

Borrowers in income-driven repayment plans receive forgiveness of their outstanding principal and interest after making a predetermined number of qualifying payments—either 240 or 300, depending on the plan. Borrowers in such plans can also receive forgiveness after as few as 120 payments through the Public Service Loan Forgiveness (PSLF) program if they work in the public sector throughout their repayment period. However, given the difficulty in identifying the borrowers who will qualify for and participate in the PSLF program, we do not model the effects of PSLF on repayment or forgiveness. Therefore, projections of repayment and forgiveness in this paper should be interpreted as upper and lower bounds, respectively.[13]

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[13] Estimates of PSLF take-up and forgiveness are included in CBO's baseline estimates of loans disbursed between 2020 and 2029, which are presented in CBO (2020).

Using data from the NSLDS and from the empirical earnings model, we project overall repaid and forgiven amounts of student loans for borrowers who entered repayment between 2006 and 2017, separately by type of repayment plan—income-driven repayment and fixed-payment plans—and by undergraduate and graduate status (see Table 6).[14] Forgiven amounts are expressed in present-value terms, discounted to the year of a loan's disbursement using interest rates on Treasury securities. The share of the original loan balance forgiven is calculated as the ratio of the discounted forgiven amount to the originally disbursed amount.

Borrowers who entered repayment between 2006 and 2017 and have not enrolled in income-driven repayment plans are projected to repay more in present-value terms, on average, than they originally borrowed (see Table 6). For borrowers in income-driven repayment plans, projected forgiveness is significant, though most are projected to make considerable payments toward their loans and to repay only slightly less, on average, than borrowers not in such plans. For example, among undergraduate borrowers, average repayment as a share of the original balance is 102 percent for those in fixed-payment plans and 100 percent for those in income-driven plans. Among graduate borrowers, those values are 101 percent and 95 percent, respectively. Overall, average forgiveness for all student borrowers in the 2006–2017 cohorts is 4 percent of original balance for undergraduate borrowers and 9 percent for graduate borrowers. For the more recent cohorts, however, average forgiveness increases considerably as enrollment in income-driven repayment plans, particularly the more generous plans, increases.

Projections of average forgiveness mask significant heterogeneity among borrowers: There is more forgiveness projected both for low-income borrowers and for borrowers with large loan balances.[15] On average, borrowers who take out larger loans are projected to have a larger share of their original balance forgiven. In addition, among students who borrow similar amounts, those with lower earnings are projected to have a greater share of their loans forgiven (see Figure 7). Overall, a greater share of forgiven debt is projected to be held by borrowers with low earnings. However, that pattern is weaker for graduate students with large loans.

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[14] See Appendix A for more information on the earnings model and on CBOLT, which provided its underlying framework.

[15] Average loan repayment also varies by loan amount and earnings. Repayment as a percentage of original loan disbursement is lower, on average, for borrowers with low earnings and large loans (see Table B-2 in Appendix B).

Average forgiveness is also projected to be greater for graduate borrowers. For example, for undergraduate borrowers who entered repayment between 2010 and 2017 and are in the lowest earnings and highest borrowing quintiles, 17 percent of the disbursed amount of loans is projected to be forgiven (see Table 7).[16] That portion rises to 36 percent, on average, for graduate borrowers in the same cohorts who are in the lowest earnings and highest borrowing quintiles. Even for graduate borrowers in the middle earnings quintiles, more than a fifth of the originally disbursed amount is projected to be forgiven.[17] That occurs for two reasons. First, graduate borrowers are more likely to enroll in income-driven repayment plans. Second, graduate borrowers have larger loan balances, so even those with relatively high earnings may not pay back their loans.

## VII. Concluding Remarks

This paper enhances the transparency of CBO's work by providing additional information on the agency's analysis of the characteristics and repayment behavior of borrowers in income-driven repayment plans for student loans. That analysis helped inform the agency's methods for estimating the budgetary costs of those loans under current law and illustrative policy options in its February 2020 report (CBO, 2020). This paper documents historical trends in enrollment and repayment in those plans and provides details on the methods used to project borrowers' earnings, repayment, and resulting forgiveness.

Using administrative data on student borrowers, we document three new facts about income-driven repayment plans. First, the plans are heavily adversely selected by borrowers with low income and large balances. Second, the typical borrower in an income-driven repayment plan is negatively amortizing, and considerable loan forgiveness is projected for many borrowers in such plans, particularly those with low income. Third, the increased take-up of income-driven repayment plans can account for almost all of the decline in student loan repayment rates between 2007 and 2017, which suggests that changes in enrollment could have important implications for the repayment of student loans and their budgetary costs in the future.

The findings of the paper also contribute to the academic literature on student loans in the context of insurance contracts. Income-driven repayment plans provide insurance to borrowers

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[16] It is important to note that the projected average forgiveness for each cohort includes borrowers who did not enroll in income-driven plans. As the share of borrowers in such plans continues to increase, so will the projected average forgiveness.

[17] As expected, average forgiveness among borrowers in income-driven plans exceeds average forgiveness among all borrowers (borrowers in fixed-payment plans do not receive forgiveness). Figure B-1 in Appendix B shows the distribution of forgiveness among borrowers in income-driven plans only.

against negative labor income shocks. Yet such contracts do not exist in the private sector in the United States. The chief finding of this paper—that borrowers with large loans but relatively low earnings are disproportionately more likely to select income-driven repayment plans—suggest a potential explanation. Private lenders might not offer income-driven repayment options if information asymmetries result in adverse selection into those plans. Future research can shed more light on that issue.

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**Figure 1.**
**Borrowers and Loan Balances, by Type of Repayment Plan**

### Millions of Borrowers



### Loan Balance, in Billions of Dollars



### Percentage of Borrowers



### Percentage of Loan Balance
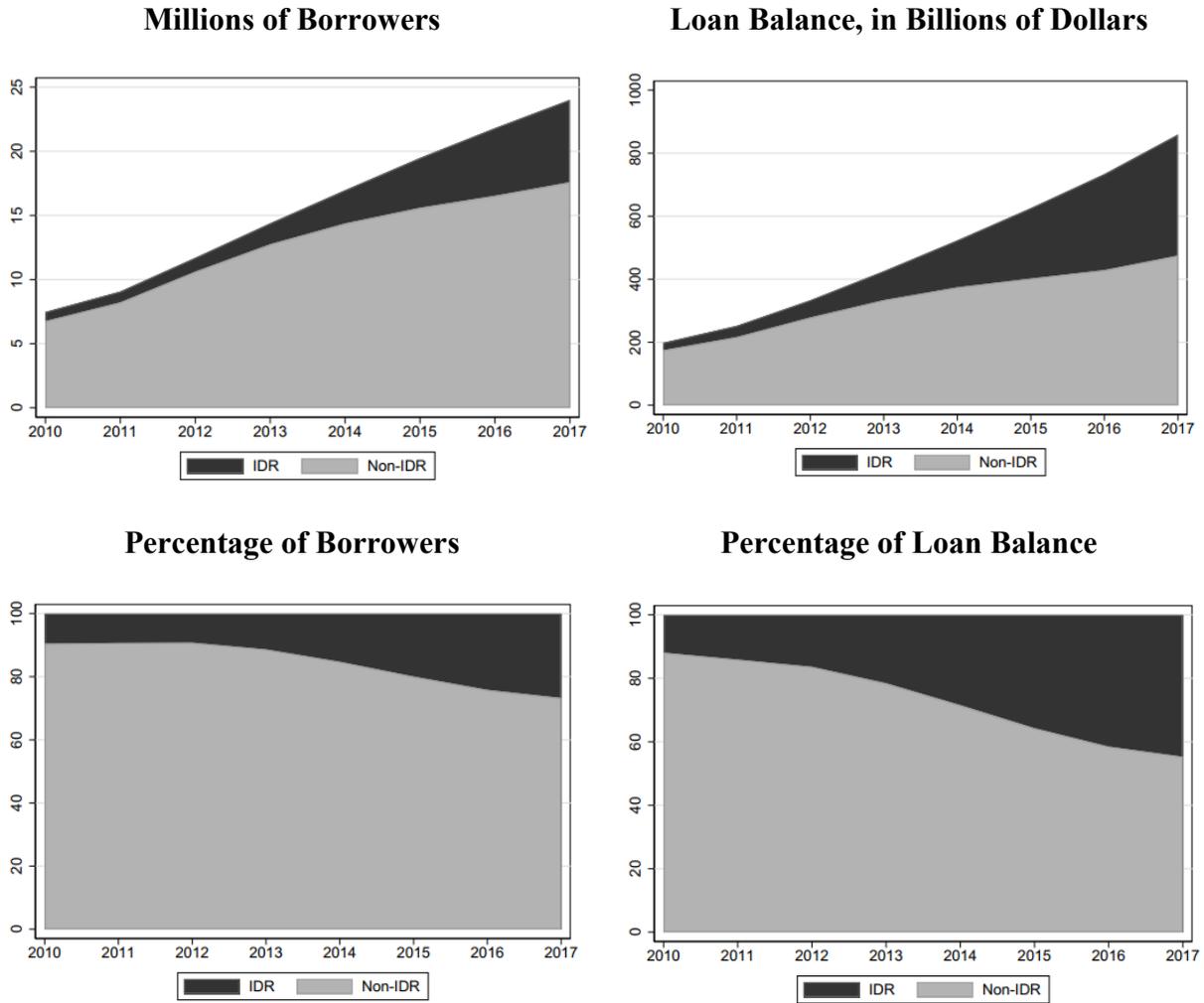


Source: Authors' calculations using data from the National Student Loan Data System.

The data include only direct student loans.

IDR = income-driven repayment.

**Figure 2.**
**Take-Up of Income-Driven Repayment Plans, by Loan Disbursement and Earnings**
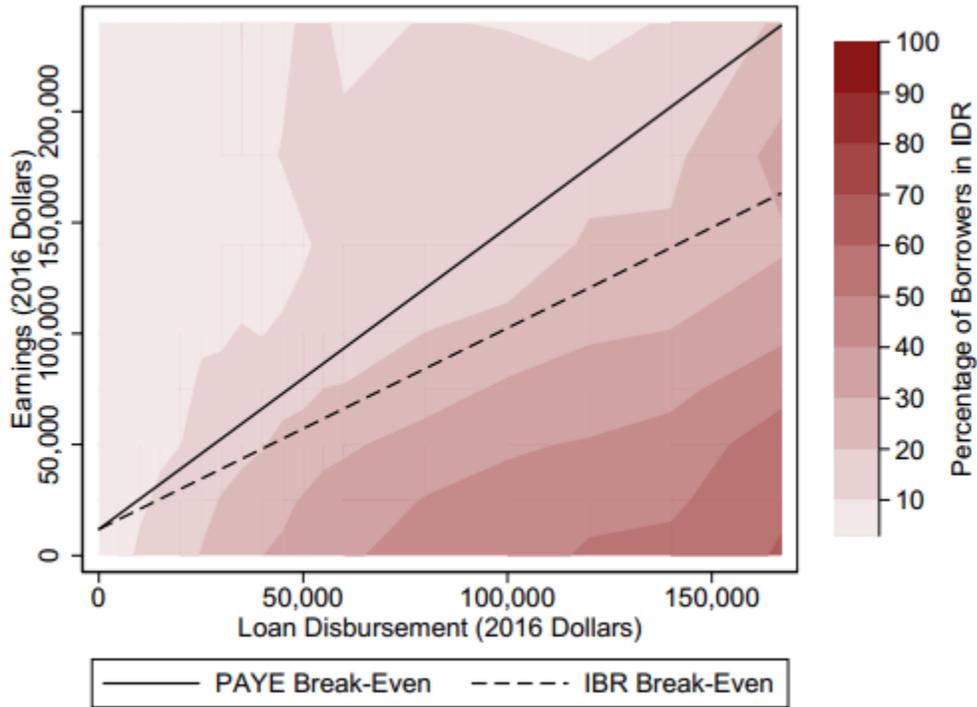


Source: Authors' calculations using data from the National Student Loan Data System matched with imputed tax data for the years 1996 to 2013.

The diagonal lines show break-even points of partial financial hardship that would qualify borrowers for the PAYE and IBR plans. Borrowers below the lines have lower payments in the respective plans than they would in the standard 10-year fixed-payment plan. Take-up is defined as having ever made a payment though an income-driven plan, and earnings are defined as average earnings in the first two years after the year of the borrowers' last loan disbursement.

IDR = income-driven repayment.

IBR = income-based repayment.

PAYE = Pay as You Earn.

**Figure 3.**

**Take-Up of Income-Driven Repayment, by Projected Earnings and Loan Disbursement**

| Undergraduate Borrowers | Graduate Borrowers |

**Take-Up by Projected Earnings**



**Take-Up by Loan Disbursement**



Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The figure shows the share of borrowers entering repayment between 2013 and 2016 who were enrolled in income-driven repayment plans in 2017, by borrowers' total disbursements and imputed earnings. Earnings are measured as average nominal earnings in the first five years of repayment.

IDR = income-driven repayment.

**Figure 4.**
**Ratio of Outstanding Balance to Original Balance Over Time, by Type of Repayment Plan**
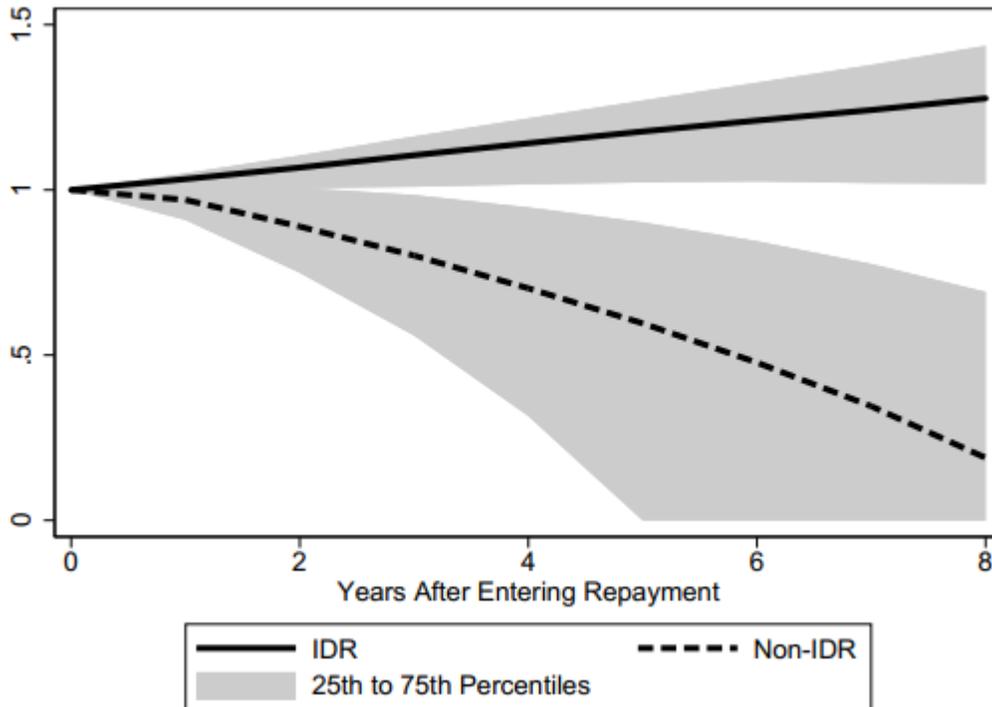


Source: Authors' calculations using data from the National Student Loan Data System.

Outstanding balance is estimated as the ratio of borrowers' outstanding balance to their balance upon entering repayment. The solid and dashed lines show the median outstanding balance by type of repayment plan for borrowers who began repayment in 2010. Borrowers who defaulted on their loans were excluded from the analysis. The shaded areas denote the 25th and 75th percentiles of outstanding balance for each type of plan.

**Figure 5.**
**Ratio of Outstanding Balance to Original Balance Over Time, by Type of Repayment Plan and Cohort**



Source: Authors' calculations using data from the National Student Loan Data System.

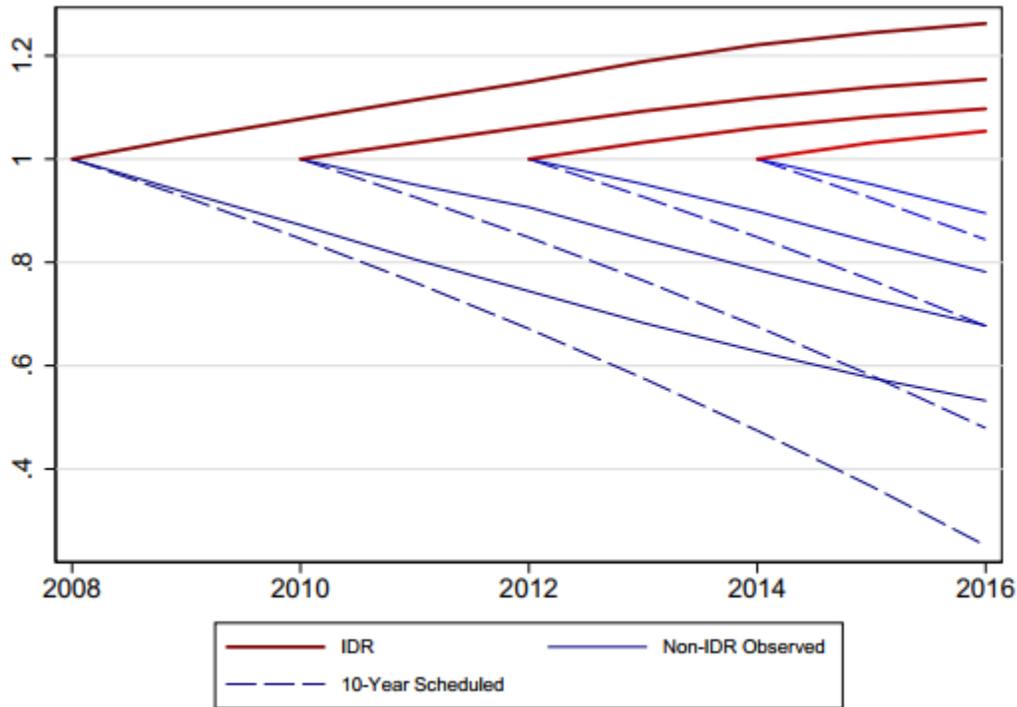Outstanding balance is estimated as the ratio of borrowers' outstanding balance to their balance upon entering repayment. A cohort comprises all borrowers who began repaying their loans in a given year. The solid red lines show the outstanding balance for borrowers in income-driven repayment plans. The dashed blue lines show the scheduled balance under the standard 10-year fixed-payment plan, and the solid blue lines show the actual outstanding balance for borrowers not in income-driven repayment plans.

**Figure 6.**
**Cumulative Default Rates for Borrowers Who Began Repaying Loans in 2012, by Type of Repayment Plan**
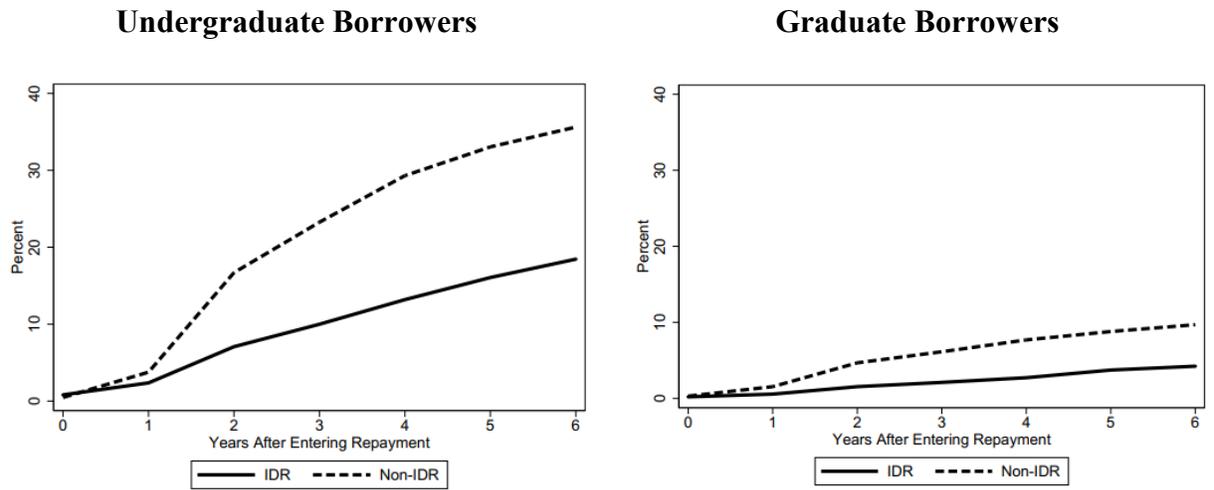


Source: Authors' calculations using data from the National Student Loan Data System.

Borrowers are categorized as repaying through an income-driven plan if they were enrolled in such a plan in their first or second year of repayment.

**Figure 7.**
**Projected Forgiveness for Borrowers Entering Repayment Between 2010 and 2017, by Loan Balance and Projected Earnings**
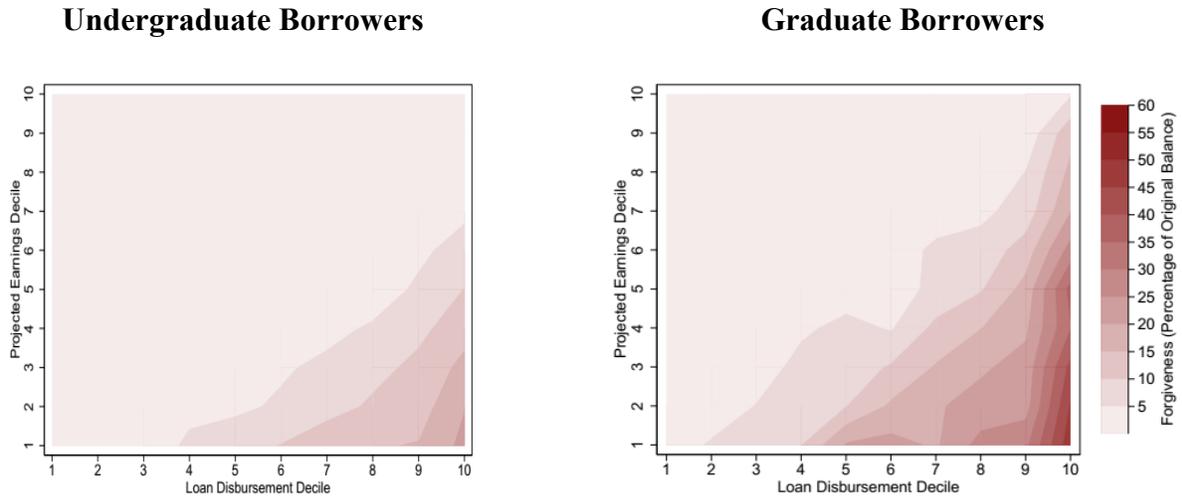


Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The figure shows projected forgiveness as a share of borrowers' original balance. Forgiven amounts are discounted to their present value in the year of disbursement using interest rates on Treasury securities. Earnings are calculated as projected average annual earnings within the first 20 years after borrowers began repaying their loans. Earnings and original loan balances are measured in 2020 dollars. Deciles of earnings and loan disbursement are defined within borrowers with the same level of education. The sample comprises all borrowers who entered repayment between 2010 and 2017, including those not in income-driven repayment plans.

**Table 1.**
**Income-Driven Repayment Plans**

| Repayment Plan | Introduction | Monthly Payment | Time to Forgiveness[a] | Eligible Borrowers |
|---|---|---|---|---|
| Income-Contingent Repayment (ICR) | July 1994 | 20 percent of discretionary income, up to a cap based on the borrower's earnings and marital status and the amount he or she would pay under a 12-year fixed-payment plan[b] | 25 years | Borrowers with direct subsidized or unsubsidized loans, direct student PLUS loans, or PLUS loans made to parents that have been consolidated |
| Income-Based Repayment (IBR) | | | | |
| Original plan for new borrowers before July 1, 2014 | July 2009 | 15 percent of discretionary income, up to the amount the borrower would pay in a 10-year fixed-payment plan[c] | 25 years | Borrowers who can demonstrate a partial financial hardship and who have direct or FFEL subsidized or unsubsidized loans, direct or FFEL student PLUS loans, or direct or guaranteed consolidation loans that do not include PLUS loans made to parents |
| Updated plan for new borrowers on or after July 1, 2014 | July 2014 | 10 percent of discretionary income, up to the amount the borrower would pay in a 10-year fixed-payment plan[c] | 20 years | Same as in the original plan |
| Pay as You Earn (PAYE) | December 2012 | 10 percent of discretionary income, up to the amount the borrower would pay in a 10-year fixed-payment plan[c] | 20 years | Borrowers who can demonstrate a partial financial hardship; who first borrowed after October 1, 2007; and who received a disbursement of any of the following loans after October 1, 2011: direct subsidized or unsubsidized loans, direct student PLUS loans, or direct consolidation loans that do not include PLUS loans made to parents |
| Revised Pay as You Earn (REPAYE) | December 2015 | 10 percent of discretionary income[c] | 20 years if all loans being repaid were received for undergraduate study; 25 years if any loans being repaid were received for graduate or professional study | Borrower with direct subsidized or unsubsidized loans, direct student PLUS loans, or direct consolidation loans that do not include PLUS loans made to parents |

Source: Department of Education.

FFEL= Federal Family Education Loan Program.

a. Borrowers participating in the Public Service Loan Forgiveness program may have their loans forgiven in as little as 10 years.

b. Discretionary income is defined as income above the federal poverty guideline.

c. Discretionary income is defined as income above the 150 percent of the federal poverty guideline.

**Table 2.**
**Summary Statistics**

| | Undergraduate Borrowers | | | | | Graduate Borrowers | | | |
| | Income-Driven Repayment | | Not Income-Driven Repayment | | | Income-Driven Repayment | | Not Income-Driven Repayment | |
| Year | Loan Volume ($ Billions) | Percentage of Total Volume | Loan Volume ($ Billions) | Percentage of Total Volume | | Loan Volume ($ Billions) | Percentage of Total Volume | Loan Volume ($ Billions) | Percentage of Total Volume |
|---|---|---|---|---|---|---|---|---|---|
| 2010 | 13 | 14 | 79 | 86 | | 11 | 10 | 96 | 90 |
| 2011 | 16 | 14 | 102 | 86 | | 20 | 15 | 115 | 85 |
| 2012 | 20 | 13 | 140 | 88 | | 34 | 20 | 139 | 80 |
| 2013 | 32 | 15 | 178 | 85 | | 60 | 28 | 156 | 72 |
| 2014 | 53 | 20 | 210 | 80 | | 95 | 37 | 165 | 63 |
| 2015 | 85 | 27 | 235 | 73 | | 139 | 45 | 168 | 55 |
| 2016 | 120 | 32 | 259 | 68 | | 184 | 52 | 171 | 48 |
| 2017 | 154 | 34 | 297 | 66 | | 231 | 56 | 178 | 44 |

Source: Authors' calculations using data from the National Student Loan Data System.

**Table 3.**
**Repayment Plan Selection Model: Multinomial Logit Coefficients**

| | (1)<br>Extended | (2)<br>IBR | (3)<br>PAYE | (4)<br>REPAYE |
|---|---|---|---|---|
| Log Total Disbursement | 3.646*** | 1.179*** | 1.003*** | 0.956*** |
| | (0.087) | (0.013) | (0.016) | (0.017) |
| Log Total Disbursement × 3rd or 4th Year of College | -0.850*** | 0.541*** | 0.400*** | 0.602*** |
| | (0.096) | (0.023) | (0.028) | (0.033) |
| Log Total Disbursement × Graduate School | -2.516*** | 0.419*** | 0.447*** | 0.738*** |
| | (0.089) | (0.021) | (0.027) | (0.031) |
| Age at Repayment | | | | |
| [25, 30) | 0.148*** | 0.180*** | 0.006 | 0.090*** |
| | (0.031) | (0.015) | (0.019) | (0.022) |
| [30, 35) | 0.181*** | 0.030* | 0.037 | 0.068*** |
| | (0.036) | (0.018) | (0.023) | (0.026) |
| [35, 40) | 0.216*** | -0.080*** | -0.013 | -0.067** |
| | (0.041) | (0.021) | (0.029) | (0.031) |
| [40, 50) | 0.199*** | -0.209*** | 0.130*** | -0.137*** |
| | (0.041) | (0.021) | (0.027) | (0.030) |
| [50, …) | 0.001 | -0.087*** | 0.258*** | -0.123*** |
| | (0.055) | (0.027) | (0.034) | (0.040) |
| Highest Level of Schooling | | | | |
| 3rd or 4th Year of College | 9.484*** | -5.619*** | -4.171*** | -6.353*** |
| | (0.996) | (0.232) | (0.285) | (0.332) |
| Graduate School | 27.054*** | -4.913*** | -4.827*** | -8.605*** |
| | (0.933) | (0.226) | (0.287) | (0.335) |
| Female | -0.003 | 0.395*** | 0.368*** | 0.447*** |
| | (0.020) | (0.011) | (0.014) | (0.016) |
| PAYE Eligible | 0.397*** | -0.371*** | 2.060*** | -0.165*** |
| | (0.024) | (0.013) | (0.025) | (0.019) |
| School Type | | | | |
| Selective Four-Year | 0.355*** | 0.539*** | 0.379*** | 0.588*** |
| | (0.036) | (0.023) | (0.030) | (0.038) |
| Nonselective Four-Year | 0.197*** | 0.585*** | 0.506*** | 0.653*** |
| | (0.043) | (0.027) | (0.034) | (0.042) |
| For-Profit | 0.071* | 0.691*** | 0.629*** | 0.775*** |
| | (0.042) | (0.025) | (0.032) | (0.040) |
| Two-Year or Less | 0.287*** | 0.703*** | 0.508*** | 0.773*** |
| | (0.050) | (0.027) | (0.036) | (0.042) |
| School Type is Missing | -0.288 | 0.465*** | 0.824*** | 0.322 |
| | (0.336) | (0.161) | (0.225) | (0.267) |
| Number of Observations | 395,583 | 395,583 | 395,583 | 395,583 |

Source: Authors' calculations using data from the National Student Loan Data System.

The table shows coefficient estimates from a multinomial logit model estimated on borrowers' payment plans in 2017. The estimation sample comprises borrowers who began repaying their loans in 2013, 2014, and 2015. The base outcome is the standard 10-year plan.

IBR = original income-based repayment.
PAYE = Pay as You Earn or updated income-based repayment.
REPAYE = Revised Pay as You Earn.
* = $p < .1$; ** = $p < .05$; *** = $p < .01$.

**Table 4.**
**Ratio of Outstanding Balance to Original Balance, by Cohort and Type of Repayment Plan**

| | Income-Driven Repayment | | | Not Income-Driven-Repayment | | |
| | Years in Repayment | | | Years in Repayment | | |
| Cohort | 2 | 3 | 5 | 2 | 3 | 5 |
|---|---|---|---|---|---|---|
| 2007 | 1.05 | 1.07 | 1.12 | 0.95 | 0.88 | 0.74 |
| 2008 | 1.03 | 1.06 | 1.13 | 0.94 | 0.88 | 0.75 |
| 2009 | 1.03 | 1.06 | 1.12 | 0.95 | 0.88 | 0.75 |
| 2010 | 1.03 | 1.06 | 1.12 | 0.95 | 0.92 | 0.79 |
| 2011 | 1.04 | 1.06 | 1.12 | 0.95 | 0.88 | 0.76 |
| 2012 | 1.03 | 1.05 | 1.11 | 0.95 | 0.88 | 0.76 |
| 2013 | 1.04 | 1.06 | 1.10 | 0.95 | 0.88 | 0.76 |
| 2014 | 1.03 | 1.05 | | 0.95 | 0.88 | |
| 2015 | 1.03 | 1.04 | | 0.96 | 0.87 | |
| 2016 | 1.03 | | | 0.94 | | |

Source: Authors' calculations using data from the National Student Loan Data System.

"Original loan balance" denotes the outstanding loan balance in the year borrowers entered repayment.

**Table 5.**
**Statistics on Outstanding Balances and Borrowers, by Cohort**

| Cohort | Outstanding Balance as a Share of Original Disbursement Years in Repayment | | | Share of Borrowers in IDR in 2017 | Outstanding Loan Volume in 2017 ($ Billions) | Outstanding Loan Volume in IDR in 2017 ($ Billions) | Share of Loan Volume in IDR in 2017 |
|---|---|---|---|---|---|---|---|
| | 2 | 3 | 5 | | | | |
| 2007 | 0.95 | 0.89 | 0.77 | 0.05 | 26.70 | 5.19 | 0.19 |
| 2008 | 0.95 | 0.89 | 0.78 | 0.06 | 29.92 | 7.79 | 0.26 |
| 2009 | 0.96 | 0.90 | 0.80 | 0.08 | 36.21 | 12.86 | 0.36 |
| 2010 | 0.97 | 0.94 | 0.84 | 0.11 | 51.38 | 22.40 | 0.44 |
| 2011 | 0.97 | 0.92 | 0.83 | 0.15 | 64.02 | 30.58 | 0.48 |
| 2012 | 0.96 | 0.92 | 0.84 | 0.18 | 82.34 | 41.66 | 0.51 |
| 2013 | 0.97 | 0.93 | 0.84 | 0.22 | 91.42 | 47.81 | 0.52 |
| 2014 | 0.97 | 0.92 | | 0.24 | 98.01 | 50.20 | 0.51 |
| 2015 | 0.98 | 0.91 | | 0.25 | 102.85 | 49.62 | 0.48 |
| 2016 | 0.96 | | | 0.24 | 106.90 | 46.55 | 0.44 |

Source: Authors' calculations using data from the National Student Loan Data System.

"Original loan balance" denotes the outstanding loan balance in the year borrowers entered repayment.

IDR = income-driven repayment.

**Table 6.**
**Projected Repayment and Forgiveness as a Percentage of Loan Disbursement, by Cohort and Type of Repayment Plan**

| | Undergraduate Borrowers | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Projected Repayment | | | Projected Forgiveness | | |
| Cohort | Total | IDR | Non-IDR | Total | IDR | Non-IDR |
| 2006 | 92.8 | 94.6 | 92.6 | 0.3 | 4.3 | 0 |
| 2007 | 97.1 | 94.9 | 97.3 | 0.8 | 8.7 | 0 |
| 2008 | 96.6 | 98.8 | 96.3 | 0.9 | 7.8 | 0 |
| 2009 | 99.8 | 103.0 | 99.3 | 1.6 | 11.8 | 0 |
| 2010 | 102.4 | 101.1 | 102.7 | 2.6 | 13.8 | 0 |
| 2011 | 105.3 | 103.7 | 105.8 | 3.6 | 15.6 | 0 |
| 2012 | 106.5 | 104.8 | 107.2 | 4.6 | 15.9 | 0 |
| 2013 | 104.6 | 101.3 | 106.1 | 6.1 | 19.1 | 0 |
| 2014 | 104.4 | 100.5 | 106.4 | 6.3 | 18.8 | 0 |
| 2015 | 103.3 | 98.1 | 105.7 | 5.8 | 18.2 | 0 |
| 2016 | 104.3 | 101.1 | 105.6 | 4.9 | 17.0 | 0 |
| 2017 | 101.3 | 96.1 | 102.9 | 4.0 | 17.0 | 0 |

| | Graduate Borrowers | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Projected Repayment | | | Projected Forgiveness | | |
| Cohort | Total | IDR | Non-IDR | Total | IDR | Non-IDR |
| 2006 | 84.6 | 82.8 | 84.7 | 0.1 | 1.6 | 0 |
| 2007 | 94.9 | 91.6 | 95.2 | 0.8 | 8.6 | 0 |
| 2008 | 94.9 | 90.1 | 95.6 | 1.5 | 11.2 | 0 |
| 2009 | 97.1 | 91.5 | 98.6 | 3.4 | 16.5 | 0 |
| 2010 | 101.6 | 98.8 | 102.8 | 5.6 | 19.0 | 0 |
| 2011 | 103.4 | 98.5 | 106.5 | 8.5 | 22.3 | 0 |
| 2012 | 106.9 | 102.1 | 110.8 | 10.6 | 23.6 | 0 |
| 2013 | 106.4 | 100.8 | 111.6 | 13.0 | 27.0 | 0 |
| 2014 | 104.7 | 95.0 | 115.1 | 16.9 | 32.6 | 0 |
| 2015 | 107.3 | 97.7 | 119.4 | 19.0 | 34.2 | 0 |
| 2016 | 107.4 | 97.2 | 119.5 | 20.3 | 37.2 | 0 |
| 2017 | 104.9 | 89.5 | 122.2 | 23.0 | 43.6 | 0 |

Source: Authors' calculations using data from the National Student Loan Data System and model projections.

Forgiven amounts and payments are discounted to their present value in the year of disbursement, using interest rates on Treasury securities.

IDR = income-driven repayment.

**Table 7.**
**Projected Forgiveness for Borrowers Entering Repayment Between 2010 and 2017, by Loan Disbursement and Projected Earnings**

| | **Undergraduate Borrowers** | | | | |
| | | | Projected Earnings Quintiles | | |
| Loan Disbursement Quintiles | Lowest | Second | Middle | Fourth | Highest |
|---|---|---|---|---|---|
| Lowest | 1.3 | 0.3 | 0.1 | 0.0 | 0.0 |
| Second | 3.8 | 1.1 | 0.3 | 0.1 | 0.0 |
| Middle | 6.9 | 2.8 | 0.6 | 0.1 | 0.0 |
| Fourth | 11.6 | 5.9 | 1.5 | 0.4 | 0.0 |
| Highest | 17.2 | 12.4 | 6.8 | 2.2 | 0.3 |

| | **Graduate Borrowers** | | | | |
| | | | Projected Earnings Quintiles | | |
| Loan Disbursement Quintiles | Lowest | Second | Middle | Fourth | Highest |
|---|---|---|---|---|---|
| Lowest | 2.5 | 0.2 | 0.2 | 0.0 | 0.0 |
| Second | 7.8 | 3.4 | 0.6 | 0.3 | 0.0 |
| Middle | 16.8 | 7.3 | 2.0 | 0.6 | 0.1 |
| Fourth | 21.8 | 15.2 | 7.2 | 2.2 | 0.3 |
| Highest | 36.3 | 28.7 | 23.2 | 12.1 | 5.4 |

Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The table shows projected forgiveness of loans as a proportion of the originally disbursed amount. Forgiven amounts are discounted to their present value in the year of the loans' disbursement, using interest rates on Treasury securities. Earnings are calculated as projected average annual earnings within the first 20 years after borrowers began repaying their loans. Quintiles of earnings and loan disbursement are defined within borrowers with the same level of education. The sample includes all borrowers who entered repayment between 2010 and 2017, including those not in income-driven repayment plans.

# Appendix A: Microsimulation Model

This section provides details on the dynamic microsimulation method we use for modeling borrowers' longitudinal household earnings. The method uses as a foundation the framework developed in the Congressional Budget Office Long-Term Model (CBOLT). That framework is modified in several ways to account for differences between the sample of student borrowers and the overall U.S. population modeled in CBOLT.[18]

The microsimulation model is longitudinal—that is, it keeps a record of each borrower's characteristics for each year. Our sample includes borrowers who entered loan repayment between 2010 and 2017. Each borrower's characteristics are modeled until his or her last year of loan repayment.

The longitudinal nature of the model allows us to consistently project borrowers' repayment. The structure allows us to use borrowers' characteristics in the past to project transitions and outcomes in the current year. It also provides an advantage over modeling approaches that instead project borrowers' loans and earnings on a more aggregate level (e.g., average outcomes for groups of borrowers). The microsimulation method can incorporate the heterogeneity in individual and household earnings seen in the data and can more accurately predict the distribution of repayment outcomes.

The method proceeds in two main steps and uses several sources of data. In the first step, we model the demographic characteristics of borrowers (such as age, gender, educational attainment, marital status, number of dependents in the household, and spouses' demographics), and in the second step, we longitudinally model borrowers' individual and household earnings as a function of those characteristics.

**Modeling Borrowers' Demographic Characteristics**

Some characteristics of borrowers are modeled to remain constant over the duration of repayment. Those characteristics include gender, birth cohort, educational attainment, and school selectivity (measured at the time borrowers enter repayment). For the cohorts of borrowers in our analysis—those who entered repayment between 2010 and 2017—information on those characteristics is drawn from the National Student Loan Data System (NSLDS), our main data source. In analyses of cohorts of borrowers who have not yet entered repayment—for example,

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[18] CBOLT is used to make long-term projections of the federal budget and economy, the size and composition of the population, the distribution of Social Security benefits and taxes among various groups, and the effects of proposed changes to the Social Security system. See Congressional Budget Office (2018).

those who will borrow between 2020 and 2029, as examined by the Congressional Budget Office (CBO) in its February 2020 report (CBO, 2020)—characteristics would be imputed by using information from the NSLDS on borrowers who began repaying their loans in 2016 and by preserving the statistical relationships between their characteristics observed in the data.

Other characteristics of borrowers in the model may change over the duration of repayment. Those include age, marital status, spouse's characteristics (if a borrower is projected to be married), and number of dependent children. Age increases mechanically with time; projections of the other characteristics require the use of statistical models that predict annual changes, known as transitions.

For each borrower in the sample, we model longitudinal marriage patterns as a sequence of marital transitions (first marriage, divorce, and remarriage). We use the method outlined in O'Harra and Sabelhaus (2002). Using the retrospective marital history modules in the Survey of Income and Program Participation (SIPP) data, those authors estimated marriage transition probabilities as a function of age, gender, birth cohort, education, and previous marital status. The method also allows for nonlinear duration effects for divorce and remarriage. We use the coefficients from those estimated equations and the resulting marriage transition probabilities to stochastically predict marriage, divorce, and remarriage (up to three marriages) for every borrower in our sample. Finally, to account for differences between the sample of student borrowers and the overall population represented in the SIPP data, we calibrate borrowers' marriage rates in the model for consistency with the marriage rates of student borrowers observed in the NSLDS-matched tax data.

To model household earnings, which include spouses' earnings for borrowers who are married, we also stochastically impute the characteristics of borrowers' spouses. We assume that spouses are of different genders and that wives are two years younger than their husbands (the average difference observed in the Current Population Survey, or CPS, data for individuals in cohorts similar to those in the NSLDS). To account for assortative mating, we model spouses' education as a function of borrowers' education, birth cohort, and a set of interaction terms.[19] Estimating that relationship as an ordered logistic regression, using CPS data from 1980 through 2016, we

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[19] We estimate separate ordered logit models for borrowers of in each of three education groups: some college, college, and graduate school. We model four possible categories of education for the spouses: no more than high school, some college, college, and graduate school.

find evidence for a positive correlation between spouses' educational attainment.[20] Because we do not have information on how the characteristics of spouses in borrowers' first, second, and third marriages might differ, we model only one type of spouse per borrower.

Finally, we model the number of dependent children in a borrower's household as a function of the borrower's age, gender, birth cohort, marital status, and educational attainment, using an ordered logit model and CPS data from 1980 through 2016. We then stochastically impute the number of dependent children in borrowers' households using those predicted probabilities.

**Modeling Borrowers' Longitudinal Household Earnings**
Household earnings equal individual earnings for unmarried borrowers and equal the sum of both spouses' earnings while borrowers are married.[21] In each period—defined as a year—individual earnings are modeled as the predicted earnings for an individual with certain characteristics, an individual-specific permanent difference (intuitively similar to an individual-specific fixed effect), and annual permanent and transitory shocks. The approach follows closely that described in CBO (2006) and Schwabish and Topoleski (2013), with some modifications.

For each borrower in the sample, annual individual earnings are projected as potential annual earnings, called full-time-equivalent earnings (FTE earnings—the amount an individual could earn if fully employed throughout the year—which are then adjusted for the hours that person is predicted to work during the year).[22] The approach comprises three main steps: 1) Predict potential annual earnings for each borrower in the sample; 2) predict annual hours worked for

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[20] Because borrowers' discretionary income could be affected by their spouses' student loan repayment obligations, we also stochastically impute spouses' loan amounts, using information from the Survey of Consumer Finances on spouses' likelihood of carrying a student loan and information from the NSLDS on the loan balances of individuals with the demographic characteristics of the spouses predicted to have loans. To stochastically predict which borrowers' spouses have student loan debt, we use coefficient estimates from a logit model we estimated using data from the Survey of Consumer Finances. To impute the amount of debt, we use a hot-deck technique in which we match borrowers' spouses to borrowers in the NSLDS who are similar in terms of age, gender, cohort, and educational level.

[21] For the purposes of the analysis, we equate adjusted gross income, which is used to calculate payments in income-driven plans, with earnings. Using data from the Survey of Consumer Finances, we estimate that income from wages and salaries is the predominant source of income for the households of people between the ages of 21 and 54 with at least some college education—a population that resembles the population of student borrowers. On average, earnings comprise more than 86 percent of the total income of households headed by someone with a college degree and about 80 percent of the total income of households headed by someone with some college education.

[22] This method makes it possible to separate the effects of various factors (e.g., age, gender, educational attainment, and birth cohort) on wages from their effects on labor supply.

each borrower in the sample; and 3) compute annual individual earnings by adjusting individuals' predicted potential earnings for the hours worked.

The FTE earnings for each individual in the sample are also modeled in several steps. For each borrower in the sample, FTE earnings are the sum of four components: 1) the predicted value from an earnings equation; 2) the value of the individual's permanent earnings differential (PED), which is defined as the gap between that person's earnings and the predicted value from the earnings equation; 3) a permanent shock to earnings, the effect of which accumulates over time; and 4) a transitory shock, which reflects any additional but temporary variation in a person's earnings (the transitory shock dissipates after one period).

To capture predictable differences in earnings across groups over time, wage-indexed FTE earnings are modeled as a function of demographic characteristics.[23] The estimated equations are age–earnings profiles that vary by gender, education, and birth cohort; those profiles reflect predictable differences across groups, as shown in equation 1. In all equations, $i$ stands for individual, $g$ for gender, $e$ for educational attainment, $c$ for cohort, and $t$ for age.

We construct predicted log FTE earnings profiles, denoted $\hat{E}_{g,e,c,t}$ for each combination of gender, education, age, and cohort $(g, e, c, t)$. We estimate those profiles using separate ordinary least squares regressions for each $(g, t)$ combination.[24]

We calculate PEDs as the five-year average of the difference between observed income in the NSLDS-matched tax data and predicted FTE earnings among people with similar characteristics (gender, age, education, and cohort), as follows. The PED for each individual $(\text{PED}_i)$ is given by equation 1,

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[23] To isolate stable earnings patterns across groups, we eliminate the effects of inflation and productivity before this estimation. Those effects are then added back during the simulation, varying appropriately with the conditions in the broader economy. Thus, rather than simply being adjusted with a standard price index, earnings are adjusted by average earnings growth, calculated as total wages (as reported by the Bureau of Economic Analysis) divided by the total number of workers (as reported by the Bureau of Labor Statistics). This approach is consistent with the concept that productivity is an important determinant of earnings over long periods, and it is the same approach used in CBOLT (see CBO, 2006). For consistency with CBOLT, earnings in the model are indexed to wages in 1993.

[24] We estimate the equations using CPS data from 1980 through 2016. Unlike the approach used in CBO (2006), our approach here does not separately control for the receipt of Old Age Survivor and Disability Insurance benefits. FTE earnings for each person in the CPS data are computed by starting with reported earnings and adjusting for the hours a person actually worked during the year.

$$\text{PED}_i = \frac{\sum_{t=1}^{5} E_{i,t} - \hat{E}_{g,e,c,t}}{5} \qquad (1)$$

where $E_{i,t}$ denotes the adjusted gross income for a given individual from the NSLDS-matched tax data and $\hat{E}_{g,e,c,t}$ denotes the predicted value based on demographic characteristics such as gender, educational attainment, 10-year birth cohort, and age. The PED acts as a measure of individual-specific effects and captures individual heterogeneity in the model. In addition, the PED is the model's main tool for capturing the correlation between type of repayment plan and borrowers' earnings. The PED is averaged between the second and sixth year after a borrower enters repayment.[25] We estimate the mean and variance of the resulting PED distribution by gender, education level, type of repayment plan (income-driven repayment plan versus fixed-payment plan), and school selectivity.[26]

As Figure A-1 illustrates, the estimated PED distribution indicates that, conditional on observable characteristics, the average earnings of borrowers in income-driven repayment plans are lower than the average earnings of borrowers in fixed-payment plans.[27] For each borrower in our simulation sample, a PED is randomly drawn from the relevant PED distribution for a borrower with the same gender, level of education, type of repayment plan, and school

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[25] We performed sensitivity analysis by choosing alternative five-year periods, such as years 6 to 10, 10 to 14, and 14 to 18. The results remained largely invariant to those options.

[27] We used data from the 2008 Barron's Admissions Competitiveness Index provided by the National Center for Education Statistics to categorize schools by their level of selectivity. School categories include highly selective, selective, nonselective, for-profit, and two-year or less. We found slightly larger differences in the means of the PED distribution by repayment plan in the highly selective schools than in other schools, but overall, the pattern remained largely unchanged across school selectivity groups.

[27] We use the Survey of Consumer Finances as a source of external validity for those findings. The 2016 wave of the survey provides information on student borrowers and their post-graduation income and allows us to identify those who are in income-driven repayment plans. Controlling for observable characteristics such as age, gender, educational attainment, and birth cohort, we estimate an average difference in log annual earnings of −0.27 between borrowers who were in income-driven repayment plans and those who were not. That average difference in log earnings is roughly equal to the estimated difference of −0.26 in mean PEDs between the two groups based on the NSLDS-matched tax data.

selectivity. That PED remains fixed for a given borrower over his or her lifetime and can be thought of as an individual-specific fixed effect that remains unchanged over the life cycle.[28]

Finally, to project FTE earnings for each individual in the sample, we pull together the predicted earnings based on the earnings equation, the PED, and the permanent and transitory shocks. Specifically, an individual's predicted log FTE earnings with permanent and transitory shocks are given by equation 2.[29]

$$E_{i,t} = \hat{E}_{g,e,c,t} + \text{PED}_i + v_{i,g,t} + \varepsilon_{i,g,t} \qquad (2)$$

The permanent shock is given by equation 3:

$$v_{i,g,t} = \sum_{s=1}^{t} \alpha_{i,g,s}, \alpha_{i,g,s} \sim N(0, \sigma_{p,g}^2), \qquad (3)$$

where $\sigma_{p,g}^2$ is the permanent variance, estimated separately for each gender. The permanent shock accumulates over time.

The transitory shock component is assumed to be normally distributed and is given by equation 4:

$$\varepsilon_{i,g,t} \sim N(0, \sigma_{\tau,g}^2), \qquad (4)$$

where $\sigma_{\tau,g}^2$ is the transitory variance, estimated separately for each gender. The transitory shock dissipates after one period.

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[28] Before the PEDs are randomly drawn, the standard deviation of the PED distribution is rescaled by a factor of 0.545. The shrinking of the variance of the distribution is necessary because PED is calculated as an average over five years, and the resulting variance would include both permanent and transitory components. Instead, the simulation method requires draws from a PED distribution devoid of transitory variance. To calculate the correct shrinkage factor, we estimated permanent and transitory variances in the NSLDS-matched tax data. Those estimates reveal that the transitory variance in the NSLDS-matched data is multiple times higher than the transitory variance reported by Schwabish and Topoleski (2013), who used administrative longitudinal earnings data from the Social Security Administration. We suspect that the high transitory variance of earnings in the NSLDS-matched tax data might be the result of the imputation method, which did not preserve all of the longitudinal properties of the original income tax data.

[29] Equation 2 follows Schwabish and Topoleski (2013). We use point estimates for the permanent and transitory variances for different age and gender groups, as reported in that paper.

Finally, we convert FTE earnings into actual earnings, $Y_{i,t}$, by imputing hours of work for each borrower in each year of the simulation. $Y_{i,t}$ is a function of hours worked and $E_{i,t}$, given by equation 5,

$$Y_{i,t} = \exp(E_{i,t}) * \frac{h_{i,t}}{2080} * (1 - 1[PT_{i,t}] * 0.15), \qquad (5)$$

where $h_{i,t}$ denotes hours worked and $1[PT_{i,t}]$ is a dummy variable indicating part-time work. The additional 15 percent downward adjustment in the case of part-time work is to account for the full-time wage premium (CBO, 2006).

Each individual's annual hours worked are modeled with a set of labor supply equations estimated using data from the March CPS. We apply the method outlined in CBO (2006), and we use the coefficient estimates of the equations reported in that paper to stochastically predict labor force participation, full-time versus part-time status, hours worked if part time, and unemployment spells in each period for each borrower in the sample. Full-time workers by definition work 2,080 hours per year (40 hours a week for 52 weeks, including paid vacation and sick leave), whereas annual hours worked for part-time workers are modeled via an ordered logistic regression as a function of borrowers' characteristics. To capture persistence, some equations also use lagged outcome variables, which are described below.[30]

Labor force participation is estimated via a logit model, following CBO (2006), defined in equation 6.

$$\Pr(LFP_{i,g,t}) = f(LFP_{i,t-1}, X_{i,g,t}) \qquad (6)$$

Full- versus part-time work is likewise given by a logit model, defined in equation 7.

$$\Pr(FT_{i,g,t}) = f(X_{i,g,t}) + \theta_{i,g,t} \qquad (7)$$

Part-time hours are modeled using equation 8.

$$\Pr(hours_{i,g,t}^{bin} | PT_{i,g,t}) = f(X_{i,g,t}) + \theta_{i,g,t} \qquad (8)$$

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[30] The original labor supply equations developed and estimated in CBO (2006) include receipt of Old-Age, Survivors, and Disability Insurance benefits as one of the control variables. For the purposes of this analysis, and because few in our sample of borrowers would be receiving such benefits during loan repayment, we treat those coefficients as being effectively equal to zero.

Unemployment is modeled using equation 9,

$$\Pr(Unemp_{i,g,t}) = f(X_{i,g,t}, U_t, E_{i,t}) + \theta_{i,g,t}, \qquad (9)$$

where $X_{i,g,t}$ are education, marital status, time trend, birth cohort, an indicator of whether an individual is in school, and number of children under the age of 6; $U_t$ is the aggregate unemployment rate; and $E_{i,t}$ is the log of FTE earnings.

An error-correction component, $\theta$, models persistence in the labor supply variables that determine earnings, $Y_{i,t}$. Lagged labor supply variables are not observed in the CPS, but that persistence can be modeled with the error-correction component, which adds the difference between the regression with earnings, $f'_{t-1}(x_{i,t-1}, Y_{i,t-1})$, and the naïve regression, $f_{t-1}(x_{i,t-1})$, as shown in equation 10.[31]

$$\theta_{i,g,t} = f'_{t-1}(x_{i,t-1}, Y_{i,t-1}) - f_{t-1}(x_{i,t-1}) \qquad (10)$$

If a borrower is projected not to participate in the labor force in a given period, his or her earnings are set to $0. If a borrower is projected to experience a spell of unemployment, then his or her annual hours are adjusted downward.[32] Finally, the effects of inflation and productivity are added to borrowers' projected earnings profiles by adjusting earnings for wage growth over time and matching that growth to the growth in aggregate earnings projected in CBO's long-term macroeconomic forecast.[33]

Overall, the microsimulation model performs well in terms of matching the distribution of household earnings in our sample of borrowers. Figure A-2 graphs the kernel density of simulated log earnings of the households of borrowers between the ages of 25 and 44 and compares it with the distribution of household log adjusted gross income observed in the NSLDS-matched tax data for households of borrowers of similar ages. The model also replicates reasonably well the difference in the household earnings distribution by repayment plan observed in the data (see Figure A-3). The model further performs well in replicating the relationship between borrowers' propensity to enroll in an income-driven repayment plan and their original loan balance and post-graduation earnings (see Figure A-4).

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[31] For more information, see CBO (2006), pp. 14–16.

[32] The reduction in annual hours for a person who experiences a spell of unemployment is based on whether he or she works full time or part time, as in CBO (2006).

[33] For information on the long-term macroeconomic forecast used in this paper, see CBO (2019).

**Model Sensitivity**

This section illustrates the sensitivity of the model's predictions to some of the analytical assumptions. Table A-1 illustrates the variability in predicted repayment and forgiveness for cohorts of borrowers in income-driven plans under the baseline model and five alternative scenarios. Those scenarios vary some of the vital parameters in our earnings simulation. Under scenarios 1 and 2, we model the mean of the PED distribution to be higher by 0.1 or lower by 0.1, respectively, than under the baseline model. Intuitively, that is roughly equivalent to about a 10 percent increase and a 10 percent decrease, respectively, in permanent earnings for all student borrowers. Under scenarios 3 and 4, we model aggregate earnings growth starting in 2018 to be 1 percentage point higher or 1 percentage point lower, respectively, than in the preferred specification, which uses the average earnings growth projected in CBO's long-term macroeconomic forecast as of 2019. Finally, under scenario 5, we model no permanent differential in the PED distribution by type of plan. Intuitively, that scenario is equivalent to there being no adverse selection into income-driven repayment based on post-graduation earnings.

The results indicate that the model's predictions are fairly sensitive to simulated changes in the average PED. For example, among both undergraduate and graduate borrowers who entered repayment between 2010 and 2017, an increase of 0.1 in the mean PED increases average repayment by about 3 percentage points and reduces average forgiveness by about 2 percentage points. The effects are opposite in direction and somewhat stronger in absolute value when the mean PED is decreased by 0.1: Average repayment declines by about 5 percentage points among both undergraduate and graduate borrowers, and average forgiveness increases by 3 percentage points among undergraduate borrowers and by 4 percentage points among graduate borrowers.

Overall, we find that the results are similarly sensitive to a 1 percentage-point deviation in projected aggregate earnings growth.[34] A 1 percentage-point increase in the growth of earnings relative to CBO's baseline projection starting in 2018 leads average repayment to increase by 2 percentage points for undergraduate students and 3 percentage points for graduate students and average forgiveness to decrease by 2 percentage points for all borrowers regardless of their level of education. A 1 percentage-point decrease in the growth of earnings relative to CBO's baseline projection leads repayment to decrease by 4 and 5 percentage points and forgiveness to increase by 3 and 4 percentage points among undergraduate and graduate students, respectively.

We also find that estimated repayment and forgiveness are relatively sensitive to the model's assumption of adverse selection based on earnings. Without adverse selection, projected

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[34] Aggregate earnings growth over the simulated period is projected to average around 3.5 percent.

forgiveness as a share of disbursement declines by 4 percentage points, on average, for undergraduate borrowers in the 2010–2017 repayment cohorts and by 6 percentage points, on average, for graduate borrowers in those cohorts.

**Figure A-1.**
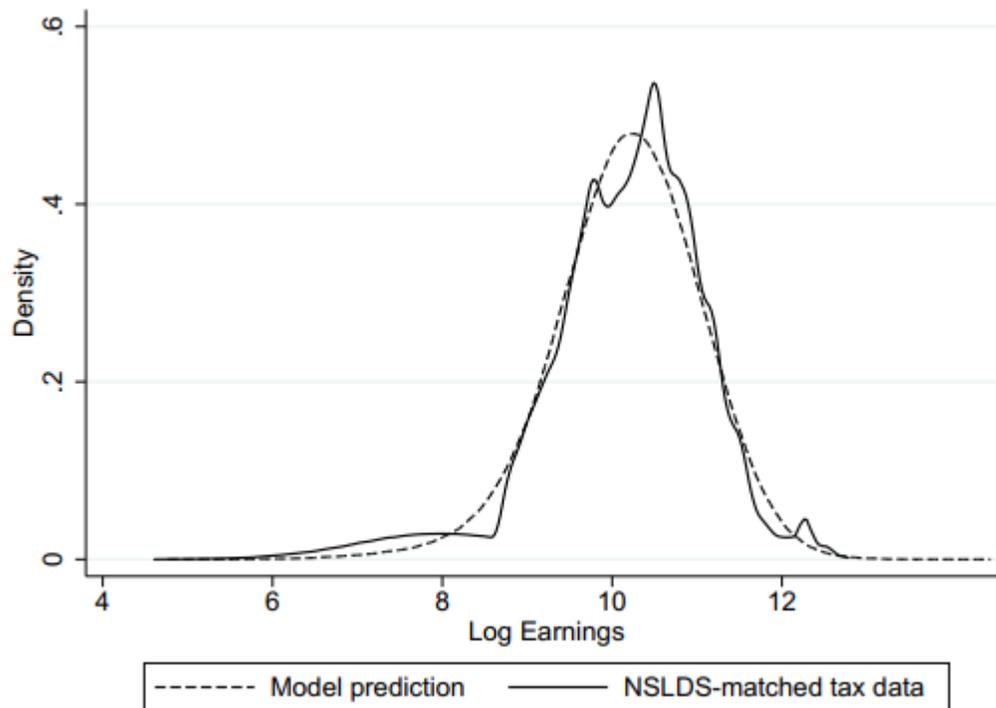**Distribution of Estimated Permanent Earnings Differentials, by Type of Repayment Plan**
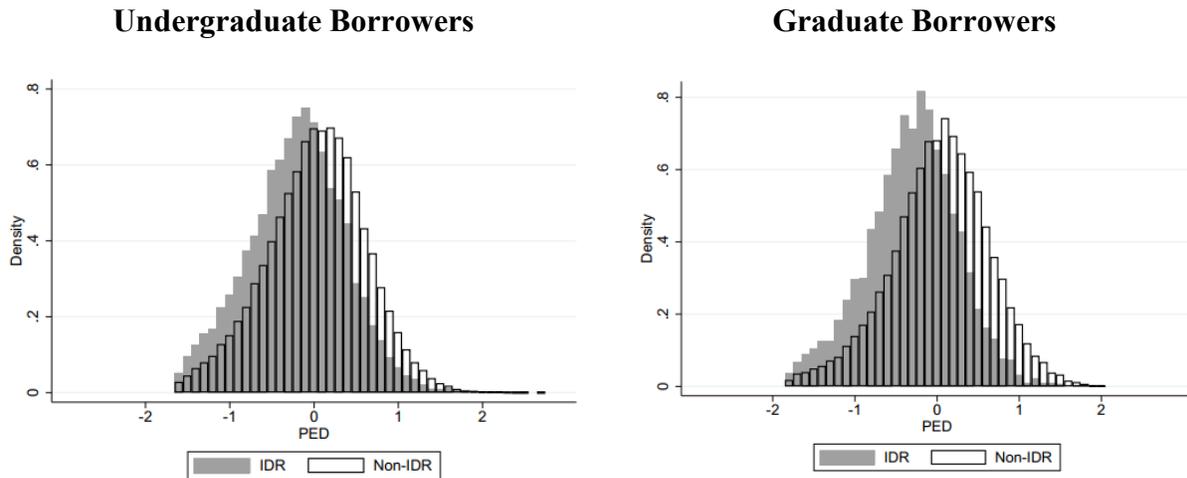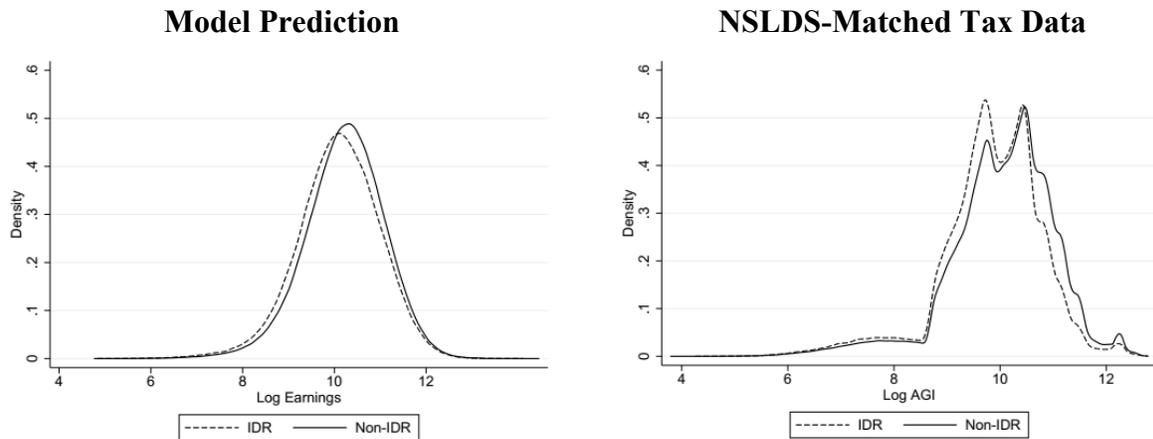


Source: Authors' calculations using model projections and data from the National Student Loan Data System matched with imputed tax data.

The permanent earnings differential for each borrower is defined as the difference in the natural logs of that borrower's observed income and the predicted earnings for a borrower with similar demographic characteristics, averaged over five years (from two to six years after the borrower enters repayment).

IDR = income-driven repayment.

**Figure A-2.**
**Kernel Density Distribution of Earnings for Borrowers' Households: Model Predictions
Versus Observed Data**



Source: Authors' calculations using model projections and data from the National Student Loan Data System
matched with imputed tax data.

Household earnings are indexed to 1993 wage levels and equal the summed earnings of a borrower and his or her
spouse if the borrower is married or the borrower's individual earnings if he or she is not married. The model fit is
illustrated for borrowers between the ages of 25 and 44 who entered repayment between 2010 and 2017.

NSLDS = National Student Loan Data System.

**Figure A-3.**
**Kernel Density Distribution of Earnings for Borrowers' Households, by Repayment Plan:**
**Model Predictions Versus Observed Data**



Source: Authors' calculations using model projections and data from the National Student Loan Data System matched with imputed tax data.

Household earnings are indexed to 1993 wage levels and equal the summed earnings of a borrower and his or her spouse if the borrower is married or the borrower's individual earnings if he or she is not married. The model's predicted distribution is illustrated for borrowers between the ages of 25 and 44 who entered repayment between 2010 and 2017.

AGI = adjusted gross income.

NSLDS = National Student Loan Data System.

**Figure A-4.**
**Projected Take-Up of Income-Driven Repayment Plans, by Loan Disbursement and Projected Earnings**
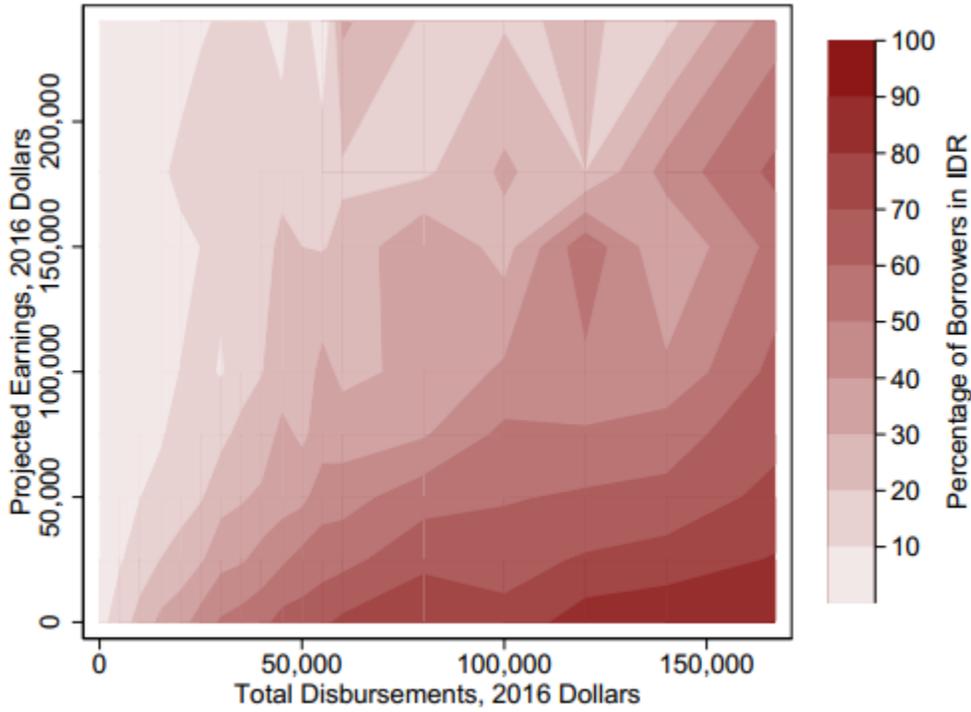


Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The figure shows the share of borrowers in income-driven repayment plans by loan disbursement amount and projected post-graduation earnings. Borrowers in this analysis entered repayment between 2010 and 2017. Take-up is defined as having ever made a payment though an income-driven plan. Earnings are calculated as projected average annual earnings within the first 20 years after borrowers began repaying their loans.

IDR = income-driven repayment.

**Table A-1.**

**Sensitivity Analysis: Projected Repayment and Forgiveness Under Baseline Model and Alternative Scenarios**

| | | Projected Repayment | | | | | Projected Forgiveness | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Baseline | Permanent Earnings Differential | | Aggregate Earnings Growth | | No Earnings Difference by IDR Status | Baseline | Permanent Earnings Differential | | Aggregate Earnings Growth | | No Earnings Difference by IDR Status |
| | | +0.1 | -0.1 | +0.01 | -0.01 | | | +0.1 | -0.1 | +0.01 | -0.01 | |
| Cohort | | (1) | (2) | (3) | (4) | (5) | | (1) | (2) | (3) | (4) | (5) |
| 2010 | 101.1 | 102.9 | 97.5 | 102.3 | 98.0 | 107.0 | 13.8 | 13.0 | 16.5 | 13.1 | 16.5 | 9.6 |
| 2011 | 103.7 | 105.5 | 99.2 | 104.8 | 100.0 | 108.3 | 15.6 | 14.4 | 18.9 | 14.6 | 18.5 | 13.0 |
| 2012 | 104.8 | 107.1 | 100.3 | 106.3 | 101.1 | 108.4 | 15.9 | 14.1 | 18.9 | 14.6 | 18.7 | 13.2 |
| 2013 | 101.3 | 105.8 | 98.1 | 105.0 | 99.1 | 106.8 | 19.1 | 15.9 | 21.3 | 16.2 | 20.9 | 14.9 |
| 2014 | 100.5 | 103.4 | 95.2 | 102.4 | 96.2 | 106.3 | 18.8 | 16.8 | 22.3 | 17.2 | 21.9 | 14.9 |
| 2015 | 98.1 | 102.0 | 93.5 | 101.1 | 94.6 | 105.9 | 18.2 | 15.6 | 21.6 | 16.0 | 21.2 | 12.8 |
| 2016 | 101.1 | 104.2 | 95.3 | 103.5 | 96.2 | 107.4 | 17.0 | 14.2 | 20.6 | 14.4 | 20.3 | 12.4 |
| 2017 | 96.1 | 100.7 | 91.7 | 100.2 | 92.3 | 104.0 | 17.0 | 13.6 | 19.7 | 13.6 | 19.7 | 11.5 |

**Graduate Borrowers**

| Cohort | | (1) | (2) | (3) | (4) | (5) | | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 98.8 | 99.9 | 93.9 | 99.4 | 94.4 | 106.6 | 19.0 | 17.5 | 21.3 | 17.6 | 21.2 | 12.9 |
| 2011 | 98.5 | 100.4 | 93.9 | 99.7 | 94.6 | 104.9 | 22.3 | 22.0 | 26.4 | 22.0 | 26.1 | 18.4 |
| 2012 | 102.1 | 104.8 | 97.9 | 104.4 | 98.6 | 110.5 | 23.6 | 21.8 | 26.5 | 21.7 | 26.2 | 17.1 |
| 2013 | 100.8 | 103.1 | 95.5 | 102.5 | 96.1 | 106.7 | 27.0 | 25.3 | 30.5 | 25.6 | 30.3 | 23.9 |
| 2014 | 95.0 | 99.9 | 91.5 | 99.4 | 92.1 | 105.7 | 32.6 | 28.7 | 34.3 | 28.7 | 34.3 | 24.6 |
| 2015 | 97.7 | 102.1 | 92.1 | 101.7 | 92.6 | 108.2 | 34.2 | 31.3 | 37.9 | 31.2 | 37.8 | 27.0 |
| 2016 | 97.2 | 100.8 | 90.2 | 100.6 | 90.4 | 107.4 | 37.2 | 36.0 | 43.1 | 35.8 | 43.2 | 30.7 |
| 2017 | 89.5 | 92.9 | 82.1 | 93.0 | 81.9 | 98.6 | 43.6 | 41.7 | 49.1 | 41.5 | 49.7 | 37.4 |

Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The table shows projected forgiveness and repayment as a share of borrowers' original disbursement amount, by cohort and type of repayment plan under the baseline model and several alternative scenarios. Forgiven amounts—the total unpaid balance that is forgiven—and payments are discounted to their present value in the year of disbursement using interest rates on Treasury securities. Under scenarios 1 and 2, the permanent earnings differential is increased and decreased by 0.1, respectively, for all borrowers. Under scenarios 3 and 4, starting in 2018, aggregate earnings growth is increased and decreased, respectively, by 1 percentage point relative to the preferred specification. Under scenario 5, no earnings differential is modeled between borrowers in income-driven plans and those in other repayment plans.

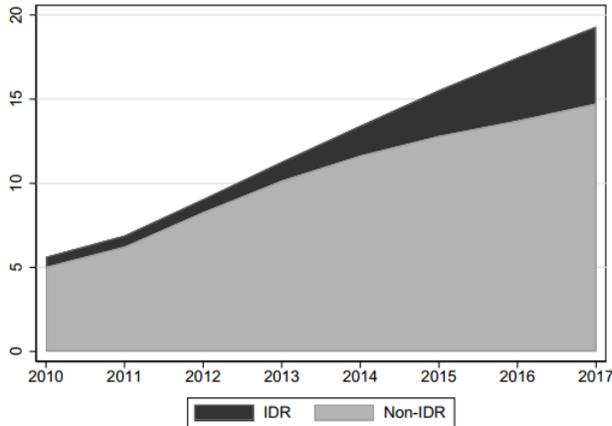IDR = income-driven repayment.

# Appendix B: Additional Results

In this paper, we provide estimates of repayment rates and forgiveness for several cohorts of borrowers. The tables and figures in this appendix complement those statistics by providing additional information on projected repayment and forgiveness by borrower education level for a subsample of borrowers.

Figures B-1 and B-2 complement Figure 1 by showing changes in enrollment and loan volume, respectively, in income-driven repayment plans, separately for undergraduate and graduate borrowers. Figure B-3 complements Figure 7 by showing projected forgiveness—the present value of forgiven amounts as a percentage of original loan disbursement—only for borrowers in income-driven plans. Table B-1 complements Table 5 by showing borrowers' repayment rates two, three, and five years into repayment, as well as the share of borrowers and the share of loan volume in income-driven repayment for borrowers in various cohorts, separately for undergraduate and graduate borrowers. Table B-2 complements Table 7 by showing projected overall repayment—the present value of total loan payments as a percentage of original disbursements—for borrowers entering repayment between 2010 and 2017.
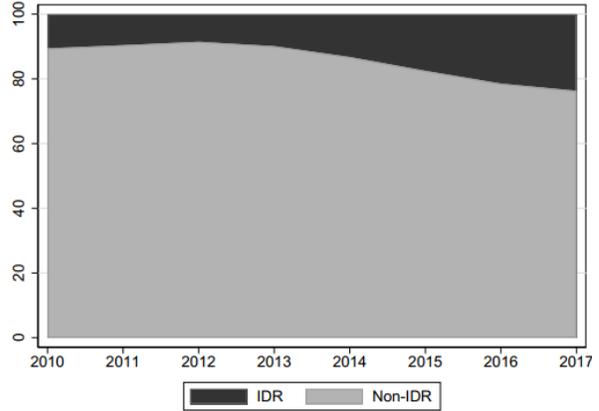
**Figure B-1.**
**Borrowers, by Type of Repayment Plan**

## Undergraduate Borrowers

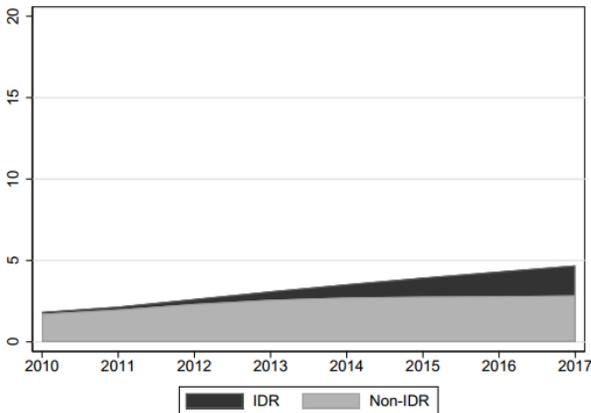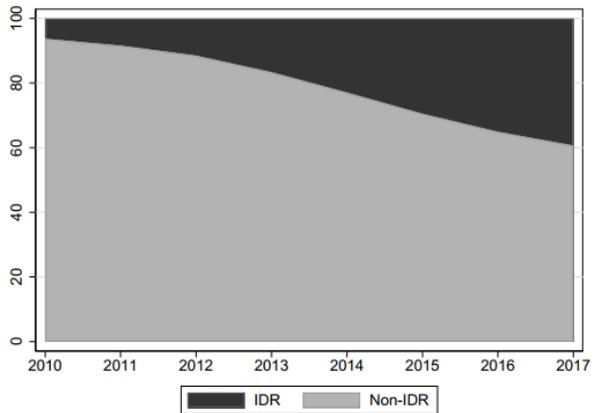### Millions of Borrowers

### Percentage of Borrowers

## Graduate Borrowers

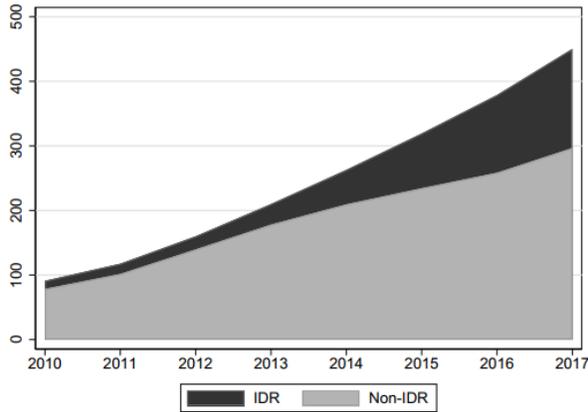### Millions of Borrowers

### Percentage of Borrowers

Source: Authors' calculations using data from the National Student Loan Data System.
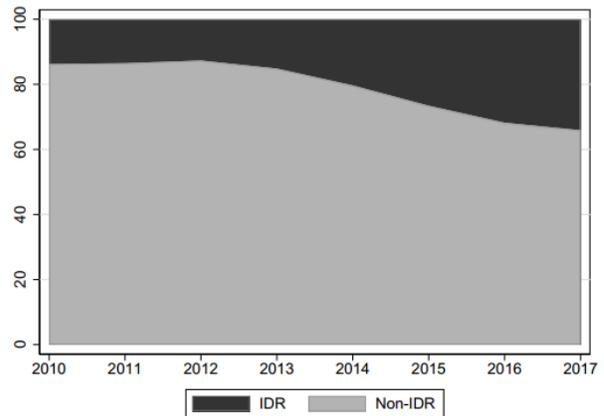
IDR = income-driven repayment.

**Figure B-2.**
**Loan Volume, by Type of Repayment Plan**

## Undergraduate Borrowers' Loans

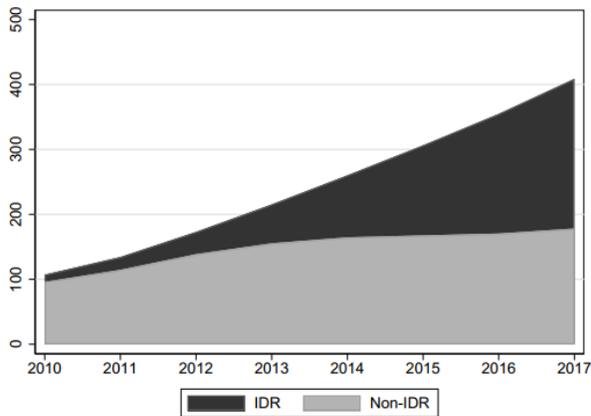**Loan Balance, in Billions of Dollars**  **Percentage of Loan Balance**
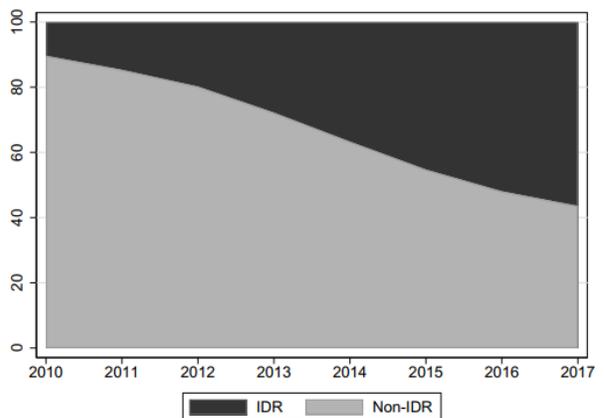


## Graduate Borrowers' Loans

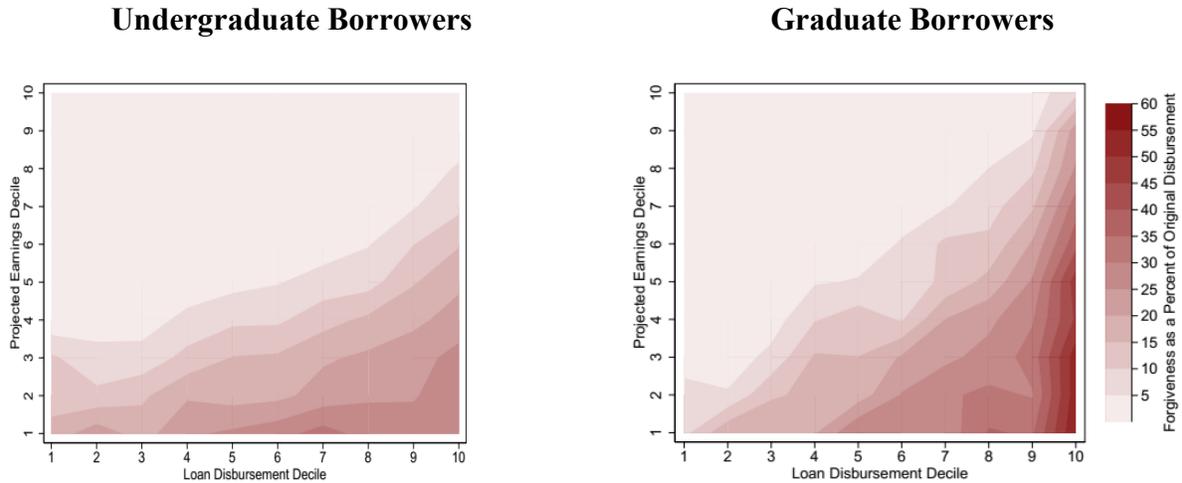**Loan Balance, in Billions of Dollars**  **Percentage of Loan Balance**



Source: Authors' calculations using data from the National Student Loan Data System.

IDR = income-driven repayment.

**Figure B-3.**
**Projected Forgiveness for Borrowers in Income-Driven Plans Entering Repayment Between 2010 and 2017, by Loan Disbursement and Projected Earnings**



Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The figure shows projected forgiveness as a share of borrowers' original disbursement amount. Forgiven amounts are discounted to their present value in the year of disbursement, using interest rates on Treasury securities. Earnings are calculated as projected average annual earnings within the first 20 years after borrowers began repaying their loans. Earnings and original loan balances are measured in 2020 dollars. Deciles of earnings and loan disbursement are defined within borrowers with the same level of education. The sample includes only borrowers in income-driven plans who entered repayment between 2010 and 2017.

**Table B-1.**
**Statistics on Outstanding Balances and Borrowers, by Cohort**

| | Outstanding Balance as a Share of Loan Disbursement | | | | | | |
| | Years in Repayment | | | Share of Borrowers in IDR in 2017 | Outstanding Loan Volume in 2017 ($ Billions) | Outstanding Loan Volume in IDR in 2017 ($ Billions) | Share of Loan Volume in IDR in 2017 |
| Cohort | 2 | 3 | 5 | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Undergraduate Borrowers | | | |
| 2007 | 0.95 | 0.89 | 0.76 | 0.06 | 12.39 | 2.40 | 0.19 |
| 2008 | 0.95 | 0.89 | 0.78 | 0.07 | 13.61 | 3.03 | 0.22 |
| 2009 | 0.96 | 0.91 | 0.80 | 0.10 | 16.54 | 4.51 | 0.27 |
| 2010 | 0.97 | 0.95 | 0.85 | 0.13 | 25.45 | 8.30 | 0.33 |
| 2011 | 0.97 | 0.92 | 0.84 | 0.16 | 32.85 | 11.70 | 0.36 |
| 2012 | 0.97 | 0.93 | 0.85 | 0.19 | 43.29 | 16.62 | 0.38 |
| 2013 | 0.97 | 0.93 | 0.85 | 0.21 | 48.53 | 19.32 | 0.40 |
| 2014 | 0.97 | 0.93 | | 0.21 | 51.88 | 19.91 | 0.38 |
| 2015 | 0.98 | 0.91 | | 0.20 | 54.14 | 18.70 | 0.35 |
| 2016 | 0.96 | | | 0.18 | 56.09 | 16.48 | 0.29 |
| | | | | Graduate Borrowers | | | |
| 2007 | 0.95 | 0.90 | 0.81 | 0.08 | 14.32 | 2.79 | 0.20 |
| 2008 | 0.95 | 0.89 | 0.79 | 0.11 | 16.31 | 4.76 | 0.29 |
| 2009 | 0.95 | 0.89 | 0.79 | 0.18 | 19.66 | 8.35 | 0.42 |
| 2010 | 0.94 | 0.89 | 0.80 | 0.24 | 25.93 | 14.10 | 0.54 |
| 2011 | 0.94 | 0.88 | 0.80 | 0.30 | 31.17 | 18.88 | 0.61 |
| 2012 | 0.94 | 0.88 | 0.79 | 0.34 | 39.05 | 25.04 | 0.64 |
| 2013 | 0.96 | 0.90 | 0.83 | 0.39 | 42.88 | 28.50 | 0.66 |
| 2014 | 0.96 | 0.92 | | 0.42 | 46.13 | 30.30 | 0.66 |
| 2015 | 0.97 | 0.92 | | 0.43 | 48.71 | 30.92 | 0.63 |
| 2016 | 0.96 | | | 0.41 | 50.81 | 30.07 | 0.59 |

Source: Authors' calculations using data from the National Student Loan Data System.

IDR = income-driven repayment.

**Table B-2.**
**Projected Repayment for Borrowers Entering Repayment Between 2010 and 2017, by Loan Disbursement and Projected Earnings**

| | **Undergraduate Borrowers** | | | | |
| | Projected Earnings Quintiles | | | | |
| Loan Disbursement Quintiles | Lowest | Second | Middle | Fourth | Highest |
|---|---|---|---|---|---|
| Lowest | 106.5 | 106.1 | 105.7 | 105.9 | 105.2 |
| Second | 107.0 | 109.1 | 108.7 | 107.8 | 106.6 |
| Middle | 99.9 | 104.8 | 106.4 | 106.2 | 105.1 |
| Fourth | 94.7 | 102.2 | 106.5 | 107.3 | 106.9 |
| Highest | 82.6 | 88.9 | 95.9 | 101.3 | 100.7 |

| | **Graduate Borrowers** | | | | |
| | Projected Earnings Quintiles | | | | |
| Loan Disbursement Quintiles | Lowest | Second | Middle | Fourth | Highest |
|---|---|---|---|---|---|
| Lowest | 97.8 | 97.2 | 97.2 | 97.0 | 95.4 |
| Second | 97.5 | 99.7 | 101.2 | 100.6 | 97.7 |
| Middle | 91.5 | 101.6 | 107.1 | 105.3 | 101.1 |
| Fourth | 88.4 | 96.4 | 107.8 | 107.9 | 108.5 |
| Highest | 78.3 | 85.9 | 95.8 | 109.0 | 116.2 |

Source: Authors' calculations using data from the National Student Loan Data System and model projections.

The table shows projected repayment as a percentage of borrowers' original disbursement amount. Payments are discounted to their present value in the year of disbursement, using interest rates on Treasury securities. Earnings are calculated as projected average annual earnings within the first 20 years after borrowers began repaying their loans. Quintiles of earnings and loan disbursement are defined within borrowers with the same level of education. The sample comprises all borrowers who entered repayment between 2010 and 2017, including those not in income-driven repayment plans.