CHAPTER 8

Student Loans and Repayment: Theory, Evidence, and Policy

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Abstract

Rising costs of and returns to college have led to sizeable increases in the demand for student loans in many countries. In the USA, student loan default rates have also risen for recent cohorts as labor market uncertainty and debt levels have increased. We discuss these trends as well as recent evidence on the extent to which students are able to obtain enough credit for college and the extent to which they are able to repay their student debts after. We then discuss optimal student credit arrangements that balance three important objectives: (i) providing credit for students to access college and finance consumption while in school, (ii) providing insurance against uncertain adverse schooling or post-school labor market outcomes in the form of income-contingent repayments, and (iii) providing incentives for student borrowers to honor their loan obligations (in expectation) when information and commitment frictions are present. Specifically, we develop a two-period educational investment model with uncertainty and show how student loan contracts can be designed to optimally address incentive problems related to moral hazard, costly income verification, and limited commitment by the borrower. We also survey other research related to the optimal design of student loan contracts in imperfect markets. Finally, we provide practical policy guidance for re-designing student loan programs to more efficiently provide insurance while addressing information and commitment frictions in the market.

Keywords

Human capital, Borrowing, Student loans, Default, Repayment, Income-contingent, Credit constraint

JEL Codes

D14, D82, H21, H52, I22, I24, J24

1. INTRODUCTION

Three recent economic trends have important implications for financing higher education: (i) rising costs of postsecondary education, (ii) rising average returns to schooling in the labor market, and (iii) increasing labor market risk. These trends have been underway in the USA for decades; however, similar trends are also apparent in many other developed countries. Governments around the world are struggling to adapt tuition and financial aid policies in response to these changes. In an era of tight budgets, postsecondary students are being asked to pay more for their education, often with the help of government-provided student loans.

While some countries have only recently introduced student loan programs, many American students have relied on student loans to finance college for decades.

Still, the rising returns and costs of education, coupled with increased labor market uncertainty, have generated new interest in the efficient design of government student loan programs. In this chapter, we consider both theoretical and empirical issues relevant to the design of student loan programs with a particular focus on the US context.

The rising returns to and costs of college have dramatically increased the demand for credit by American students. Since the mid-1990s, more and more students have exhausted resources available to them from government student loan programs, with many turning to private lenders for additional credit. Despite an increase in private student lending, there is concern that a growing fraction of youth from low- and even middle-income backgrounds are unable to access the resources they need to attend college (Lochner and Monge-Naranjo, 2011, 2012).

At the same time, new concerns have arisen that many recent students may be taking on too much debt while in school. Growing levels of debt, coupled with rising labor market uncertainty, make it increasingly likely that some students are unable to repay their debts. These problems became strikingly evident during the Great Recession, when many recent college graduates (and dropouts) had difficulties finding their first job (Elsby et al., 2010; Hoynes et al., 2012). For the first time in more than a decade, default rates on government student loans began to rise in the USA.

Altogether, these trends raise two seemingly contradictory concerns: Can today's college students borrow enough? Or, are they borrowing too much? Growing evidence suggests that both concerns are justified and that there is room to improve upon the current structure of student loan programs. This has led to recent interest in income-contingent student loans in the USA and many other countries.

We, therefore, devote considerable attention to the design of optimal student lending programs in an environment with uncertainty and various market imperfections that limit the extent of credit and insurance that can be provided. In a two-period environment, we derive optimal student credit contracts that are limited by borrower commitment (repayment enforcement) concerns, incomplete contracts, moral hazard (hidden effort), and costly income verification. We show how these incentive and contractual problems distort consumption allocations across postschool earnings realizations, intertemporal consumption smoothing via limits on borrowing, and educational investment decisions. We also summarize other related research on these issues and related concerns about adverse selection in higher education, as well as dynamic contracting issues in richer environments with multiple years of postschool repayment. Based on results from our theoretical analysis and the literature more generally, we discuss important policy lessons that can help guide the design of optimal government student loan programs.

The rest of this chapter proceeds as follows. Section 2 documents several recent trends in the labor market and education sector relevant to our analysis. We then describe current student loan markets (especially in the USA) in Section 3, before summarizing literatures on borrowing constraints in higher education (Section 4) and student loan repayment (Section 5). Our analysis of optimal student credit contracts under uncertainty and various information and contractual frictions appears in Section 6, followed by a discussion of important policy lessons in Section 7. Concluding remarks and suggestions for future research are reserved for Section 8.

2. TRENDS

2.1 Three Important Economic Trends

Three important economic trends have substantially altered the landscape of higher education in recent decades, affecting college attendance patterns, as well as borrowing and repayment behavior. These trends are all well-established in the USA, but some are also apparent to varying degrees in other developed countries. We focus primarily on the USA but also comment on a few other notable examples.

First, the costs of college have increased markedly in recent decades, even after accounting for inflation. Fig. 1 reports average tuition, fees, room, and board (TFRB)

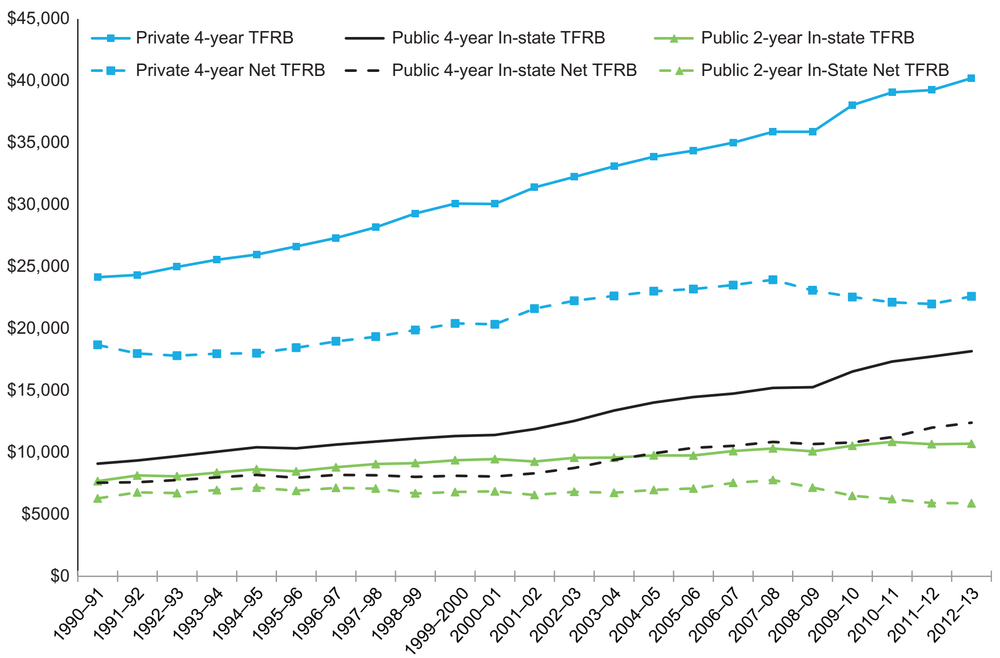

Figure 1 Evolution of average tuition, fees, room, and board in the USA (2013 $). *Source: College Board (2013) (online Tables 7 and 8), Trends in College Pricing.*

in the USA (in constant year 2013 dollars) from 1990–91 to 2012–13 for private non-profit 4-year institutions as well as public 4-year and 2-year institutions. Since 1990–91, average posted TFRB doubled at 4-year public schools, while it increased by 65% at private 4-year institutions. Average published costs rose less (39%) at 2-year public schools. The dashed lines in Fig. 1 report net TFRB each year after subtracting off tuition-waivers, grants, and tax benefits, which also increased over this period. Accounting for expansions in student aid, the average net cost of attendance at public and private 4-year colleges increased by "only" 64% and 21%, respectively, while net TFRB declined slightly (6%) at public 2-year schools. Driving some of these changes are increases in the underlying costs of higher education. Current fund expenditures per student at all public institutions in the USA rose by 28% between 1990–91 and 2000–01 reflecting an annual growth rate of 2.5% (Snyder et al., 2009, Table 360).[1] Expenditures per student have also risen in many other developed countries (OECD, 2013). In some of these countries, governments have shouldered much of the increase, while tuition fees have risen substantially in others like Australia, Canada, the Netherlands, New Zealand, and the UK.[2]

Second, average returns to college have increased sharply in many developed countries, including Australia, Canada, Germany, the UK, and the USA.[3] In the USA, Autor et al. (2008) document a nearly 25% increase in weekly earnings for college graduates between 1979 and 2005, compared with a 4% decline among workers with only a high school diploma. Even after accounting for rising tuition levels, Avery and Turner (2012) calculate that the difference in discounted lifetime earnings (net of tuition payments) between college and high school graduates rose by more than $300,000 for men and $200,000 for women between 1980 and 2008.[4] Heckman et al. (2008) estimate that internal rates of return to college versus high school rose by 45% for black men and 60% for white men between 1980 and 2000.

Third, labor market uncertainty has increased considerably in the USA. Numerous studies document increases in the variance of both transitory and persistent shocks to

[1] Jones and Yang (2014) argue that much of the increase in the costs of higher education can be traced to the rising costs of high skilled labor due to skill-biased technological change.

[2] Tuition and fees rose by a factor of 2.5 in Canada between 1990–91 and 2012–13. Australia, the Netherlands, and the UK all moved from fully government-financed higher education in the late 1980s to charging modest tuition fees by the end of the 1990s. Current statutory tuition fees in the Netherlands stand at roughly US$5000, while tuition in Australia now averages more than US$6500. Most dramatically, tuition and fees nearly tripled from just over £3000 to £9000 (nearly US$5000 to over US$14,500) at most UK schools in 2012. Tuition fees have also increased substantially in New Zealand since fee deregulation in 1991.

[3] See eg, Card and Lemieux (2001) for evidence on Canada, the UK, and USA; Boudarbat et al. (2010) on Canada; Dustmann et al. (2009) on Germany; and Wei (2010) on Australia. Pereira and Martins (2000) estimate increasing returns to education more generally in Denmark, Italy, and Spain, as well.

[4] These calculations are based on a 3% discount rate.

earnings beginning in the early 1970s.[5] Lochner and Shin (2014) estimate that the variance in permanent shocks to earnings increased by more than 15 percentage points for American men over the 1980s and 1990s, while the variance of transitory shocks rose by 5–10 percentage points over that period. A number of recent studies also document increases in the variances of permanent and transitory shocks to earnings in Europe since the 1980s.[6] The considerable uncertainty faced by recent school-leavers has been highlighted throughout the Great Recession with unemployment rates rising for young workers regardless of their educational background.[7] While very persistent shocks early in borrowers' careers clearly threaten their ability to repay their debts in full, even severe negative transitory shocks can make maintaining payments difficult for a few years without some form of assistance or income-contingency.

2.2 US Trends in Student Borrowing and Debt

Despite rising costs of college and labor market uncertainty, the steady rise in labor market returns to college has driven American college attendance rates steadily upward over the past few decades. The fraction of Americans that had enrolled in college by age 19 increased by 25 percentage points between cohorts born in 1961 and 1988, while college completion rates rose by about 7 percentage points over this time period (Bailey and Dynarski, 2011).

Along with the increase in college-going, the rising costs of and returns to college have led to a considerable increase in the demand for student loans in the USA.[8] Fig. 2 demonstrates the dramatic increase in annual student borrowing between 2000–01 and 2010–11 as reported by College Board (2011).[9] Not surprisingly, debt levels from student loans have also exploded, surpassing total credit card debt in the USA. Analyzing data drawn from a random sample of personal credit reports (FRBNY Consumer Credit Panel/Equifax, henceforth CCP), Bleemer et al. (2014) report that combined government and private student debt levels in the US quadrupled (in nominal terms) from $250 billion in 2003 to $1.1 trillion in 2013.

[5] See Gottschalk and Moffitt (2009) for a recent survey of this literature. More recent work includes Heathcote et al. (2010a,b), Moffitt and Gottschalk (2012), and Lochner and Shin (2014).

[6] Fuchs-Schundeln et al. (2010) document an increase in the variance of permanent shocks in Germany, while Jappelli and Pistaferri (2010) estimate increases in the variance of transitory shocks in Italy. Domeij and Floden (2010) document increases in the variance of both transitory and permanent shocks in Sweden over this period. In Britain, Blundell et al. (2013) find that increases in the variance of permanent and transitory shocks has been concentrated in recessions.

[7] See Elsby et al. (2010) and Hoynes et al. (2012) for evidence on unemployment rates during the Great Recession by age and education in the USA. Bell and Blanchflower (2011) document sizeable increases in unemployment throughout Europe for young workers with and without postsecondary education.

[8] Hershbein and Hollenbeck (2015) estimate that changes in the composition of college graduates (eg, parental education and income, race, institution of attendance, college major) explain very little of the increase in student borrowing between 1990 and 2008.

[9] Total Stafford loan disbursements also more than doubled in the previous decade (College Board, 2001).

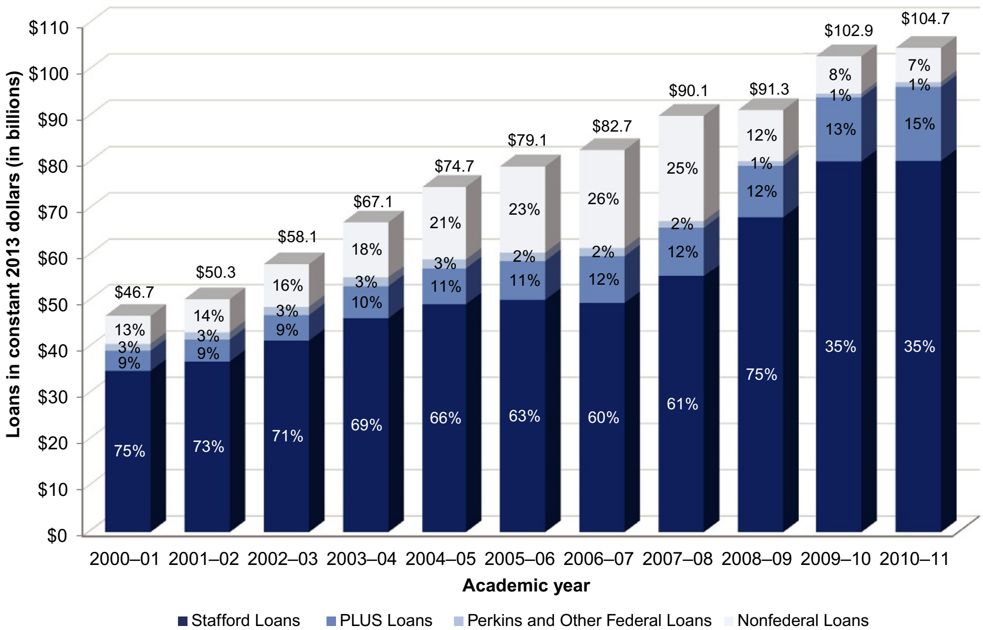

Figure 2 Growth in student loan disbursements in the USA (in 2013 $). *Source:* *College Board (2011)*.

The dramatic increases in aggregate student borrowing and debt levels reflect not only the rise in college enrolment in the USA over the past few decades, but also an increase in the share of students taking out loans and greater borrowing among those choosing to borrow. Based on the CCP, Bleemer et al. (2014) show that the fraction of 25-year olds with government and/or private student debt rose from 25% in 2003 to 45% in 2013. Over that same decade, average student debt levels among 22- to 25-year olds with positive debt nearly doubled from $10,600 to $20,900 (in 2013 $). Akers and Chingos (2014) use the Survey of Consumer Finances (SCF) to study the evolution of household education debt (including both private and government student loans) over two decades for respondents ages 20–40. As shown in Fig. 3, the fraction of these households with education debt nearly doubled from 14% in 1989 to 36% in 2010, while the average amount of debt (among families with debt) more than tripled.[10] Altogether, these figures imply an eightfold increase in average debt levels (per person) among all 20- to 40-year-old households (borrowers and nonborrowers alike) between 1989 and 2010.[11]

[10] Brown et al. (2016) compare household debt levels in the CCP and SCF for the years 2004, 2007, and 2010. Their findings suggest that student loan debts appear to be under-reported by 24% (2004) to 34% (2010) in the SCF relative to credit report records in the CCP.

[11] In discussing the results of Akers and Chingos (2014), we refer to 20- to 40-year-old households as households in which the SCF respondent was between the ages of 20 and 40.

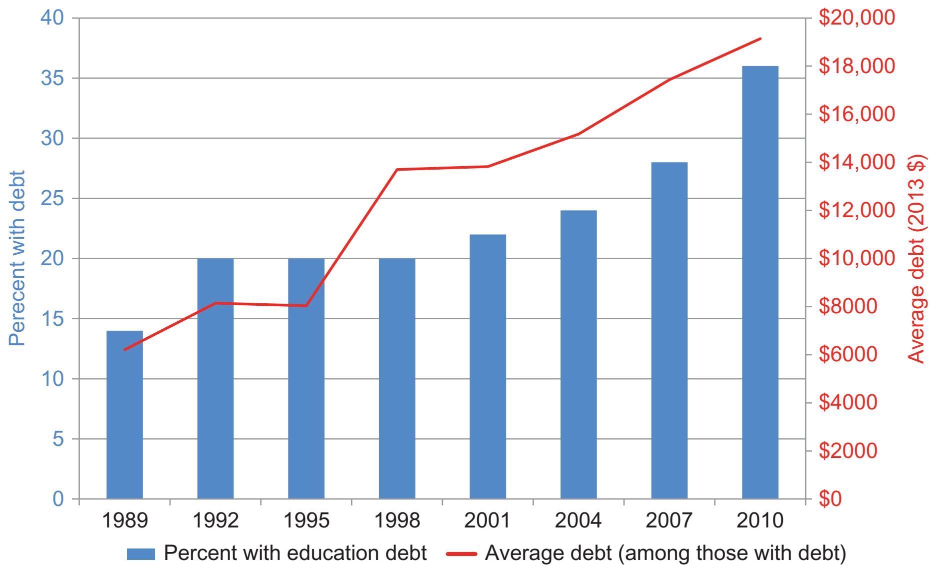

Figure 3 Incidence and amount (in 2013 $) of household education debt for 20- to 40-year olds in the USA. *Source:* *Akers and Chingos (2014, Table 1).*

Table 1 Education debt for baccalaureate degree recipients in NPSAS (2013 $)

Year graduating	Percent with education debt	Avg. cumulative student loan debt (per borrower)	Avg. cumulative student loan debt (per graduate)
1989–90	55	13,500	7300
1995–96	53	17,800	9300
1999–2000	64	22,900	14,600
2003–04	66	23,000	15,100
2007–08	68	25,800	17,600
2011–12	71	29,700	21,200

Source: Hershbein and Hollenbeck (2014, 2015).

With the CCP and SCF, it is difficult to determine debt levels at the time students leave school, so figures from these sources reflect both borrowing and early repayment behavior. By contrast, the National Postsecondary Student Aid Study (NPSAS) allows researchers to study the evolution of education-related debt accumulated during college. Using the NPSAS, Hershbein and Hollenbeck (2014, 2015) consider total student debt (government and private) accumulated by baccalaureate degree recipients who graduated in various years back to 1989–90 (see Table 1). They report that the fraction of baccalaureate recipients graduating with education debt increased by nearly one-third from 55% in 1992–93 to 71% in 2011–12, while average total student debt per graduating

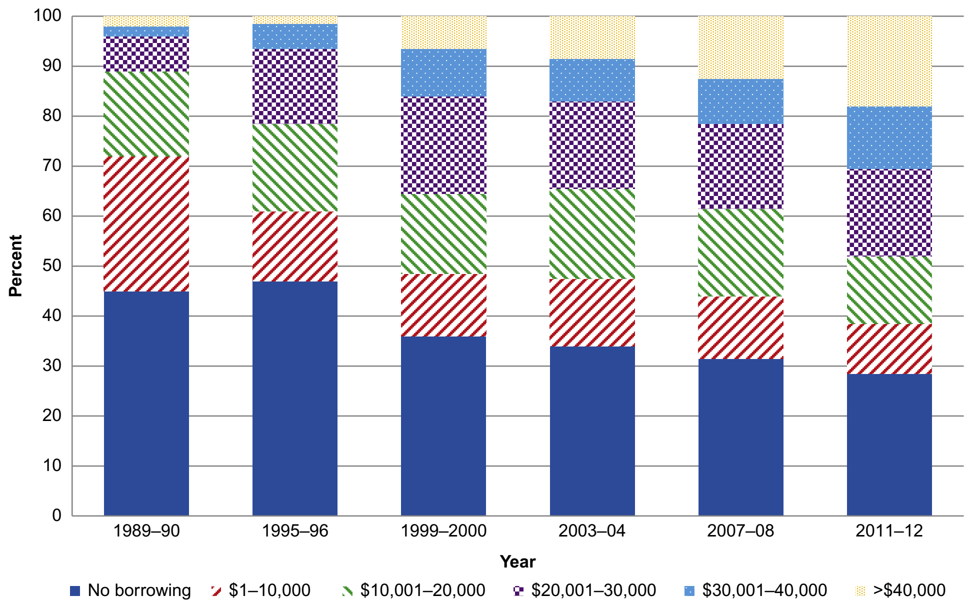

Figure 4 Distribution of cumulative undergraduate debt for baccalaureate recipients over time (NPSAS). *Source: Hershbein and Hollenbeck (2014, 2015).*

borrower more than doubled. Together, total student debt per graduate tripled between the 1989–90 and 2011–12 cohorts.

Fig. 4 documents the changing distribution of cumulative loan amounts among baccalaureate recipients over time in the NPSAS (Hershbein and Hollenbeck, 2014, 2015). The figure reveals different trends at the low and high ends of the debt distribution. The fraction of college graduates borrowing less than $10,000 (including nonborrowers) declined sharply in the 1990s but remained quite stable thereafter until the financial crisis in 2008. By contrast, undergraduate student debts of at least $30,000 increased more consistently over time, with the exception of the early 2000s when the entire distribution of debt was relatively stable. Since 1989–90, the fraction of college graduates that borrowed more than $30,000 increased from 4% to 30%. Though not shown in the figure, less than 1% of all graduates had accumulated more than $50,000 in student debt before 1999–2000, while 10% had by 2011–12 (Hershbein and Hollenbeck, 2014, 2015).

Fig. 5, from Steele and Baum (2009), reports the distribution of accumulated student loan debt separately for associate and baccalaureate degree recipients in the 2007–08 NPSAS. Students earning their associate degree borrowed considerably less, on average, than did those earning a baccalaureate degree. Roughly one-half of associate degree earners did not borrow anything, while only 5% borrowed $30,000 or more.

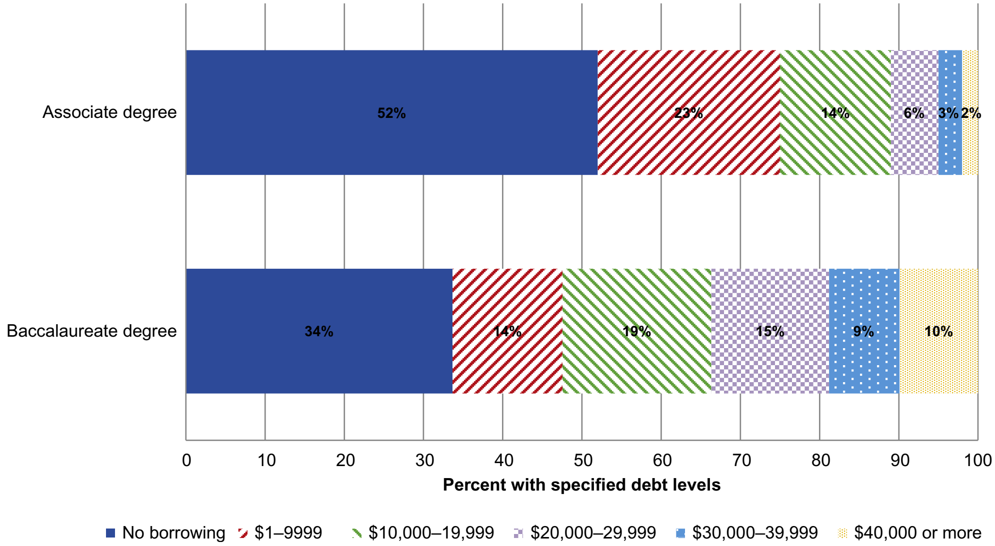

Figure 5 Distribution of cumulative student loan debt by undergraduate degree (NPSAS 2007–08). Data from 2007–08 NPSAS and includes US citizens and residents. Excludes PLUS loans, loans from family/friends, and credit cards. *Source: Steele and Baum (2009).*

It is important to note that students from all income backgrounds borrow from federal student loan programs and increasingly so. Fig. 6 documents the growth in average federal student loan amounts for dependent undergraduates by parental income quartile between 1989–90 and 2003–04 based on available NPSAS (Berkner, 2000; Wei and Berkner, 2008). This growth reflects increases at both the extensive margin (percent borrowing) as well as the intensive margin (amount per borrower) and is most pronounced for the highest income quartile. The sizeable increases in borrowing between 1992–93 and 1995–96 for all but the lowest income quartile coincide with the introduction of unsubsidized Stafford loans, which can be taken out irrespective of financial need.

The steady rise in total student borrowing over the late 1990s and 2000s belies the fact that government student loan limits remained unchanged (in nominal dollars) between 1993 and 2008. Adjusting for inflation, this reflects a nearly 50% decline in value. In 2008, aggregate Stafford loan limits for dependent undergraduate students jumped from $23,000 to $31,000, although this value was still more than 10% below the 1993 limit after accounting for inflation. Not surprisingly, a rising number of students have exhausted available government student loan sources over this period. For example, the share of full-time/full-year undergraduates that "maxed out" Stafford loans increased nearly sixfold from 5.5% in 1989–90 to 32.1% in 2003–04 (Berkner, 2000; Wei and Berkner, 2008).

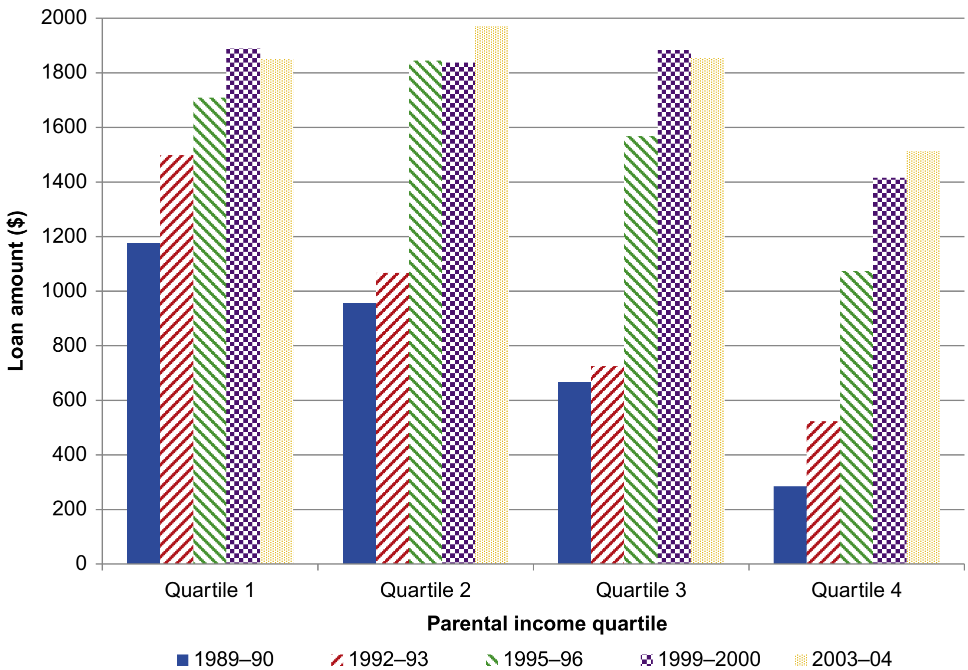

Figure 6 Growth in average federal loan amounts (including nonborrowers) for dependent undergraduates by parental income quartile. *Source:* *Berkner (2000) and Wei and Berkner (2008).*

Undergraduates turned more and more to private lenders to help finance their education prior to the 2008 increase in federal student loan limits and contemporaneous collapse in private credit markets. Between 1999–2000 and 2007–08, average debt from federal student loan programs declined by a few thousand dollars among baccalaureate degree recipients, but this was more than compensated for by a sizeable jump in private student loan debt (Woo, 2014). The top parts of each bar in Fig. 2 reveal the aggregate shift in undergraduate borrowing toward nonfederal sources (mostly private lenders), which peaked at 25% of all student loan dollars in 2007–08 before dropping below 10%.[12] Finally, data from the NPSAS shows that the fraction of undergraduates using private student loans rose from 5% in 2003–04 to 14% in 2007–08 before dropping back to 6% in 2011–12 (Arvidson et al., 2013).

Akers and Chingos (2014) discuss three important reasons that these increases in student borrowing do not necessarily imply greater monthly repayment burdens on today's borrowers: (i) earnings have increased significantly for college students, especially those

[12] These figures do not include student credit card borrowing, which has also risen over this period. In 2008, 85% of undergraduates had at least one credit card and carried an average balance of $3173 (Sallie Mae, 2008).

graduating with a baccalaureate degree or higher, (ii) nominal interest rates on federal student loans have fallen, and (iii) amortization periods for federal student loans have been extended.[13] Indeed, Akers and Chingos (2014) report that among 20- to 40-year-old households with positive education debt and monthly wage income of at least $1000, median student loan payment-to-income ratios remained relatively constant at 3–4% between 1992 and 2010, while average monthly payment-to-income ratios actually fell by half over the 1990s and have remained fairly stable thereafter. The incidence of high payment-to-income ratios (eg, at least 20%) also fell over this period. It is important to note, however, that these statistics (in all years) likely understate the financial burden of student loan payments on recent school-leavers, since they exclude very low-income households (wage income less than $1000 per month) from their analysis and since earnings levels are typically lowest in the first few years out of school.[14]

2.3 US Trends in Student Loan Delinquency and Default

Student loan delinquency and default rates provide another useful picture of borrowers' capacity and willingness to repay their student loan obligations. Fig. 7 reports official 2- and 3-year cohort default rates from 1987 to 2011. These default measures reflect the fraction of students entering repayment in a given year that default on their federal student loans within the next 2 or 3 years, respectively.[15] Despite increases in student debt levels over the 1990s, default rates declined considerably over this period. While largely unstudied, this decline likely reflects the increase in earnings associated with postsecondary schooling over that period as well as increased enforcement and collection efforts by the federal government.[16] After remaining relatively stable over the early 2000s, default rates on federal student loans began to increase sharply with the financial crisis of 2007–08 and the onset of the Great Recession. Two-year cohort default rates more than doubled from 4.6% in 2005 to 10% in 2011.

[13] Nominal interest rates on federal student loans fell from 8.3% in 1992 to 5.5% in 2010; average amortization periods on federal student loans increased from 7.5 to 13.4 years among 20- to 40-year-old households with debt (Akers and Chingos, 2014). Together, these imply a reduction in annual repayments of 42% for the same loan amount.

[14] The downward trend in payment-to-income ratios may also be driven, at least partially, by more severe under-reporting of student debt in the SCF as suggested by Brown et al. (2016). See footnote 10.

[15] Borrowers that are 270 days or more (180 days or more prior to 1998) late on their Stafford student loan payments are considered to be in default.

[16] Throughout the 1990s, the federal government expanded default collection efforts to garnish wages and seize income tax refunds from borrowers that default. The Department of Education began to exclude postsecondary institutions with high default rates (currently 30% or higher for 3 consecutive years) from participating in federal student aid (including Pell Grant) programs in the early 1990s. The 1998 change in the definition of default from 180 to 270 days late also contributed to some of the decline.

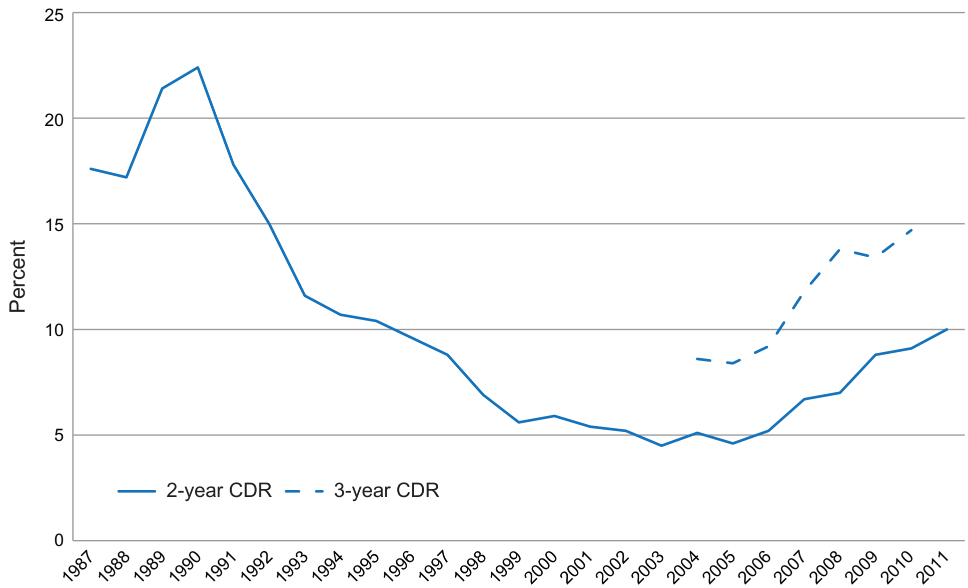

Figure 7 Trends in federal student loan cohort default rates.

Fig. 8 reveals that the decline in default rates over the 1990s was most pronounced among 2-year schools and 4-year for-profit institutions, which all had much higher initial default rates than 4-year public and private nonprofit schools.[17] Since 2005, default rates have increased most at for-profit institutions and public 2-year schools, which now stand at 13–15%. Default rates at these institutions are at least 5 percentage points higher than at other school types.

Default is only one very extreme form of nonpayment. Using CCP data, Brown et al. (2015) show high and increasing rates of delinquency (90 or more days late) on student loan payments (including government and private student loans) over the past decade. Among borrowers under age 30 still in repayment, the fraction delinquent on student loans increased sharply from 20% in 2004 to 35% in 2012. Using student loan records from five major loan guarantee agencies, Cunningham and Kienzl (2014) report that among students entering repayment in 2005, 26% had become delinquent and 15% had defaulted at some point over the next 5 years; another 16% had received a forbearance or deferment for economic hardship. Altogether, 57% had experienced a period where they did not make their expected payments.

[17] These figures are calculated from official default rates by institution as maintained by Department of Education.

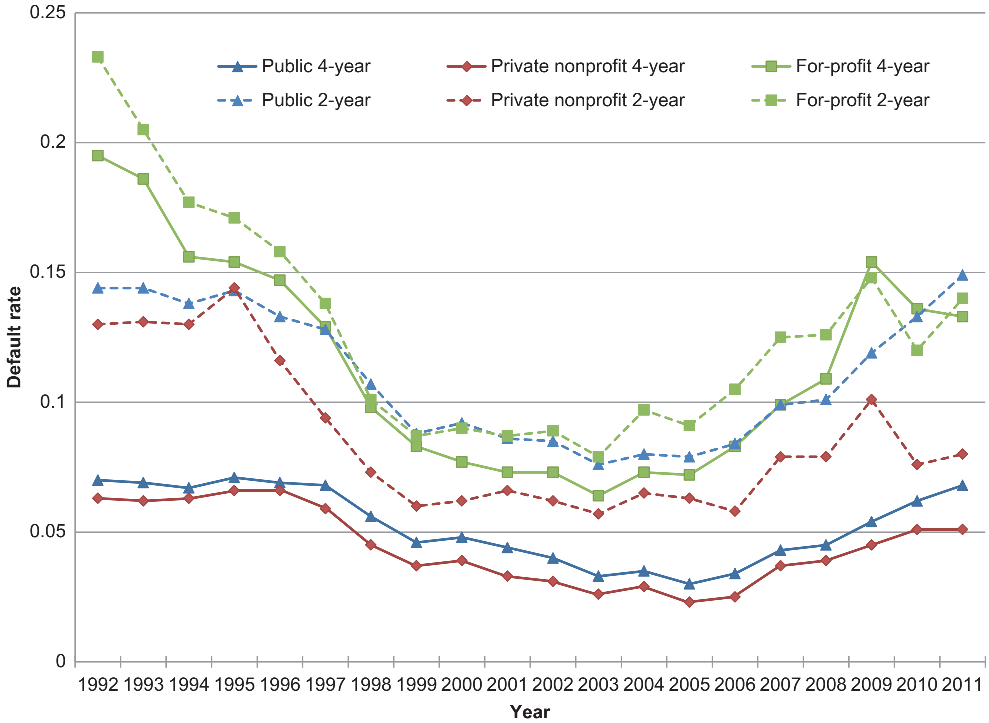

Figure 8 Trends in federal student loan 2-year cohort default rates by institution type.

2.4 Summary of Major Trends

Summarizing these trends for the USA, both the costs of and returns to college have risen dramatically in recent decades. On balance, the net returns to college have risen, which has led to important increases in college attendance rates. Student borrowing has also risen at both the extensive and intensive margins. While borrowing from government student loan programs has increased over this period, students have turned increasingly more to private lenders since the early 1990s to help fill the gap between sharply growing demand for credit and relatively stable or declining supply from government sources. Rising debt levels, coupled with an increase in labor market uncertainty, have given rise to higher delinquency and default rates on government and private student loans.

After discussing the current student loan environment in the USA and a few other countries, we return to some of these issues below in Sections 4 and 5, where we summarize evidence on borrowing constraints in higher education and the determinants of student loan repayment/default.

3. CURRENT STUDENT LOAN ENVIRONMENT

In this section, we describe the current student loan environment with an emphasis on the USA. However, we also provide a brief international context for student loan programs, devoting considerable attention to income-contingent loan repayment schemes.

3.1 Federal Student Loan Programs in the USA

Most federal loans are provided through the Stafford loan program, which awarded about $90 billion in the 2011–12 academic year, compared to $19 billion awarded through Federal Parent Loans (PLUS) and GradPLUS Loans combined, and just under $1 billion through the Perkins Loan program. For some perspective, total Pell Grant awards amounted to about $34 billion. See the College Board (2013) for these and related statistics. Important features of the main federal student loan programs are summarized in Table 2. We briefly discuss these programs in the following sections.

3.1.1 Stafford Loans

The federal government offers Stafford loans to undergraduate and graduate students through the William D. Ford Federal Direct Student Loan (FDSL) program.[18] Students are not charged interest on subsidized loans as long as they are enrolled in school, while interest accrues on unsubsidized loans. Only undergraduates are eligible for unsubsidized loans. In order to qualify for subsidized loans, undergraduate students must demonstrate financial need, which depends on family income, dependency status, and the cost of institution attended. Unsubsidized loans are available to both undergraduate and graduate students and can be obtained without demonstrating need. In general, students under age 24 are assumed to be "dependent," in which case their parents' income is an important determinant of their financial need.

Dependency status and year in college determine the total amount of Stafford loans a student is eligible for, as seen in Table 2. Dependent students can borrow as much as $31,000 over their undergraduate years, while independent students can borrow twice that amount.[19] Annual limits are lowest for the first year of college, increasing in the following 2 years.

[18] In the past, private lenders provided loans to students under the Federal Family Education Loan Program (FFEL), and the federal government guaranteed those loans with a promise to cover unpaid amounts. Regardless of the source of funds, the rules governing FDSL and FFEL programs were essentially the same. Prior to the introduction of unsubsidized Stafford loans in the early 1990s, Supplemental Loans to Students (SLS) were an alternative source of unsubsidized federal loans for independent students.

[19] Dependent students whose parents do not qualify for the PLUS program can borrow up to the independent student Stafford loan limits.

Table 2 Summary of current federal student loan programs

	Stafford: Dependent students	Stafford: Independent students[a]	Perkins	PLUS and GradPLUS
Recipient	Students	Students	Students	PLUS: parents GradPLUS: grad. students
Eligibility	Subsidized: undergrad., financial need[b] Unsubsidized: all students		Financial need	No adverse credit history or cosigner required
Undergraduate limits				
Year 1	$5500	$9500	$5500	All need
Year 2	$6500	$10,500	$5500	All need
Years 3+	$7500	$12,500	$5500	All need
Cum. total	$31,000	$57,500	$27,500	All need
Graduate limits				
Annual	$20,500		$8000	All need
Cum. total[c]	$138,500		$60,000	All need
Interest rate	Undergrad.: variable, ≤8.25% Grad.: variable, ≤9.5%		5%	Variable, 10.5% limit
Fees	1.07%		None	4.3%
Grace period	6 months		9 months	Up to 6 months

[a]Students whose parents do not qualify for PLUS loans can borrow up to independent student limits from the Stafford program.
[b]Subsidized Stafford loan amounts cannot exceed $3500 in year 1, $4500 in year 2, $5500 in years 3+, and $23,000 cumulative.
[c]Cumulative graduate loan limits include loans from undergraduate loans.

Interest rates on Stafford loans are variable subject to upper limits of 8.25% for undergraduates and 9.5% for graduate students.[20] Fees are levied on borrowers of about 1%, which is proportionally subtracted from each disbursement. Students need not re-pay their loans while enrolled at least half-time, though interest does accrue on unsubsidized loans. After leaving school, borrowers are given a 6-month grace period before they are required to begin re-paying their Stafford loans.

[20] Interest rates for undergraduate and graduate students are equal to the 10-year treasury note plus 2.05% and 3.6%, respectively, subject to the upper limits. For the 2013–14 academic year, the rates equal 3.86% and 5.41% for undergraduates and graduates, respectively.

3.1.2 PLUS and GradPLUS Loans

The PLUS program allows parents who do not have an adverse credit rating to borrow for their dependent children's education. The GradPLUS program offers the same opportunities for graduate and professional students to borrow for their own education. Generally, parents and graduate students can borrow up to the total cost of schooling less any other financial aid given to the student. For this purpose, the cost of schooling is determined by the school of attendance and includes such expenses as tuition and fees, reasonable room and board allowances, expenses for books, supplies, and equipment. Interest rates are variable (10-year treasury note plus 4.6%) subject to a 10.5% limit, and fees of 4.3% of loan amounts are charged on origination. Graduate students enrolled at least half-time can defer all GradPLUS loan payments until 6 months after leaving school. Parents borrowing from the PLUS program can also request such a deferment.

3.1.3 Perkins Loans

The Perkins loan program targets students in need, distributing funds provided by the government and participating postsecondary institutions. Loan amounts depend on the student's level of need and funding by the school attended, but they are subject to an upper limit of $5500 per year for undergraduates and $8000 per year for graduate students. By far the most financially attractive loan alternative for students, Perkins loans entail no fees and a fixed low interest rate of 5% (see Table 2). Students are also given a 9-month grace period after finishing (leaving) school before they must begin re-payment of a Perkins loan.

3.1.4 Federal Student Loan Repayment and Default

Re-payment of student loans begins 6 (Stafford) or 9 (Perkins) months after finishing school with collection managed by the Department of Education. To simplify repayment, borrowers can consolidate most of their federal loans into a single Direct Consolidation Loan. Borrowers with Stafford or Direct Consolidation Loans have a number of repayment plans available to them.[21]

Under the *Standard Repayment Plan* and *Extended Repayment Plan*, borrowers make a standard fixed monthly payment based on their loan amount amortized over 10–30 years. For example, repayment periods are limited to 10 years for borrowers owing less than $7500, 20 years for borrowers owing less than $40,000, and 30 years for those owing $60,000 or more.[22] Borrowers may also choose the *Graduated Repayment Plan*, which starts payments at low monthly amounts, increasing payment amounts every 2 years over

[21] Payments for nonconsolidated Perkins Loans are fixed based on a 10-year amortization period.

[22] These repayment periods apply to borrowers who hold consolidated loans. For those with other nonconsolidated federal loans, the *Extended Repayment Plan* allows for repayment periods of up to 25 years for those with loans exceeding $30,000.

the 10- to 30-year repayment period. Final payments may be as much as three times initial payments under this plan. While the reduced starting payments of the *Graduated Repayment Plan* can be helpful for borrowers with modest initial earnings after leaving school, payments are not automatically adjusted based on income levels. Thus, payments under all of these debt-based repayment plans may be difficult for those who experience periods of unemployment or unusually low earnings. If these borrowers can demonstrate financial hardship, they may qualify for either a forbearance or deferment, which temporarily reduces or delays payments.[23]

Alternatively, borrowers may choose from a variety of income-based plans that directly link payment amounts to current income. The newest (and most attractive) of these plans is known as the *Pay As You Earn Plan* (PAYE). Under this plan, monthly payments are the lesser of the fixed payment under the 10-year *Standard Repayment Plan* and 10% of discretionary family income.[24] Borrowers on PAYE never pay more than the standard payment amount, and those with income less than 150% of the poverty level are not required to make any payment. Interest continues to accumulate even when payments are reduced or zero; however, any remaining balance after 20 years is forgiven.

It is important to point out that income-based repayment amounts and eligibility for forbearance/deferment do not depend on parental income or wealth, despite the important role these resources play in determining financial aid offerings at the time of enrolment. As documented in Section 5.3, parental support can be an important resource for former students that would otherwise have difficulties repaying their loans due to poor labor market outcomes; however, this form of support is not easily identified by lenders and is not currently considered by government student loan programs (except the PLUS program, which lends directly to parents themselves).

Loans covered by the federal system cannot generally be expunged through bankruptcy except in very special circumstances. Thus, the only way a borrower can "avoid" making required payments is to simply stop making them, or default. A borrower is considered to be in default once he becomes 270 days late in making a payment. If the loan is not fully re-paid immediately, or if a suitable re-payment plan is not agreed upon with the lender, the default status will be reported to credit bureaus, and collection costs may be added to the amount outstanding. Up to 15% of the

[23] Borrowers can request a deferment during periods of unemployment or when working full time but earning less than the federal minimum wage or 1.5 times the poverty level. Borrowers are entitled to deferments of up to 3 years due to unemployment or economic hardship. Borrowers can request a forbearance (usually up to 12 months at a time) due to economic hardship (eg, monthly payments exceed 20% of gross income).

[24] Discretionary income is the amount over 150% of the poverty guideline (based on family size and state of residence). In 2014, the federal poverty guideline for a single- (two-) person family was $11,670 ($15,730) in the 48 contiguous states, so the income-based payment amount for a single- (two-) person family is 10% of any income over $17,505 ($23,595).

borrower's disposable earnings can be garnished (without a court order), and federal tax refunds or Social Security payments can be seized and applied toward the balance.[25] In practice, these sanctions are sometimes limited by the inability of collectors to locate those who have defaulted. Wage garnishments are ineffective against defaulters that are self-employed. Furthermore, individuals can object to the wage garnishment if it would leave them with a weekly take-home pay of less than 30 (h/week) times the federal minimum hourly wage, or if the garnishment would otherwise result in an extreme financial hardship.

Just how costly are these punishments for those defaulting on their student loans? Of the $92 billion in delinquent student loans in 2011, the US Department of Education collected slightly over $1 billion through wage garnishments and $1.7 billion from income tax offsets (U.S. Department of the Treasury, 2012). Much more is eventually collected from defaulting borrowers as they rehabilitate their loans and continue their payments. The estimated lifetime recovery rate (net of collection costs) for Stafford loans disbursed in 2014 that will go into default at some point is roughly 85%.[26]

We do not know of any specific estimates of the impacts of student loan delinquency and default on future access to credit. Musto (2004) estimates a negative effect of personal bankruptcy on credit scores and access to new credit; however, these findings cannot be directly extrapolated to student loan delinquency and default since these actions do not lead to a discharge of debts as in the case of bankruptcy. Interestingly, the recent work of Albanesi and Nosal (2015) on the bankruptcy law reform of 2005 suggests that defaults on student loans may have even more detrimental consequences on credit scores and access to new credit than filing for bankruptcy, since the latter clears other forms of unsecured debt.

3.2 Private Student Loan Programs in the USA

As noted earlier, 14% of all undergraduates in 2007–08 turned to private student loan programs to help finance their education. Due to tightening private credit markets and expansions in the Stafford loan program, the fraction of undergraduates borrowing from private lenders dropped by more than half over the next few years (Arvidson et al., 2013). However, private student loans are still an important source of funding for some students, especially those attending more expensive private nonprofit and proprietary schools.

[25] Other sanctions against borrowers who default include a possible hold on college transcripts, ineligibility for further federal student loans, and ineligibility for a deferment or forbearance. Since the early 1990s, the government has also punished educational institutions with high student default rates by making their students ineligible to borrow from federal lending programs.

[26] See page S-31 of the Department of Education's *Student Loans Overview* for the Fiscal Year 2014 Budget Proposal available at http://www2.ed.gov/about/overview/budget/budget14/justifications/s-loansoverview.pdf.

Private loans are not need-based. Instead, students or their families must demonstrate their creditworthiness to lenders whose aim is to earn a competitive return. Private student loans are generally capped by the total costs of college less any other financial aid; however, lenders sometimes impose tighter constraints. Eligibility, loan limits, and terms generally depend on the borrower's credit score and sometimes depend on other factors that may affect repayment, such as the institution of attendance and degree pursued. In most cases, lenders require a cosigner (with an eligible credit score) to commit to repaying the loan if students themselves do not; a cosigner may also improve the terms of the loan. In this way, private student loan contracts, unlike those of government student loan programs, effectively incorporate the potential for postschool parental support. Among student loans distributed by some of the top private lenders in recent years, more than 90% (60%) of all undergraduate (graduate) borrowers had a cosigner (Arvidson et al., 2013). Interest rates charged on private loans are typically higher than those offered by federal student loan programs, especially for borrowers with poor credit records. Rates may be fixed or variable and are usually pegged to either the prime rate or the London Interbank Offer Rate (LIBOR).

Repayment terms typically range between 10 and 25 years, almost universally with fixed debt-based payments. Some programs require borrowers to begin repaying their loan shortly after taking it out, while others provide students with deferments during enrolment periods. Some even offer up to a 6-month grace period after students leave school. In some cases, lenders may offer opportunities for deferment/forbearance due to economic hardship. All of these attributes are at the discretion of the lender.

Since 2005, private student loans (like federal student loans) cannot be expunged through bankruptcy except in exceptional circumstances.[27] However, private lenders do not have the same powers as the federal government to enforce repayment. Most notably, lenders must receive a court judgment in order to garnish wages or seize a delinquent borrower's assets.

3.3 The International Experience

Many countries offer government student loans for higher education (OECD, 2013). In most cases, the general structure for these programs is similar to that of the USA in that students can borrow to help cover tuition/fees and living expenses, payments can be deferred until after leaving school, and repayment terms are debt-based.[28] Contingencies like deferment/forbearance for borrowers experiencing financial hardship are common; however, most countries do not offer explicit income-contingent repayment schemes.[29] Exceptions include Australia, Canada, Chile, New Zealand, the UK, and

[27] These limits on bankruptcy do not extend to other sources of financing like credit cards or home mortgages, which are also sometimes used to finance higher education.

[28] Even in Nordic countries like Denmark, Norway, and Sweden that charge zero or negligible tuition and fees, government loans are an important source of funding for student living expenses.

[29] None consider parental resources in determining repayment amounts.

Table 3 Summary of income-contingent repayment plans

	Australia	New Zealand	United Kingdom	Canada	United States
Program name	HECS-HELP		Maintenance and tuition fee loans	RAP[a]	PAYE[a]
Year adopted	1989	1992	1998	2009	2012
Collected with taxes?	Yes	Yes	Yes	No	No
Covers living expenses?	No	Yes	Yes	Yes	Yes
Interest rate[b]	CPI	0%	RPI + 0–3%	Prime + 2.5 or 5%	10-year T-Note + 2.05%
Fees	10%[c]	$60 initial, $40 annual	No	No	No
Minimum income threshold for payment?	Yes	Yes	Yes	Varies by family size	Varies by family size
Repayment begins	Income > threshold	Income > threshold	April after school ends	After school + 6 months	After school + 6 months
Repayment rate (% of income)	4–8%	12% (over threshold)	9% (over threshold)	0–20% (over threshold)	10% (over threshold)
Repayment rate increase with income?	Yes	No	No	Yes	No
Prepayment discount?	5%	No	No	No	No
Loan forgiveness?	No	No	After 30 years	After 15 years	After 20 years

[a]Eligibility for both RAP in Canada and PAYE in the USA requires financial hardship.
[b]In Australia, debt levels increase with inflation as determined by the consumer price index (CPI). In the UK, interest rates are linked to the Retail Price Index (RPI) and increase with borrower income levels. In New Zealand, an interest rate of 5.9% is charged for borrowers who move overseas. In Canada, the variable rate is prime + 2.5% and the fixed rate is prime + 5%.
[c]Australian borrowers who make up-front fee payments (rather than borrow) receive a 10% discount.

South Africa, which all have explicit income-contingent repayment programs. Because recent policy discussions often refer to these programs in Australia, New Zealand, and the UK, we discuss them in some detail along with similar plans in Canada and the USA.[30] Table 3 summarizes key aspects of these income-contingent loan programs.

[30] Chapman (2006) provides a comprehensive discussion of income-contingent programs around the world.

While the details of student loan programs in Australia, New Zealand, and the UK have changed over the years, repayment schemes have been fully income-contingent for many years. Students choose how much they wish to borrow each schooling period — Australian students can borrow up to tuition/fees, while New Zealand and UK students can also borrow to cover living expenses — and do not need to make any payments until after leaving school.[31] In all cases, repayment amounts depend on borrower income levels and are collected through the tax system. Borrowers with income below specified minimum thresholds need not make any payments, while payments increase with income above the thresholds. Annual income thresholds range from a low of 19,800 NZ dollars (roughly US$15,500) in New Zealand to £21,000 (roughly US$35,000) in the UK to a high of 51,300 Australian dollars (roughly US$45,000) in Australia. Borrowers in New Zealand and the UK pay 12% and 9%, respectively, of their income above this threshold toward their loan balance once they leave school. In Australia, those with incomes above the threshold must make payments of 4–8% of their total income with the repayment rate increasing in their income level.[32] Australian borrowers receive a 5% discount on any additional prepayments they make above the required amount.

In Australia and New Zealand, borrowers are expected to make payments until their student debt is paid off; although, student debts can be cancelled through bankruptcy in New Zealand (not Australia). Fees and interest rates charged on the loans will determine the number of years borrowers must make payments, even if they do not affect annual payment amounts. In Australia, students who attend Commonwealth-supported (ie, public) institutions do not face any explicit fees on HECS-HELP loans; however, a discount of 10% is granted for any amount over $500 paid up front for tuition. This effectively implies a 10% initiation fee on student loans.[33] Other than these fees, Australian students do not pay any real interest on their loans; although, the value of student debts is adjusted with the CPI to account for inflation. By contrast, New Zealand charges modest fees of $60 at the time a loan is established and $40 each year thereafter; however, it charges zero interest and does not adjust loan amounts for inflation.

The UK does not charge any initial fees on loans, but it charges interest based on the RPI. While in school, interest accrues at a rate equal to the RPI + 3%. After school, students with income below the income threshold of £21,000 face an interest rate equal to the RPI. Above the threshold, the rate linearly increases in income until £41,000 when it reaches a maximum of RPI + 3%. Any outstanding debt is cancelled 30 years after repayment begins; however, debts cannot be cancelled through bankruptcy.

[31] In most cases, New Zealand students can borrow for up to 7 full-time equivalent school years.

[32] Students in Australia and New Zealand must make payments while enrolled in school if they earn above the income thresholds when they are enrolled.

[33] Under the FEE-HELP program in Australia, which provides loans to students at institutions that are not subsidized by the government, an explicit 25% initiation fee is charged on all loans, but there is no discount on up-front payments.

Like the USA, Canada offers student loans under debt-based repayment contracts along with an option for income-contingent repayment for borrowers with low income levels.[34] Standard repayment terms (fixed payments based on 10- or 15-year amortization periods) are similar to those in the USA and include a 6-month grace period after school before repayment begins. Interest accrues at either a fixed (prime + 5%) or floating (prime + 2.5%) rate. Introduced in 2009, the Canada Student Loans Program's (CSLP) Repayment Assistance Plan (RAP) offers reduced income-based payments for borrowers with low postschool incomes. Like PAYE in the USA, RAP payments are given by the lesser of the standard debt-based payment and an income-based amount ranging from zero to 20% of income above a minimum threshold. Borrowers earning less than a minimum income threshold need not make any payments under RAP.[35] For low payment levels, interest payments are covered by the government. After 15 years, any debt still outstanding is forgiven. As in the USA, student loan debts cannot typically be expunged through bankruptcy. The official 3-year cohort default rate of 14.3% for loans with repayment periods beginning in 2008–09 was very similar to the corresponding rate of 13.4% for the USA.

3.4 Comparing Income-Contingent Repayment Amounts

Fig. 9 shows annual required payment amounts as a function of postschool income in Australia, New Zealand, and the UK, along with income-based payments on RAP in Canada and PAYE in the USA. All amounts have been translated into US dollars to ease comparison.[36] The figure clearly shows that repayments are lowest in the UK and, to a lesser extent, Australia. Canada appears to be the least generous (especially as incomes rise above $30,000); however, it is important to remember that actual RAP payment amounts never exceed standard debt-based payments. So, a student borrowing $20,000 at an interest rate of 5.5% (the current CSLP floating rate) would never be required to pay more than $2650 per year. Repayments in the USA are similarly capped; although, the current interest rate (3.96%) and corresponding annual payment ($2450) are slightly lower. Thus, for low student debt levels, Canadian and US repayments are similar to those in New Zealand at low- to middle-income levels and lower at higher incomes. Of course, debt-based payments in Canada and the USA are increasing with student debt levels. So, for example, debt-based payments for students borrowing $40,000 at current interest rates would be roughly $5300 in Canada and $4900 in the USA. In this case, payments are relatively high in Canada for borrowers with incomes between $30,000 and $60,000.

[34] In 2010–11, the Canada Student Loans Program provided $2.2 billion in loans to approximately 425,000 full-time students in all provinces/territories except Quebec, which maintains its own student financial aid system (Human Resources and Skills Development Canada, 2012).

[35] The minimum income threshold increases with family size beginning at CA$20,208 (in annual terms) for childless single borrowers.

[36] Based on September, 2014, exchange rates.

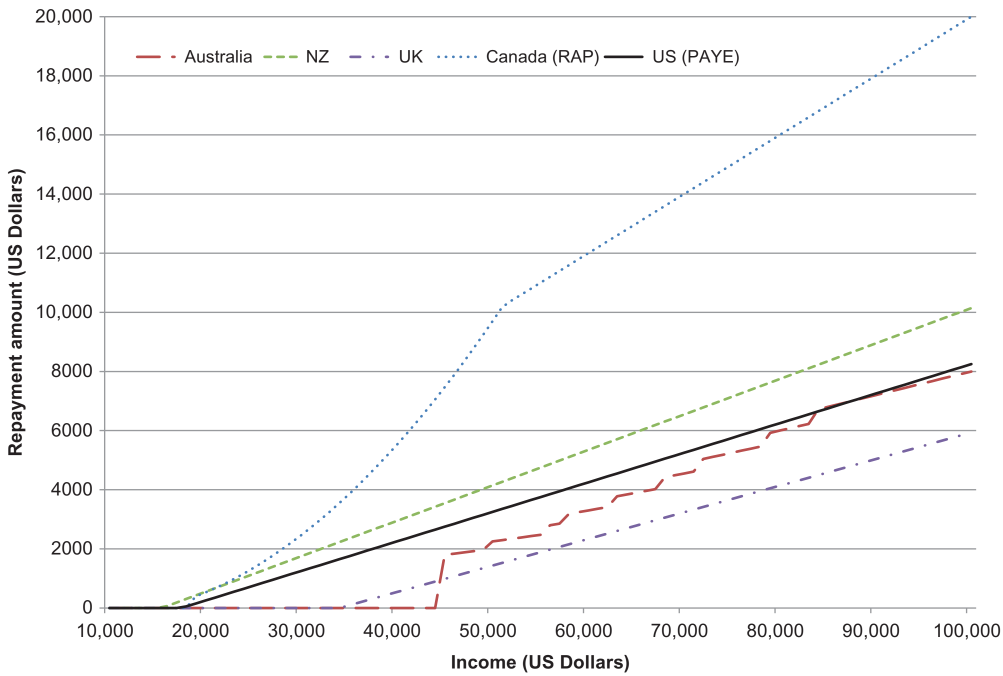

Figure 9 Income-contingent loan repayment functions for selected countries. *Notes:* All currencies translated to US dollars using Sept, 2014, exchange rates. Repayments for Canada and U.S. are for single childless persons and only reflect the income-contingent repayment amount which may exceed the debt-based payment.

4. CAN COLLEGE STUDENTS BORROW ENOUGH?

As noted in Section 2.2, an increasing number of American undergraduates exhaust their government student loan options, turning to private lenders for additional credit. The 2008 increase in Stafford loan limits effectively shifted the balance of student loan portfolios back toward government sources (see Fig. 2), but it is less clear whether this policy expanded total (government plus private) student credit. Regardless, without more regular increases in federal student loan limits, it is likely that continued increases in net tuition costs and returns to college will raise demands for credit beyond supply for many students.

While it is straightforward to measure the number of students who exhaust their government student loans — one-third of all full-time/full-year undergraduates in 2003–04 (Wei and Berkner, 2008) — the rise of private student lending over the past 20 years makes it much more difficult to determine how many potential students may be unable to borrow what they want and the extent to which constraints on borrowing distort behavior. Lochner and Monge-Naranjo (2011, 2012) argue that the increased supply of student credit offered by private lenders over the late 1990s and early 2000s likely did not meet the growing demands of many potential students.[37] However, there is little consensus regarding the extent and overall impact of credit constraints in the market for higher education.[38] We offer a brief review of evidence on borrowing constraints in the US education sector but refer the reader to Lochner and Monge-Naranjo (2012) for a more comprehensive recent review.[39]

A few studies directly or indirectly estimate the fraction of youth that are borrowing constrained. In their analysis of college dropout behavior, Stinebrickner and Stinebrickner (2008) directly ask students enrolled at Berea College in Kentucky whether they would like to borrow more than they are currently able to. Based on their answers to this question, about 20% of recent Berea students appear to be borrowing constrained. Given the unique schooling environment at Berea — the school enrolls a primarily low-income population but there is no tuition — it is difficult to draw strong conclusions about the extent of constraints in the broader US population, including those who never enroll in college. Based on an innovative model of intergenerational transfers and schooling, Brown et al. (2012) estimate the fraction of youth that are constrained based on whether they receive postschool transfers from their parents. Their estimates suggest that roughly half of all American youth making their college-going decisions in the 1970s, 1980s, and 1990s were borrowing constrained. Finally, Keane and Wolpin (2001) and Johnson (2013) use different cohorts of the National Longitudinal Survey of Youth (NLSY) to estimate similar dynamic behavioral models of schooling, work, and consumption that incorporate borrowing constraints and parental transfers. Using the 1979 Cohort of the NLSY (NLSY79), Keane and Wolpin (2001) estimate that most American youth were borrowing constrained in the early 1980s, whereas Johnson (2013) finds that few youth were constrained in the early 2000s based on the 1997 Cohort of the NLSY (NLSY97). In the latter analysis, students are reluctant to take on much debt due to future labor market uncertainty.[40] Unfortunately, the contrasting empirical approaches and sample populations used in these four studies make it difficult to reconcile their very different findings. There is little consensus regarding the share of American youth that face binding borrowing constraints at college-going ages.

[37] For example, private lenders almost always require a cosigner for undergraduate borrowers (Arvidson et al., 2013), so students whose parents have very low income or who have a poor credit record are unlikely to obtain private student loans.

[38] Caucutt and Lochner (2012) argue that credit constraints appear to distort human capital investments in young children more than at college-going ages.

[39] See Carneiro and Heckman (2002) for an earlier review of this literature.

[40] By contrast, Keane and Wolpin (2001) estimate very weak risk aversion among students. While the implied demands for credit are high, the costs associated with limited borrowing opportunities are low based on their estimates.

There is slightly more agreement about the extent to which binding constraints distort schooling choices. Most studies analyzing the NLSY79 find little evidence that borrowing constraints affected college attendance in the early 1980s. Cameron and Heckman (1998, 1999), Carneiro and Heckman (2002), and Belley and Lochner (2007) all estimate a weak relationship between family income and college-going after controlling for differences in cognitive achievement and family background. Cameron and Taber (2004) find no evidence to suggest that rates of return to schooling vary with direct and indirect costs of college in ways that are consistent with borrowing constraints. Even Keane and Wolpin (2001), who estimate that many NLSY79 youth are borrowing constrained, find that those constraints primarily affect consumption and labor supply behavior rather than schooling choices.

The rising costs of and returns to college, coupled with stable real government student loan limits, make it likely that constraints have become more salient in recent years (Belley and Lochner, 2007; Lochner and Monge-Naranjo, 2011). One in three full-time/full-year undergraduates in 2003–04 had exhausted their Stafford loan options, a sixfold increase over their 1989–90 counterparts (Berkner, 2000; Wei and Berkner, 2008). Despite an expansion of private student loan opportunities, family income has become an increasingly important determinant of who attends college. Youth from high-income families in the NLSY97 are 16 percentage points more likely to attend college than are youth from low-income families, conditional on adolescent cognitive achievement and family background; this is roughly twice the gap observed in the NLSY79 (Belley and Lochner, 2007). Bailey and Dynarski (2011) show that gaps in college completion rates by family income also increased across these two cohorts; although, they do not account for differences in family background or achievement levels. Altogether, these findings are consistent with an important increase in the extent to which credit constraints discourage postsecondary attendance in the USA.[41]

Although Johnson (2013) estimates that fewer youth are borrowing constrained in the NLSY97 compared to estimates in Keane and Wolpin (2001) based on the NLSY79, Johnson (2013) finds that raising borrowing limits would have a greater, though still modest, impact on college completion rates. His estimates suggest that allowing students to borrow up to the total costs of schooling would increase college completion rates by 8%.[42] Unfortunately, neither of these studies help explain the rising importance of family income as a determinant of college attendance observed over the past few decades.

[41] Belley and Lochner (2007) show that the rising importance of family income cannot be explained by a model with a time-invariant "consumption value" of schooling.

[42] Based on a calibrated dynamic equilibrium model of schooling and work with intergenerational transfers and borrowing constraints, Abbott et al. (2013) reach similar conclusions to those of Johnson (2013), further showing that long-term general equilibrium effects of increased student loan limits are likely to be smaller than the short-term effects due to skill price equilibrium responses and to changes in the distribution of family assets over time.

Credit constraints may also affect the quality of institutions youth choose to attend. Belley and Lochner (2007) estimate that family income has become a more important determinant of attendance at 4-year colleges (relative to 2-year schools) in recent years. However, this is not the case for income — attendance patterns at highly selective (mostly private) schools versus less-selective institutions. Kinsler and Pavan (2011) estimate that attendance at very selective institutions has become relatively more accessible for youth from low-income families due to sizeable increases in need-based aid that accompanied skyrocketing tuition levels. There is little evidence that youth significantly delay college due to borrowing constraints (Belley and Lochner, 2007).

Borrowing constraints affect more than schooling decisions. Evidence from Keane and Wolpin (2001), Stinebrickner and Stinebrickner (2008), and Johnson (2013) suggests that consumption can be quite low while in school for constrained youth. Constrained students also appear to work more than those that are not constrained (Keane and Wolpin, 2001; Belley and Lochner, 2007). Evidence from Belley and Lochner (2007) suggests that this distortion has become more important for high ability youth in recent years. Unfortunately, little attention has been paid to the welfare impacts of these distortions on youth.[43]

As we discuss further in Section 6, uninsured labor market risk can discourage college attendance in much the same way as credit constraints might. Youth from low-income families may be unwilling to take on large debts of their own to cover the costs of college when there is a possibility that they will not find a (good) job after leaving school. Indeed, standard assumptions about risk aversion coupled with estimated unemployment probabilities and a lack of insurance opportunities (ie, repayment assistance or income-contingent repayments) imply very little demand for credit in Johnson's (2013) analysis. Navarro (2010) also explores the importance of heterogeneity, uncertainty, and borrowing constraints as determinants of college attendance in a life-cycle model. His estimates suggest that eliminating uncertainty would substantially change who attends college; although, it would have little impact on the aggregate attendance rate. Most interestingly, he finds that simultaneously removing uncertainty and borrowing constraints would lead to sizeable increases in college attendance, highlighting an important interaction between borrowing limits and risk/uncertainty. The demand for credit can be much higher with explicit insurance mechanisms or implicit ones such as bankruptcy, default, or other options (eg, deferment and forgiveness in government student loans). Despite their importance, the empirical literature on schooling has generally paid little attention to the roles of risk and insurance. We examine these issues further in the remaining sections of this paper.

[43] The fact that schooling decisions are not affected in Keane and Wolpin (2001) suggests that the welfare impacts of the consumption and leisure distortions are probably quite small in their analysis.

5. DO SOME STUDENTS BORROW TOO MUCH?

Even if a growing number of American youth are finding it more difficult to finance the rising costs of higher education, increases in student borrowing and default rates raise concerns that some students may be borrowing too much. As we discuss further in the next section, an optimal student lending scheme should yield the same ex ante expected return from all borrowers; however, ex post returns will not generally be the same. In an uncertain labor market, unlucky borrowers will be asked to repay less, either through formal payment reductions (eg, deferment, forbearance, income-contingent repayments) or may even default. In this section, we discuss studies that empirically examine the determinants of student loan repayment and default.

In designing and evaluating student loan programs, it is important to quantify the expected payment amounts collected from different types of borrowers and to empirically identify the choices and labor market outcomes that influence actual ex post returns on student loans. Both government and private lenders are particularly interested in the ex ante expected returns on the loans they disburse. While default is a key factor affecting expected returns on student loans, other factors can also be important. For example, government student loans offer opportunities for deferment or forbearance, which temporarily suspend payments (without interest accrual in some cases). Income-contingent lending programs like "Pay As You Earn" can lead to full or partial loan forgiveness for borrowers experiencing low-income levels for extended periods, which clearly reduces expected returns on the loans. The timing of income-based payments can also influence expected returns if lenders have different discount rates from the nominal interest rates charged on the loans. Finally, the timing of default also impacts returns to lenders. It matters if a borrower defaults (without re-entering repayment) immediately after leaving school or after 5 years of payments, since the discounted value of payments is higher in the latter case. Ultimately, the creditworthiness of different borrowers (based on their background or their schooling choices) depends on their expected payment streams and not simply whether they ever enter default.

Despite the recent attention paid to rising student debt levels and default, surprisingly little is known about the determinants of student loan repayment behavior. Until very recently, the literature almost exclusively studied cohorts that attended college more than 30 years ago, measuring the determinants of default within the first couple years after leaving school.[44] Gross et al. (2009) provide a recent review of this literature. Among the demographic characteristics that have been examined, most studies find that default

[44] Dynarski (1994), Flint (1997), and Volkwein et al. (1998) study the determinants of student loan default using nationally representative data from the 1987 NPSAS that surveyed borrowers leaving school in the late 1970s and 1980s. Other early US-based studies analyze default behavior at specific institutions or in individual states. Schwartz and Finnie (2002) study repayment problems for 1990 baccalaureate recipients in Canada.

rates are highest for minorities and students from low-income families. The length and type of schooling also matter, with college dropouts and students attending 2-year and for-profit private institutions defaulting at higher rates. Finally, as one might expect, default rates are typically increasing in student debt levels and decreasing in postschool earnings.

A handful of very recent studies analyze student loan repayment/nonpayment among cohorts that attended college in the 1990s or later.[45] Given the important changes in the education sector and labor market over the past few decades, we focus attention on these studies; although, conclusions regarding the importance of demographic characteristics, educational attainment, debt levels, and postschool earnings for default are largely consistent with the earlier literature. In addition to studying more recent cohorts, these analyses extend previous work by exploring in detail three important dimensions of student loan repayment/nonpayment. First, using data on American students graduating from college in 1992–93, Lochner and Monge-Naranjo (2015) consider multiple measures of student loan repayment and nonpayment (including the standard measure, default) 10 years after graduation in order to better understand how different factors affect expected returns on student loans. Second, Deming et al. (2012) and Hillman (2014) use data for American students attending college in the mid-1990s and early 2000s to examine differences in default and nonpayment rates across institution types (especially for-profits vs public and nonprofits) as highlighted in Fig. 8. Third, Lochner et al. (2013) combine administrative and survey data to study the impacts of a broad array of available financial resources (income, savings, and family support) on student loan repayment in Canada over the past few years. We discuss key findings from these recent studies.

5.1 Student Loan Repayment/Nonpayment 10 Years After Graduation

Lochner and Monge-Naranjo (2015) use data from the 1993–2003 Baccalaureate and Beyond Longitudinal Study (B&B) to analyze different repayment and nonpayment measures to learn more about the expected returns on student loans to different borrowers. The B&B follows a random sample of 1992–93 American college graduates for 10 years and contains rich information about the individual and family background of respondents, as well as their schooling choices, borrowing, and repayment behavior.

Table 4 reports repayment status 5 and 10 years after graduation in B&B. In both years, 8% of all borrowers were not making any payments on their loans. In addition to default, deferment and forbearance are important forms of nonpayment, especially in the earlier period. Table 5 documents varying degrees of persistence for different repayment states. Among borrowers making loan payments (or fully repaid) 5 years after

[45] In addition to the studies discussed in detail, Cunningham and Kienzl (2014) examine default and delinquency rates by institution type and educational attainment for students entering repayment in 2005. Their findings are consistent with results surveyed in Gross et al. (2009).

Table 4 Repayment status for 1992–93 baccalaureate recipients 5 and 10 years after graduation (B&B)

Status	**Years since graduation**	
	5	**10**
Fully repaid	0.269 (0.013)	0.639 (0.013)
Repaying or fully paid	0.920 (0.008)	0.917 (0.007)
Deferment or forbearance	0.038 (0.006)	0.025 (0.004)
Default	0.042 (0.006)	0.058 (0.005)

Note: The table reports means (standard errors) for repayment status indicators based on the B&B sample of borrowers.
Source: Lochner and Monge-Naranjo (2015).

Table 5 Repayment status transition probabilities for 1992–93 baccalaureate recipients (B&B)

Repayment status 5 years after graduation	**Repayment status 10 years after graduation**		
	Repaying/ fully paid	**Deferment/ forbearance**	**Default**
Repaying or fully paid	0.939 (0.006)	0.020 (0.004)	0.040 (0.005)
Deferment or forbearance	0.749 (0.063)	0.165 (0.057)	0.085 (0.032)
Default	0.544 (0.070)	0.038 (0.020)	0.418 (0.068)

Notes: The probability of each status in 2003 conditional on the status in 1998. Estimates based on the B&B sample of borrowers. Standard errors are listed in parentheses.
Source: Lochner and Monge-Naranjo (2015).

graduating, 94% remained in that state 5 years later while only 4% had entered default. Roughly half of all borrowers in default 5 years after school had returned to making payments (or fully repaid) after another 5 years, while 42% were still in default. Not surprisingly, deferment/forbearance is the least persistent state, since it is designed to provide temporary aid to borrowers in need. Among borrowers in deferment/forbearance 5 years after school, three-in-four were making payments (or had fully repaid), while 8.5% were in default 5 years later. The dynamic nature of student loan repayment status suggests that standard measures of default at any fixed date, especially in the first few years of repayment, provide a limited picture of lifetime payments and expected returns to lenders. One would expect greater persistence in nonpayment as time elapses; however, the literature is surprisingly silent on this issue.

Using student loan records, Lochner and Monge-Naranjo (2015) compute five different measures of repayment and nonpayment of student loans 10 years after graduation: the fraction of initial student debt still outstanding, an indicator for default status, an indicator for nonpayment status (includes default, deferment, and forbearance), the fraction of initial debt that is in default, and the fraction of initial debt that is in nonpayment. Analyzing the determinants of these repayment/nonpayment measures, they focus on the roles of individual and family background factors, college major, postsecondary institution characteristics, student debt levels, and postschool earnings. Table 6 reports estimates for all five repayment/nonpayment outcomes based on their most general specification that simultaneously controls for all of these potential determinants. Only variables that are statistically significant for at least one outcome are included.[46]

Among the individual and family background characteristics, only race is consistently important for all measures of repayment/nonpayment. Ten Years after graduation, black borrowers owe 22% more on their loans, are 6 percentage points more likely to be in default, 9 percentage points more likely to be in nonpayment, have defaulted on 11% more loans, and are in nonpayment on roughly 16% more of their undergraduate debt compared with white borrowers. These striking differences are largely unaffected by controls for choice of college major, institution, or even student debt levels and postschool earnings. By contrast, the repayment and nonpayment patterns of Hispanics are very similar to those of whites. Asians show high default/nonpayment rates (similar to blacks) but their shares of debt still owed or debt in default/nonpayment are not significantly different from those of whites. This suggests that many Asians who enter default/nonpayment do so after repaying much of their student loan debt. Looking across columns in Table 6, the estimated racial differences in default rates versus other (arguably better) measures of expected losses are sometimes sizeable (eg, modest black–white differences in default understate much larger differences in the fraction of initial debt that is in nonpayment) and highlight the value of looking beyond simple default rates if the goal is to better understand expected returns on student loans.

Among measures of family socioeconomic status, financial aid dependency status and parental income (when first applying for aid) are largely unimportant (and statistically insignificant so not reported in Table 6) for repayment/nonpayment after controlling for other factors. However, maternal college attendance is associated with a greater share of debt repaid after 10 years.

The B&B data reveal modest variation in repayment/nonpayment across college major choices; however, which majors are most successful in terms of repayment depends on the measure. Engineering majors owe a significantly smaller share of their debts (than "other" majors) after 10 years, while social science and humanities majors owe a larger share. Humanities majors are also in nonpayment on the greatest share of debt. Default

[46] The table notes detail all other variables included in the analysis.

Table 6 Effects of significant factors on student loan repayment/nonpayment outcomes 10 years after graduation

Variable	Share of UG debt still owed	Fraction in default	Fraction not paying	Default × share of debt still owed	Not paying × share of debt still owed
Black	0.216*	0.055*	0.085*	0.108*	0.158*
	(0.040)	(0.022)	(0.025)	(0.021)	(0.029)
Asian	0.107	0.072*	0.089*	0.003	0.008
	(0.062)	(0.033)	(0.038)	(0.033)	(0.045)
SAT/ACT Quartile 4	0.029	0.006	0.006	0.022	0.041*
	(0.028)	(0.018)	(0.020)	(0.015)	(0.020)
Mother some college	−0.047*	0.023	0.008	0.001	−0.014
	(0.021)	(0.014)	(0.016)	(0.011)	(0.015)
Mother BA+	−0.062*	0.003	−0.007	−0.019	−0.013
	(0.021)	(0.015)	(0.017)	(0.011)	(0.016)
Business	−0.020	−0.081*	−0.051	−0.024	−0.010
	(0.032)	(0.031)	(0.029)	(0.017)	(0.024)
Engineering	−0.090*	−0.018	−0.021	−0.016	−0.008
	(0.038)	(0.029)	(0.035)	(0.020)	(0.028)
Health	−0.007	−0.048	−0.020	−0.042*	−0.027
	(0.038)	(0.027)	(0.029)	(0.020)	(0.028)
Social Science	0.078*	−0.022	−0.014	−0.008	0.008
	(0.035)	(0.024)	(0.027)	(0.019)	(0.026)
Humanities	0.083*	0.001	0.023	0.031	0.081*
	(0.035)	(0.023)	(0.025)	(0.019)	(0.026)
HBCU	0.041	−0.005	−0.040	−0.060	−0.117*
	(0.069)	(0.038)	(0.044)	(0.037)	(0.050)
1997 earnings	−0.011*	−0.001	−0.003	−0.005	−0.004
($10,000)	(0.005)	(0.004)	(0.005)	(0.003)	(0.004)
2003 earnings	−0.004	−0.008*	−0.012*	−0.001	−0.004*
($10,000)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)
UG loan amount	0.133*	0.028*	0.039*	0.029*	0.034*
($10,000)	(0.012)	(0.008)	(0.008)	(0.007)	(0.009)

Notes: The table reports estimated effects on reported repayment/nonpayment outcomes based on a sample of baccalaureate recipients in 1992–93. Outcomes are measured 10 years after graduation, and regressors are only included in this table if the estimated coefficient on that variable is statistically significant for at least one repayment/nonpayment outcome. In addition to regressors above, specifications also control for the following: gender; Hispanic; SAT/ACT quartiles 1–3; dependent status; parental income (for dependents); major indicators for public affairs, biology, math/science, history, and psychology; institutional control indicators for private for-profit and private nonprofit; Barron's Admissions Competitiveness Index indicators for most competitive, competitive, and noncompetitive; and state or region fixed effects. Standard errors in parentheses.
*$p < 0.05$.
Source: Lochner and Monge-Naranjo (2015).

rates are lowest for business majors, whereas health majors default on the lowest fraction of their debts (these are the only significantly different coefficients). In most cases, differences in these repayment measures across majors are modest compared with differences between blacks and whites. The increasing importance of college major as a determinant of earnings (Gemici and Wiswall, 2011) suggests that greater differences in repayment across majors for more recent students might be expected, but this is far from certain given the modest role of earnings differences in explaining variation in repayment/nonpayment by college major.

Not surprisingly, borrowers are less likely to experience repayment problems when they have low debt levels or high postschool earnings. As a ballpark figure for all repayment/nonpayment measures, an additional $1000 in debt can be roughly offset by an additional $10,000 in income. For example, an additional $1000 in student debt increases the share of debt in nonpayment by 0.3 percentage points, while an extra $10,000 in earnings 9 years after graduation reduces this share by 0.4 percentage points.

Given the importance of postschool earnings for repayment, one might expect that differences in average earnings levels across demographic groups or college majors would translate into corresponding differences in repayment/nonpayment rates — but this is not always the case. Despite substantial differences in postschool earnings by race, gender, and academic aptitude, differences in student loan repayment/nonpayment across these demographic characteristics are, at best, modest for all except race. And, while blacks have significantly higher nonpayment rates than whites, the gaps are not explained by differences in postschool earnings — nor are they explained by choice of major, type of institution, or student debt levels. Differences in postschool earnings (and debt) also explain less than half of the variation in repayment/nonpayment across college majors.

Despite large differences in national cohort rates between 4-year public and nonprofit schools on the one hand and for-profit schools on the other (see Fig. 8), the multivariate analysis of Lochner and Monge-Naranjo (2015) suggests little difference in repayment patterns across graduates from different types of institutions after controlling for borrower characteristics.[47] However, as noted by Deming et al. (2012), dropout rates are much higher at for-profit institutions. Since default rates are typically higher for dropouts than graduates (Gross et al., 2009), at least some of the default problem at 4-year for-profit schools may simply reflect an underlying dropout problem. We next discuss two recent studies that attempt to better understand the high observed default rates at for-profit institutions.

5.2 Default and Nonpayment at For-Profit Institutions

As Fig. 8 highlights, official cohort default rates have been highest at for-profit (and 2-year) institutions over most of the past two decades. Do the high default rates at for-profit schools indicate that these schools are doing something wrong — burdening

[47] Lochner and Monge-Naranjo (2015) include indicators for institutional control (public vs private non-profit vs for-profit) and college selectivity as measured by Barron's Admissions Competitiveness Index. Because coefficient estimates for all of these variables are insignificant in all specifications, they do not appear in Table 6.

their students with high debts while failing to provide a good education? Or, is it simply the case that these institutions enroll high-risk students that are more likely to experience repayment problems regardless of where they attend school? A few recent studies explore this issue.

Combining annual institution-level data on official 2-year cohort default rates with data from the Integrated Postsecondary Education Data System (IPEDS) in 2005–08, Deming et al. (2012) estimate that default rates at for-profit schools are 8.7 percentage points higher than at 4-year public schools and 5.7 percentage points higher than at 2-year community colleges, even when the sample is limited to open admission schools and differences in student composition, financial aid take-up, and various institutional offerings are accounted for.[48]

Deming et al. (2012) and Hillman (2014) use individual-level data from the Beginning Postsecondary Studies (BPS) to analyze the determinants of student loan default and nonpayment measured 5–6 years after students entered college. Both of these studies explore qualitatively similar specifications to those discussed earlier for Lochner and Monge-Naranjo (2015), so we do not discuss them in detail. We focus our discussion on the estimated differences in default or nonpayment between students attending for-profit schools versus public or nonprofit schools conditional on a broad range of other factors (eg, demographic and family characteristics, major/program type, degree received, debt levels, postschool income or unemployment).[49]

Deming et al. (2012) use the BPS cohort of first-time students entering 2-year and 4-year colleges in 2003–04 to study the impacts of attending for-profit institutions on a wide variety of educational outcomes. Accounting for a broad set of factors, they estimate that students attending for-profit schools experience higher levels of unemployment and lower earnings during the first few years after leaving school. Furthermore, for-profit students leave school with more debt and have student loan default rates that are 7–8 percentage points higher when compared with students that attended public and nonprofit schools. Hillman (2014) studies a similar sample (conditioning on similar factors) but estimates separate impacts of attending 2- and 4-year for-profit schools. His estimates suggest that students attending for-profit 2- and 4-year schools are 26% and 19%, respectively, more likely to default than students attending public 4-year colleges. One concern with both of these studies is the fact that students

[48] Specifically, they control for the fraction of students that are part-time, at least 25 years old, female, black, and Hispanic; the number of recipients and amounts disbursed for Pell grants and student loans; types of degree and highest degree offered; and indicators for institutional offerings of distance education, remedial course, job placement assistance, part-time employment services for students, and open admissions.

[49] Hershaff (2014) also uses individual-level data from the BPS and institution-level cohort default rate data combined with IPEDS to study differences in student loan repayment across students with Direct Loans relative to loans in the FFEL Guarantee program.

attending college for 4–5 years would have had little, if any, chance to default on their student loans by the time default is measured in the BPS.[50]

5.3 The Roles of Income, Savings, and Family Support

As we discuss further below, an efficient lending program should provide some form of insurance against uncertain labor market outcomes with payments depending on available resources. While lenders can expect some losses from impoverished borrowers, they should collect from those with adequate resources. Yet, measuring the full array of resources available to borrowers after they leave school can be challenging. Although labor market income is an important financial resource, access to other resources like personal savings, loans/gifts from families, or other in-kind assistance from families (eg, the opportunity to live at home) may be readily available.

Combining administrative data on student loan amounts and repayment with data from the Canada Student Loan Program's (CSLP) 2011–12 Client Satisfaction Surveys (CSS), Lochner et al. (2013) provide evidence on the link between a broad array of available resources (ie, income, savings, and family support) and student loan repayment in Canada. Because their data also contain questions soliciting borrowers' views on the importance of repaying student loans and the potential consequences of not doing so, they are able to account for heterogeneity in these factors when assessing the importance of income and other resources.

For perspective, the official 3-year cohort default rate of 14.3% for CSLP loans with repayment periods beginning in 2008–09 was very similar to the corresponding rate of 13.4% for the USA. More than one-in-four CSLP borrowers in their first 2 years of repayment were experiencing some form of repayment problem at the time of the CSS.

Lochner et al. (2013) estimate that postschool income has strong effects on student loan repayment for recent Canadian students. Borrowers earning more than $40,000 per year have nonpayment rates of 2–3%, while borrowers with annual income of less than $20,000 are more than 10 times as likely to experience some form of repayment problem. These sizeable gaps remain even after controlling for differences in other demographic characteristics, educational attainment, views on the consequences of nonpayment, and student debt. On the one hand, the very low nonpayment rates among borrowers with high earnings suggest that student loan repayment is well-enforced in Canada. On the other hand, high delinquency and default rates among low-income borrowers signal important gaps in more formal insurance mechanisms like the CSLP's RAP.[51]

[50] Students have a 6-month grace period before they are expected to begin Stafford loan payments and another 9 months of missed payments before they would be considered to be in default.

[51] RAP is an income-contingent repayment scheme that reduces CSLP loan payments for eligible borrowers to "affordable" amounts no greater than 20% of gross family income. See Section 3.3 for further details on RAP.

Despite relatively high nonpayment rates for low-income borrowers, more than half of these borrowers continue to make their standard student loan payments. Other financial resources in the form of personal savings and family support are crucial to understanding this. Roughly half of all borrowers claim to have at least $1000 in savings, while 30% say they could expect to receive $2500 or more in financial support from their parents if they needed it. Low-income borrowers with negligible savings and little or no family support are more likely than not (59%) to experience some form of repayment problem, while fewer than 5% of low-income borrowers with both savings and family support do. Consistent with larger literatures in economics emphasizing the roles of savings and family transfers as important insurance mechanisms (Becker, 1991), Lochner et al. (2013) estimate that borrower income has small and statistically insignificant effects on the likelihood of repayment problems for those with modest savings and access to family assistance. By contrast, among borrowers with negligible savings and little or no family assistance, the effects of income on repayment are extremely strong. Measures of parental income when students first borrow are a relatively poor proxy for these other forms of self- and family-insurance, suggesting that efforts to accurately measure savings and potential family transfers offer tangible benefits.

Interestingly, these findings may offer an explanation for the poor repayment performance of American black students conditional on their postschool income, debt and other characteristics as discussed earlier. Given relatively low wealth levels among American blacks (Shapiro and Oliver, 1997; Barsky et al., 2002), it is likely that weaker financial support from parents at least partially explains their high nonpayment rates.

These findings also have important implications for the design of income-contingent repayment schemes. Lochner et al. (2013) estimate that expanding RAP to automatically cover all borrowers would reduce program revenues by roughly half for borrowers early in their repayment period.[52] This is because a more universal income-based repayment scheme would significantly reduce repayment levels for many low-income borrowers who currently make their standard payments. At the same time, little revenue would be raised from inducing borrowers currently in delinquency/default to make income-based payments, since the vast majority of these borrowers have very low-income levels.

Lochner et al. (2013) find that slightly more than half of all low-income borrowers have little self- or family-insurance. These borrowers currently have high delinquency/default rates and would surely benefit from greater government insurance as discussed in the next section. Yet, their results also suggest considerable caution is warranted before broadly expanding current income-contingent repayment schemes. Many low-income borrowers have access to savings and family support that enables them to make

[52] RAP currently requires borrowers to re-apply every 6 months with eligibility restricted to borrowers with low family income relative to their standard debt-based loan repayment amount. Any debt remaining after 15 years is forgiven. See Section 3.3 for further details on RAP.

standard payments. Lowering payments for these borrowers based on their incomes alone (without raising payment levels for others) could significantly reduce student loan program revenues. These results present important practical challenges regarding the appropriate measurement of borrower resources and the extent to which loan repayments should depend on broader family resources and transfers (to the extent possible).

6. DESIGNING THE OPTIMAL CREDIT PROGRAM

In this section, we use standard economic models to provide benchmarks on how credit and repayment for higher education should be designed in order to maximize efficiency and welfare. Using the same simple environment, we derive optimal credit contracts under a variety of incentive problems and contractual limitations. Starting from the "first best" — when investments maximize expected net income and all idiosyncratic risk is fully insured — we sequentially consider the impact on both investments and insurance of introducing limited commitment/enforcement, incomplete contracts, moral hazard (hidden action) and costly state verification (CSV). These incentive problems are standard in the theoretical literature of optimal contracts and are the staple in some applied fields (eg, corporate finance); however, only recently have they been systematically considered in studies of human capital investment as we discuss further below. We go beyond the usual approach of analyzing one incentive problem at a time, and consider models in which two or three co-exist.[53] While our analysis is largely normative, the implications of different models also provide useful insights about the observed patterns of repayment and default.

We first consider a two-period human capital investment framework with labor market risk in which we analytically characterize the nature of distortions introduced to investment and insurance by different incentive problems. At the end of the section, we discuss richer environments in which other forms of dynamic incentives and contractual issues may arise, reviewing the related literature on various incentive problems in financing human capital investment.

6.1 Basic Environment

Consider individuals that live for two periods, youth and maturity. Individuals are heterogenous in two broad characteristics: their ability, $a > 0$, and their initial wealth,

[53] We do not tackle the difficult problems associated with endogenous parental support discussed in the previous section. Doing so would require consideration of private information about family wealth for access to credit as in Mestieri (2012) and accounting for the hidden savings problem in the design of ex post loan repayments. This can have important implications for the optimal contract as discussed in Kocherlakota (2004) and Abraham et al. (2011); however, the contract in these environments can be quite difficult to characterize.

$W \geq 0$. Ability encompasses all personal traits relevant to a person's capacity to learn (when in school) and to produce (when working). Initial wealth, which can be used for consumption and/or investment includes not only resources available from family transfers but also potential earnings during youth. We take both a and W as given to focus on college education decisions. However, our analysis could be included in richer settings in which families invest in early schooling for children (shaping a) and deciding on bequest and inter vivos transfers (determining W).

A young person can invest in schooling, h, which augments his labor earnings in the next period. We assume that investment is in terms of consumption goods, but more general specifications in which the cost of investment is also in terms of time can be easily added without changing the substance of our results.[54] Postschool labor market earnings are given by

$$y = zaf(h),$$

where $f(\cdot)$ is a positive, increasing, continuous and strictly concave function that satisfies the Inada conditions. These assumptions ensure that investment in human capital is always positive. Ability a and the function $f(\cdot)$ are assumed to be known by everyone at the time of investing h.[55] Labor market earnings and, therefore, the returns to human capital investment are also shifted by labor market risk z, a continuous random variable with support $Z \subset \mathbb{R}_+$. The distribution of risk z is endogenous to the exertion of effort, e, by the individual. However, we assume that it is independent of (a, W) and human capital investment h. At this point, one can interpret e as either effort during school or during labor markets. What is essential is that a higher effort e leads to a higher (first order increase in the) distribution of risk z.[56]

Our baseline model assumes that z has continuous densities $\phi_e(\cdot)$ conditional effort e. For most of our analysis, we assume two levels of effort $e \in \{e_L, e_H\}$, where $e_L < e_H$; however, we briefly discuss settings with more effort options below.

Throughout this section, we assume that financial markets are competitive. Lenders, or more broadly, financial intermediaries, are assumed to be risk neutral. They evaluate streams of resources by their expected net present value, discounting future resources with a discount factor $q \in (0,1)$, the inverse of the risk-free rate $(1 + r)$. We also assume that the lender is free from incentive problems and can commit to undertake actions and deliver on contracts that ex post entail a negative net payoff. Finally, we assume

[54] In the context of college, it is useful to think of h as reflecting a combination of both years of schooling and quality of the institution. We clearly abstract from issues related to the tradeoff between quality and quantity of schooling to focus on the general nature of optimal loan contracts, especially the structure of postschool repayments.

[55] We, therefore, abstract from asymmetric information about ability that can lead to adverse selection. We discuss these issues below in Section 6.8.

[56] That is, for any function $p(\cdot)$ increasing in z, the conditional expectation $E[p(z)|e]$ is increasing in e.

equal discounting between the borrower and the lender (ie, $q = \beta$) to simplify the exposition.[57]

We assume that borrowers evaluate consumption/effort allocations (as of the time they decide their schooling) according to

$$u(c_0) - v(e) + \beta \int_Z u(c_1)\phi_e(z)\, dz, \tag{1}$$

where $u(\cdot)$ is the utility of consumption (an increasing and concave function) and $v(\cdot)$ is the disutility of effort (an increasing function).

We use this environment to study the optimal design of student loans. In this environment, a student loan contract is an amount of credit d given by the lender to the student in the youth period (while in school) in exchange for a repayment $D(z)$ after school from the student to the lender. The repayment $D(z)$ may depend on the realization of labor market risk z and may be negative for some z, indicating additional postschool transfers from the lender to the borrower. While we leave conditioning on all variables but z implicit, the repayment $D(z)$ may also depend on observed student characteristics as well as his investments in human capital. Along with the pair $\{d, D(z)\}$, an allocation of consumption, effort and human capital investment $\{c_0, c_1, e, h\}$ is chosen subject to the participation constraint of the lender,

$$d \leq q \int_Z D(z)\phi_e(z)\, dz. \tag{2}$$

Once discounted, the expected value (conditional on e) of repayments cover the cost of credit provided to the borrower. As for the borrower, initial consumption is given by

$$c_0 = W + d - h. \tag{3}$$

As students, individuals consume from their initial wealth W, plus resources borrowed from the lender (or deposited if $d < 0$) less resources invested in human capital. Second period consumption may be risky and is given by

$$c_1(z) = zaf(h) - D(z), \tag{4}$$

labor earnings less repayments (or plus insurance transfers from the lender if $D(z) < 0$).

In this environment, we consider a number of different incentive and contractual problems that restrict the design of $\{d, D(z); c_0, c_1, e, h\}$. We assume that initial wealth W, ability a, first period consumption c_0, and schooling investment h are always observable by creditors. However, we will consider environments in which there are limits on repayment enforcement (limited commitment), labor market outcomes $y = zaf(h)$

[57] Differences in discounting between the lender and the borrower lead to trends between c_0 and $c_1(z)$. Such trends could be easily added, but they would complicate the algebra without providing any additional insights.

are costly to observe (CSV), and effort e is not observable (moral hazard). In the first case, we also consider the possibility of incomplete contracts, in which repayments cannot be made contingent on labor market outcomes. We explore the optimal provision of credit and repayment design under each of these incentive problems.

6.2 Unrestricted Allocations (First Best)

The natural starting point is the case in which neither incentive problems nor contractual limitations distort investment and consumption allocations. In this case, the choice of $\{d, D(z); c_0, c_1, e, h\}$ maximizes the value of the borrower's lifetime utility (Eq. 1) subject to the break-even or participation condition for the lender (Eq. 2). The program reduces to choosing $\{d, D(z); e, h\}$, because expressions (3) and (4) pin down consumption levels in both periods.

We first derive the allocations conditional on effort and then discuss the determination of optimal effort. Consider the determination of $\{d, D(z); h\}$ conditional on $e = e_i$ for $i = L,H$ (leaving the conditioning implicit for now). From the conditions for d and $D(z)$, the optimal allocation of consumption over time satisfies

$$u'(c_0) = u'(c_1(z)). \tag{5}$$

Regardless of investment decisions, the optimal contract provides perfect insurance (ie, full smoothing of consumption over labor market risk). Since utility $u(\cdot)$ is strictly concave, the equality of marginal utilities also implies equality of consumption levels (ie, $c_1(z) = c_0$ for all z). This simple result highlights the fact that insurance is a crucial aspect of the ideal contract. When repayments can be arbitrarily contingent on the realization of risk, the optimal allocation pushes the lender to absorb all the risk. Full insurance could mean that the lender must make a positive transfer to the borrower ($D(z) < 0$) after school, even if the lender provided the financing for education and early consumption. Similarly, full insurance could mean that lucky borrowers end up paying the lender several times what they borrowed, which, as discussed below, may require an unreasonable level of commitment on behalf of borrowers.

With respect to optimal investment in human capital, combining the first-order conditions for d and h yields the condition

$$E[z|e_i]af'[h] = q^{-1}. \tag{6}$$

In the first best, the expected marginal return on human capital investment equals the risk-free rate (ie, the opportunity cost for the lender to provide credit). This result holds, because the borrower is fully insured by the lender and the lender is risk-neutral. Under these circumstances, it is natural for investment in human capital to maximize the expected return on available resources, regardless of the dispersion and other higher moments of labor market risk z.

Consider the stark predictions of this environment. Conditional on the level of effort, neither the implication of consumption smoothing in Eq. (5) nor the choice of investment in Eq. (6) depend on the individual's wealth W. First, the full insurance condition indicates that lifetime consumption profiles should be flat for all students: rich and poor, high and low ability alike. The values of W and a only determine the level of consumption, not its response to income shocks z or evolution over the lifecycle. Second, condition (6) indicates that all individuals invest at the efficient level, regardless of whether they need to borrow a lot or nothing at all. Conditional on effort, only ability a and the technology of human capital production determine investment levels. All other individual factors, including available resources W and preferences for the timing of consumption, should not influence educational investments given effort; these factors only affect the financing of investments. These sharp implications of the frictionless, complete markets model have provided the basis for various tests of the presence and importance of credit constraints.[58]

We now compare the utilities and allocations conditional on the two effort levels and determine which is optimal. Let $h^F(a,e_i)$ denote the first best level of human capital conditional on e_i (ie, the solution to Eq. (6) conditional on both levels of effort, $i = L,H$). Notice first that investments will be higher for high levels of effort, since $E[z|e_H] > E(z|e_L)$. For each effort level, the expected present value of resources for the borrower is given by $W - h^F(a,e_i) + qE[z|e_i]af\left[h^F(a,e_i)\right]$. Since the agent is fully insured, consumption in both periods would equal

$$c^F(W,a;\ e_i) = \frac{W - h^F(a,e_i) + qE[z|e_i]af[h^F(a,e_i)]}{1+q}.$$

Consumption levels are strictly increasing in wealth W and ability a, as well as the expected realization $E[z|e_i]$. Since the latter is increasing in e, higher effort is also associated with higher consumption. Conditional on effort levels, the level of utilities, as of the time when investments are decided equal

$$U^F(W,a;\ e_i) = (1+\beta)u\left[c^F(W,a;\ e_i)\right] - v(e_i).$$

Whether high effort is optimal in the first best (ie, whether $U^F(W,a;\ e_H) > U^F(W,a;\ e_L)$) depends on the counterbalance of wealth effects in the demand for consumption $c^F(W,a;\ e_i)$ versus the demand for leisure (ie, utility cost of higher effort). When utility is separable between consumption and effort as assumed here, leisure is a superior good. Given ability a, a sufficiently high wealth W implies that the marginal value of consumption is low, as is optimal effort (and investment). Given wealth W, individuals with higher ability would find it more desirable to exert higher effort. Thus, more able individuals would exhibit more investment due to both the direct impact of ability on earnings and the indirect impact of ability on effort.

[58] See Lochner and Monge-Naranjo (2012) for an overview of this literature.

We now study how different incentive problems distort investment in and insurance for human capital by reshaping the allocation of credit and the structure of repayments. To focus our discussion on these issues, we abstract from effort decisions until we introduce moral hazard in Section 6.5.

6.3 Limited Commitment

A crucial, yet often implicit, assumption in the solution of optimal credit arrangements is that both parties can fully commit to deliver their payments as contracted. In practice, borrowers sometimes default on their repayments, or at least face the temptation to do so. A rational lender should foresee these temptations and determine conditions under which default will take place. Formally, the lender can foresee the borrower's participation constraints necessary to preclude default. In this section, we consider the implications of borrower commitment problems. We first assume that repayment functions $D(z)$ can be made fully contingent on the actual realization of labor market risk z. Then, we examine the case in which these contingencies are ruled out.

6.3.1 Complete Contracts With Limited Enforcement

Limited commitment problems are often invoked for investments in education, because human capital is a notably poor collateral (Becker, 1975; Friedman and Kuznets, 1945). While human capital cannot be repossessed, the cost of defaulting on a loan might depend directly on the education of the individual as it determines his earnings. Then, the amount of credit a person could obtain would be endogenously linked to his investments in education, as these investments determine the amount of credit that the borrower can credibly commit to repay (Lochner and Monge-Naranjo, 2011, 2012).[59]

To formalize this argument, assume that once a borrower leaves school, he can always opt to default on a repayment $D(z)$ contracted earlier. But, default is not without its costs. For simplicity, assume that a defaulting borrower loses a fraction $\kappa \in (0,1)$ of his labor earnings, so his postschool consumption is $c_1^D(z) = (1-\kappa)zaf(h)$. These losses could reflect punishments imposed by lenders themselves (eg, wage garnishments) or by others (eg, landlords refusing to rent or employers refusing to hire). Alternatively, the borrower could repay $D(z)$ yielding postschool consumption $c_1^R(z) = zaf(h) - D(z)$. For any realization z, borrowers compare the utility of these two consumption alternatives, repaying if and only if

$$u[zaf(h) - D(z)] \geq u[(1-\kappa)zaf(h)]. \tag{7}$$

More simply, borrowers repay if and only if the cost of defaulting exceeds the repayment amount (ie, $\kappa zaf(h) \geq D(z)$).

[59] We only consider one-sided limited commitment problems where the lender can fully commit. This is natural when considering the optimal design of government credit arrangements.

Obviously, if reneging on the debt were costless ($\kappa = 0$), then no student loan market could be sustained, since no borrower would ever repay. Similarly, if κ is high enough, the temptation to default could be eliminated, and we would be back to the first best.

The restrictions (Eq. 7) can be seen as *participation constraints* on the borrower. As long as they are satisfied, the credit contract ensures that the borrower remains in the contractual arrangement. Any contract in which default occurs can be replicated by a contract without default by setting $D(z) = \kappa z a f(h)$. Since default is costly for the borrower and the lender does not necessarily recover all of those losses, optimal contracts in this setting would always prevent default. The optimal lending contract is similar to the first best problem only restricted so that condition (7) holds for all $z \in Z$.

Let $\lambda(z)$ be the Lagrange multipliers associated with the inequality (Eq. 7) for any realized z.[60] The optimal program maximizes the value of the borrower's lifetime utility (Eq. 1) subject to the break-even or participation condition for the lender (Eq. 2), the expressions (3) and (4) for consumption during and after school, and inequality (Eq. 7) for all $z \in Z$.

The first-order optimality conditions for this problem are straightforward. The optimal repayment value $D(z)$ conditional on the realization z implies the following relationship between $c_1(z)$ and c_0:

$$u'(c_0) = [1 + \lambda(z)]u'[c_1(z)].$$

For states of the world in which the participation constraint is not binding (ie, $D(z) < \kappa z a f(h)$), $\lambda(z) = 0$ and there is full consumption smoothing: $c_1(z) = c_0$. However, when the participation constraint is binding, $\lambda(z) > 0$ and $c_1(z) > c_0$. The participation constraint restricts the repayment that can be asked of the borrower for high labor market realizations. In turn, those restrictions limit the capacity of the student to borrow resources while in school, resulting in low school-age consumption relative to postschool consumption in high-earnings states.

From the first-order conditions for d and h, one can show that optimal human capital investment satisfies

$$af'[h]E\left[z\left(\frac{1+\kappa\lambda(z)}{1+\lambda(z)}\right)\right] = q^{-1}. \tag{8}$$

Notice that $E\left[z\left(\frac{1+\kappa\lambda(z)}{1+\lambda(z)}\right)\right] < E[z]$ as long as $\kappa < 1$ and some of the participation constraints bind (ie, $\lambda(z) > 0$) for some realizations of z. Comparing Eqs. (8) to (6), it is clear that, given concavity in $f(\cdot)$, the inability to fully commit to repayment reduces human capital investment below the first best level. The presence of limited commitment

[60] The multipliers are discounted and weighted by probabilities (ie, the term $q\phi(z)\lambda(z)$ multiplies the condition (7) for each z).

reduces the expected return on human capital due to the inability to effectively borrow against returns in the highest earnings states or to spread the resources from those states to other states with fewer resources.

In contrast to the unrestricted environment above, family resources W are a determinant of investment levels under limited commitment. Individuals with low wealth levels will want to borrow more while in school. This raises desired repayment amounts $D(z)$ in all future states, causing participation constraints to bind more often and more severely. Thus, poorer students face greater distortions in their consumption and investment allocations than wealthier students.

It is important to understand the nature of credit constraints that arise endogenously from the participation constraints associated with commitment problems. As with any other model of credit constraints, this environment predicts inefficiently low early consumption levels for those that are constrained (ie, a first-order gain could be attained by increasing early consumption and reducing postschool consumption for some labor market realizations). A more unusual aspect of constraints in this environment is that they arise due to an inability to extend insurance to fully cover high earnings realizations. The participation constraints do not restrict the ability to smooth consumption across adverse labor market outcomes, since the contract allows for negative repayments for low enough realizations of z. Rather, the limits arise due to the incentives of borrowers to default on high payments associated with strong positive earnings outcomes. The lender must reduce requested repayments in those states to drive the borrower to indifference between repaying and defaulting. This reduction in repayments must be met with less credit up front.[61] Finally, it is important to note that default never formally happens in equilibrium, because repayments $D(z)$ are designed to provide as much insurance as possible while avoiding default.

The ability to write fully contingent contracts is important for many of these results. As we show next, contracts and borrower behavior differ substantially if the repayment function $D(z)$ cannot be made contingent on labor market realizations.

6.3.2 Incomplete Contracts With Limited Enforcement

Now, consider the same contracting environment, only add the restriction that repayments cannot be made contingent on labor market realizations z. Instead, assume that any lending amount d is provided in exchange for a "promise" to repay a constant amount D. However, as in the previous section, the borrower retains the option to default, which will be exercised if it is in his best interest ex post. Of course, lenders are aware of this and

[61] An interesting illustration of limited commitment is the failure of Yale's Tuition Postponement Option, which was implemented in the 1970s and finally rolled back in 1999. The most successful participants "bought out" of their commitment to pay 4% of their income as specified by the plan. See http://yaledailynews.com/blog/2001/03/27/70s-debt-program-finally-ending/.

incorporate this possibility into the contracts they write. For simplicity, we assume that lenders do not recover any payments when borrowers default.[62]

With incomplete contracts, just two amounts (d, D) must balance multiple trade-offs. On the one hand, the fact that contracts cannot provide explicit insurance against downside risks leaves the option of default to take on that role, at least partially. On the other hand, borrowers no longer have an incentive to default when they experience high earnings realizations, since the repayment amount does not increase with earnings. As a result, limited commitment with incomplete contracts may generate default from borrowers with low earnings as an implicit — and imperfect — form of insurance against downside labor market risks. This insurance is implicitly priced by lenders as they incorporate the probability of default in the amount of credit d that they offer in exchange for a defaultable promise to repay a given amount D.

To develop the optimal contract, consider a person with ability a who enters the labor market with human capital investment h and student debt D. The decision of whether to honor the debt or default on it depends on the labor market realization z. If the borrower repays, his postschool consumption is $c_1(z) = zaf(h) - D$, while it is $c_1(z) = (1-\kappa)zaf(h)$ if he defaults. The borrower is better off repaying when the realization z equals or exceeds the threshold

$$\tilde{z} \equiv \frac{D}{\kappa af(h)};$$

otherwise, he would be better off defaulting. Prior to learning z, the probability of default is given by $\Phi(\tilde{z}) = \int_0^{\tilde{z}} \phi(z)dz$. At the time schooling and borrowing/lending decisions are made, default is a stochastic event with the probability increasing in the amount of debt and decreasing in the borrower's ability and investment. Both ability and investment determine the borrower's earnings potential and are important factors for the credit contract.

Contemplating the probability of being defaulted upon, the participation constraint for the lender becomes

$$d \le qD\left[1 - \Phi(\tilde{z})\right]. \tag{9}$$

The right-hand side is the discounted expected net repayment, where we have assumed that the lender receives zero in case of default. Borrowers pay an implicit interest rate of $D/d = q^{-1}[1 - \Phi(\tilde{z})]^{-1}$, which is increasing in the probability of default.[63]

[62] Assuming that the lender recovers a fraction of the defaulting costs simply adds an additional term in the break-even condition for the lender. See Lochner and Monge-Naranjo (2012) and the discussion in Section 6.6.2.

[63] Students with high enough wealth W may choose to save $(d < 0)$ receiving payment $-d/q$ after school.

The expected utility for a student with wealth W and ability a who invests h in his human capital, borrows d, and "promises" to repay D is

$$u[W+d-h]+\beta\left\{\int_0^{\tilde{z}} u[(1-\kappa)zaf(h)]\phi(z)dz+\int_{\tilde{z}}^{\infty} u[zaf(h)-D]\phi(z)dz\right\}. \quad (10)$$

The first term reflects utility while in school, and the rest reflects expected postschool utility over both repayment and default states. Maximizing the borrowers utility (Eq. 10) subject to the lender's participation constraint (Eq. 9), the first-order conditions for d and D (after some basic simplifications and use of the expression for $\tilde{z}$) produce the following condition:

$$u'(c_0)=\frac{E\left[u'(c_1(z))|z>\tilde{z}\right]}{1-\eta(\tilde{z})\frac{\tilde{z}}{D}},$$

where $\eta(\tilde{z})\equiv\dfrac{\phi(\tilde{z})}{1-\Phi(\tilde{z})}>0$ is the hazard function for labor market risk z.[64] In this model, borrowing or lending does not lead to the standard Euler equation for the permanent income model (ie, $u'(c_0)=E[u'(c_1)]$), because here each additional unit of borrowing increases the probability of default and raises implicit interest rates. Even if early consumption is low relative to expected future consumption, borrowers may not want to take on more debt because of worsening interest rates on inframarginal dollars borrowed.

The first-order condition for investment h can be re-written as

$$E[z]af'(h)\left[\frac{E[zu'(c_1(z))]-\kappa\Phi(\tilde{z})E\left[zu'(c_1(z))|z<\tilde{z}\right]}{E[z]u'(c_0)\left[1-qD\phi(\tilde{z})\,\tilde{z}\frac{f'(h)}{f(h)}\right]}\right]=q^{-1}.$$

Limited commitment with incomplete contracting produces a wedge (the term in brackets) between the expected marginal return to human capital and its marginal cost.

[64] The first-order conditions are as follows:

$$[d]:u'(c_0)=\lambda$$

$$[h]:u'(c_0)+\lambda qD\phi(\tilde{z}|e_{\rm H})\frac{\partial\tilde{z}}{\partial h}=\beta af'(h)\left\{(1-\tilde{\kappa})\int_0^{\tilde{z}} zu'\left[(1-\tilde{\kappa})zaf(h)\right]\phi(z|e_{\rm H})dz+\int_{\tilde{z}}^{\infty} zu'[zaf(h)-D]\phi(z|e_{\rm H})dz\right\}$$

$$[D]:\lambda\left[q\left(1-\Phi(\tilde{z}|e_{\rm H})\right)-q\phi(\tilde{z}|e_{\rm H})\frac{\partial\tilde{z}}{\partial D}\right]=\beta\left\{\int_{\tilde{z}}^{\infty} u'[zaf(h)-D]\phi(z|e_{\rm H})dz\right\},$$

where λ is the Lagrange multiplier on the lender's participation constraint.

The human capital investment wedge consists of four distinct economic forces. The first two derive from the nature of constraints that arise when defaulters are disciplined via losses that depend on their earnings. First, human capital returns are reduced by a fraction κ in states that trigger default. This implicit tax on earnings unambiguously discourages investment. Second, human capital investments improve credit terms by reducing the likelihood of default. This force is captured by the expression $1-qD\phi\left(\tilde{z}|e_{\mathrm{H}}\right)\tilde{z}\frac{f'(h)}{f(h)}<1$ in the denominator. This "credit expansion" effect encourages human capital investment. The third force derives directly from market incompleteness, which limits consumption smoothing. Imperfect insurance leads to a negative covariation between labor market realizations z and their valuation $u'(c_1)$, since c_1 is increasing in z. Hence, $E[z\cdot u'(c_1)]<E[z]\cdot E[u'(c_1)]$. This reduces the marginal value of investment relative to the case with full insurance, since individuals are unable to optimally allocate the uncertain returns on their investments across postschool labor market states. The fourth force comes from the fact that $u'(c_0)>E\left[u'(c_1(z))|z>\tilde{z}\right]$ (ie, that school-age consumption is too low relative to some postschool states when the returns of human capital arrive). Unless the credit expansion effect is particularly strong, it seems likely that this environment would yield under-investment in human capital and a positive relationship between family wealth W and human capital.

Combined with limited commitment, the absence of repayment contingencies has a number of important empirical and policy implications. First, as indicated already, default can occur in equilibrium. Second, if default occurs, it is for low realizations of z when both earnings and consumption are low. Third, the option of default serves a useful insurance role, since by defaulting, the borrower can maintain a higher level of consumption when his labor market outcomes are poor. Thus, eliminating default may be inefficient and could even reduce investment in human capital. Fourth, the probability of default is explicitly linked to the ability and educational investment decisions of borrowers. More able borrowers who invest more in their human capital, all else equal, should have lower default rates. Fifth, the model also shows how student loan terms and repayments need to be adjusted for the probability of default. The implicit interest rate is $q^{-1}\left[1-\Phi\left(\frac{D}{\kappa af(h)}\right)\right]^{-1}$, an equilibrium object that depends on ability a and human capital investment h, as well as the distribution of labor market shocks z, because of their impacts on the default rate.

Despite the simplicity and many attractive features of this framework, it is difficult to justify the lack of any explicit contingencies on either theoretical or empirical grounds. Theoretically, such an assumption requires prohibitively high costs of writing contracts or an inability of lenders to observe anything about the labor market success of borrowers. Empirically, we observe explicit (albeit limited) income contingencies in repayment in both government and private student loan markets as described in Section 3.

The model also abstracts from other important incentive problems that can distort human capital accumulation and its financing. We discuss several of these problems in the next few sections.

Finally, this framework is a weak normative guide, since it abstracts from a primal component on the design of student loan programs — the structure of loan repayments $D(z)$ — even when incorporating contingencies on repayment is costly.

6.4 Costly State Verification

Instead of arbitrarily ruling out contingent repayments, we now consider an environment in which lenders must pay a cost $\vartheta \geq 0$ to observe/verify the borrower's postschool earnings. Contingencies become costly, because the repayment $D(z)$ cannot be made contingent on z unless there is verification. If there is no verification, then the repayment is a fixed amount $\bar{D}$, which implicitly depends on the amount borrowed. To explore this friction in isolation, we abstract from other incentive problems until Section 6.6. The environment in this section is, therefore, a straight adaptation of Townsend's (1979) CSV model to the study of human capital and student loans.

As in Townsend (1979), we can solve for the optimal contract by considering truthful revelation mechanisms that specify a contingent repayment $D(z)$ in cases of verification, and a constant repayment $\bar{D}$ in all others.[65] It can be shown that, since contingencies in $D(z)$ are driven by insurance motives, verification will only occur for low realizations of $z < \bar{z}$, where the optimal value of threshold $\bar{z}$ must trade-off the provision of insurance against the cost of verification. Recognizing this, the participation condition for the lender can be written as

$$d \leq q\left[\int_0^{\bar{z}} D(z)\phi(z)dz - \vartheta\Phi(\bar{z}) + \bar{D}[1-\Phi(\bar{z})]\right]. \tag{11}$$

[65] More formally, as the borrower uncovers his realization z in the labor market, he makes an announcement $\hat{z}$ to the lender. Upon this announcement, the lender can either: (i) verify the announcement ($\chi(\hat{z})=1$) at cost ϑ to learn the true outcome and execute a payment $D^v(z,\hat{z})$ that depends on the realized and announced labor market outcomes; or (ii) not verify the borrower's announcement ($\chi(\hat{z})=0$), avoiding the cost ϑ, and request a repayment $D^a(\hat{z})$ based only on the announced $\hat{z}$. We assume that the lender can commit to carry out prespecified verification policies $\chi: Z \rightarrow \{0,1\}$ that map announcements to verification decisions. The borrower knows this policy and therefore, knows the set of announcements that trigger verification and those that do not.

It is easy to see that the lender would not be able to tell apart different announcements for which $\chi = 0$. Borrowers that avoid being verified would announce the $\hat{z}$ associated with the lowest repayment. Therefore, for all states of the world in which there is no verification, the borrower repays $\bar{D} = \inf_{\{z:\chi(z)=0\}}\{D^a(z)\}$. It is also the case that, upon verification, the lender can provide as much insurance as needed. The optimal contract would also rule out detectable deviations, for example, by setting zero consumption for borrowers they catch in a lie (ie, $z \neq \hat{z}$).

The first term in brackets reflects expected payments received (or paid if $D(z) < 0$) from the borrower if there is verification, while the second term reflects the expected costs of verification. The third term reflects expected repayments when there is no verification. Given any $\{d, D(z), \bar{D}, h\}$, a borrower's expected utility is

$$u[W + d - h] + \beta\left[\int_0^{\bar{z}} u[zaf(h) - D(z)]\phi(z)dz + \int_{\bar{z}}^{\infty} u[zaf(h) - \bar{D}]\phi(z)dz\right]. \quad (12)$$

The optimal student loan contract in this setting maximizes Eq. (12) subject to Eq. (11). Combining the first-order conditions for d and $D(z)$ yields

$$u'(c_0) = u'(c_1(z)) \text{ for } z < \bar{z}.$$

The optimal contract provides full consumption smoothing ($c_1(z) = c_0$) across school and postschool periods for "bad" states of the world in which verification occurs. Once z is truthfully learned by both parties, it is optimal for the risk neutral lender to absorb all residual risk. While left implicit above, borrower's characteristics such as ability a and wealth W, as well as aspects of the environment like verification costs ϑ and the distribution of labor market risk $\phi(z)$, determine the set $[0, \bar{z}]$ for which this takes place. These factors also affect the level of consumption c_0 for the early period and for the states of verification.

The previous result is useful to derive the optimal region for verification. Consumption $c_1(z)$ does not exhibit a jump at the threshold $\bar{z}$, because this would mean that the borrower could deviate and attain a first-order gain. The condition $c_1(\bar{z}) = c_0$ imposes a direct link between $\bar{z}$, $\bar{D}$, and c_0 in the form $\bar{z} = \dfrac{c_0 + \bar{D}}{af(h)}$. Since increases in the level of consumption under verification c_0 or in the required payment in the absence of verification $\bar{D}$ both increase the value of verification for the borrower, the region of verification must also increase to satisfy the lender's participation constraint. The verification region decreases with investment, because h improves the distribution of consumption under nonverification $c_1(z)$, which discourages verification.

With these conditions, the optimal loan program can be solved entirely in terms of $\{c_0, \bar{D}, h\}$. Let ψ denote the Lagrange multiplier on the lender's participation constraint (Eq. 11).[66] The first-order conditions for this problem imply that c_0 (consumption during school and after when there is verification) is set so that

[66] The concentrated Lagrangian in terms of $\{c_0, \bar{D}, h\}$ is

$$\begin{aligned} L = \; & u(c_0) + \beta\left[u[c_0]\Phi(\bar{z}) + \int_{\bar{z}}^{\infty} u[zaf(h) - \bar{D}]\phi(z)dz\right] \\ & + \psi\left\{W + q\left[af(h)\int_0^{\bar{z}} z\phi(z)dz - (\vartheta + c_0)\Phi(\bar{z}) + \bar{D}[1 - \Phi(\bar{z})]\right] - h - c_0\right\}, \end{aligned}$$

where $\bar{z} = \frac{c_0 + \bar{D}}{af(h)}$.

$$u'(c_0) = \psi\left\{1 + \left[\frac{q\vartheta\phi(\bar{z})}{1 + q\Phi(\bar{z})}\right]\frac{1}{af(h)}\right\}. \tag{13}$$

The second term in braces represents the increased verification costs associated with a higher c_0. Aiming to save on costs of verification, the optimal contract reduces the level of c_0 and, therefore, student loan amounts. Similarly, after some simplification, the optimal level of $\bar{D}$ leads to the following condition

$$E[u'(c_1(z)) \quad |z \geq \bar{z}] = \psi\left\{1 - \eta(\bar{z})\frac{\vartheta}{af(h)}\right\}, \tag{14}$$

where $\eta(\cdot)$ is the hazard rate as defined above. As with c_0, the fixed level of debt repayment $\bar{D}$ is reduced also with the aim of reducing verification costs.

From expressions (13) and (14), it is clear that $u'(c_0) > E[u'[c_1(z)] \quad |z \geq \bar{z}]$, and the implied behavior of consumption is consistent with the usual notion of credit constraints. This is also the case when we look at implications for optimal investment in human capital. From the first-order condition for h, we can show that investment in human capital satisfies

$$E[z]af'(h)\left\{1 + \left[\frac{1 - \Phi(\bar{z})}{E[z]}\right]\left(\left[1 - \frac{\vartheta\eta(\bar{z})}{af(h)}\right]\frac{\text{Cov}[z, u'(c_1(z))|z \geq \bar{z}]}{E[u'(c_1)|z \geq \bar{z}]} + \left[\frac{\vartheta\eta(\bar{z})}{af(h)}\right]E[\bar{z} - z|z \geq \bar{z}]\right)\right\}$$
$$= q^{-1}.$$

Notice that two distinct wedges reduce the marginal value of human capital and discourage investment. The first wedge arises from imperfect insurance and risky human capital investments, which generates a negative covariance between labor market outcomes and the marginal value of those returns for the borrower. The second wedge reflects the fact that higher investment levels lead to more verification, which is costly.

Costly verification of income yields an endogenous form of market incompleteness in which lenders require the same payment from all borrowers who receive "good" labor market shocks. In this respect, the model is similar to the limited commitment framework above, which exogenously rules out all explicit income contingencies (Section 6.3.2). However, the distinction between endogenous partial market incompleteness due to costly verification and exogenous full market incompleteness with limited commitment is quite important, since these two models yield very different implications for borrowers who receive adverse labor market outcomes. In the incomplete markets model with limited commitment, these unlucky borrowers enter default, which entails additional losses or penalties and reduces consumption levels below income levels. By contrast, under CSV, unlucky borrowers are audited and receive full insurance.

Empirically, we certainly observe default in countries without fully income-contingent loan programs like the USA and Canada. However, many borrowers with low postschool earnings also receive significant reductions in their payments through forbearance or deferment. Others also take advantage of more explicit income-contingent plans for low earners. Still, even low income borrowers do not appear to receive full insurance from student loan programs.[67] As we see next, introducing other forms of asymmetric information can help in understanding when this imperfect insurance might be desirable.

6.5 Moral Hazard

A college education not only requires readily observable investment expenditures like tuition, fees, and materials (h in our setting), but it also requires other student-specific inputs that may be more difficult to measure and control, like effort and the choice of school and courses appropriate for a student's talents and potential.[68] While these actions may be crucial for a successful college experience, they may also be "hidden" or difficult to control and monitor by lenders. We incorporate these hidden actions by explicitly modeling a costly effort e. When the lender does not observe this effort, a "moral hazard" problem can arise, as the costs of effort fall entirely on the borrower while the ensuing returns can be shared between the student and the creditor.

To examine the design of student loan contracts to deal with these incentives, we re-consider the determination of effort. Recall our assumption: High effort is costly, $v(e_{\mathrm{H}}) > v(e_{\mathrm{L}})$, but also productive in that it improves the distribution of labor market shocks z. That is, the distribution of labor market risk under high effort dominates (in the first-order sense) the distribution under low effort. Even stronger, we assume a monotone likelihood ratio, that is, $l(z) \equiv \phi_{e_{\mathrm{L}}}(z)/\phi_{e_{\mathrm{H}}}(z)$ is strictly decreasing. We also assume that the support of z is the same under both levels of effort so there are no perfectly detectable deviations (realizations of z that can happen under one but not the other effort level). We restrict $l(z)$ to be bounded from below and from above.

The moral hazard problem arises, because the level of effort e cannot be directly controlled by the lender. Therefore, the level of investment h, the amount of credit d, and repayments $D(z)$ must be designed so that the borrower finds it in his own best interest to exert the effort expected by the creditor. For now, we consider a model in which moral hazard is the sole incentive problem. We defer to Section 6.6 cases in which moral hazard interacts with previously discussed contractual frictions.

Consider first a student with ability a and wealth W that faces a contract $\{d, h, D(\cdot)\}$ offered by a lender that expects he will exert the high level of effort, e_{H}. If the student conforms, he obtains an expected utility level equal to $U_{\mathrm{H}} = u(c_0) - v(e_{\mathrm{H}}) + \beta E[u[zaf(h) - D(z)]|e_{\mathrm{H}}]$. If he instead deviates and shirks, his

[67] It is important to note that other forms of social insurance (eg, unemployment insurance, welfare) may effectively deliver a fixed minimal consumption level for a range of low postschool income levels.

[68] While we emphasize effort in school, our analysis applies equally to unobservable effort in the labor market (eg, job search effort) or to the tradeoff between higher-paying jobs and those that may be more appealing on other grounds (Rothstein and Rouse, 2011).

expected utility is $U_{\rm L}=u(c_0)-v(e_{\rm L})+\beta E[u[zaf(h)-D(z)]|e_{\rm L}]$. If the high effort $e_{\rm H}$ is to be implemented, the contract $\{d,D(z),h\}$ must satisfy the following *incentive compatibility constraint (ICC)* $U_{\rm H}\geq U_{\rm L}$:

$$[v(e_{\rm L})-v(e_{\rm H})]+\beta\left[\int_0^\infty u[zaf(h)-D(z)]\left[\phi_{e_{\rm H}}(z)-\phi_{e_{\rm L}}(z)\right]dz\right]\geq 0. \tag{15}$$

The optimal student loan contract is found by choosing $\{d,D(z);e,h\}$ to maximize the expected utility of the borrower (Eq. 1) subject the break-even or participation condition for the lender (Eq. 2) and the accounting expressions for consumption in both periods, Eqs. (3) and (4). If the optimal contract requires high effort from the student, then condition (15) must also be satisfied. Relative to the first best, the provision of insurance must give way, at least partially, to rewards for the student's success.

Let $\mu\geq 0$ denote the Lagrange multiplier associated with condition (15). Combining the first-order conditions for d and $D(z)$, it is straightforward to obtain the relationship

$$u'[c_1(z)][1+\mu(1-l(z))]=u'(c_0) \tag{16}$$

between current and future consumption for any labor market outcome z. Since the likelihood ratio $l(z)$ is monotonically decreasing, when the ICC (Eq. 15) is binding, $\mu>0$ and postschool consumption $c_1(z)$ is strictly increasing in z.[69] The economics underlying this result are clear: since effort is unobservable, the only way for the contract to induce high effort is to reward higher earnings with higher consumption. This is effective, because high realizations of z are more likely with high effort while low realizations of z are more likely with low effort. The lender must adhere to this rule in order to induce high effort even if he knows that the contract always induces high effort. The downside of these contracts is that unlucky students must bear low consumption even when they have exerted high effort. Finally, notice that if high effort is not optimal so the contract need not induce it, then $e=e_{\rm L}$, $\mu=0$, and full insurance can be provided: $c_1(z)=c_0$.

The first-order condition for human capital investment h can be written as

$$qaf'(h)\{(1+\mu)E[zu'(c_1(z))|e_{\rm H}]-\mu E[zu'(c_1(z))|e_{\rm L}]\}=u'(c_0). \tag{17}$$

On the left-hand side, the first term inside braces denotes the value of earnings from additional human capital. A term weighted by μ is added, because investments help relax the ICC. In the same vein, the negative term multiplied by μ reflects the negative impact on the ICC that arises from a higher value on the option to shirk. The right-hand side is simply the marginal cost of one unit of investment.

[69] If the likelihood ratio is declining enough in z, it is possible that optimal payments are decreasing over some z.

Interestingly, using the consumption optimality condition (16), we can replace the values for $u'[c_1(z)]$ in terms of $u'(c_0)$ and the ratio $l(z)$. After simplifying, the condition (17) reduces to the first best condition

$$af'(h)E[z|e_{\mathrm{H}}] = q^{-1}.$$

As long as the contract induces the first best level of effort $e = e_{\mathrm{H}}$, it also yields the first best level of investment h. More generally, it is optimal to design the contract so that the first best investment amount is chosen for whatever effort is exerted. Importantly, this implies that if the repayment schedule $D(z)$ is well-designed and can induce appropriate effort, the education prospects of students that need to borrow are the same as those coming from richer families that can self-finance their education. The "cost" of borrowing for economically disadvantaged students comes in the form of imperfect insurance.

The key with moral hazard is in the design of $D(z)$, which can be a difficult task. It is useful to illustrate this point using the well-known CRRA utility function $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ with $\sigma > 0$. The postschool consumption schedule (Eq. 16) becomes

$$c_1(z) = c_0[1 + \mu(1 - l(z))]^{1/\sigma},$$

which is delivered by setting the repayment to

$$D(z) = zaf(h) - c_0[1 + \mu(1 - l(z))]^{1/\sigma}.$$

Given the condition that $l(0) > 1$, the contract yields $c_1(z) < c_0$ for low values of z. That is, unsuccessful students experience a fall in their consumption after school. However, notice that some insurance is still being provided, as $D(z)$ may be negative. On the contrary, for high values of z, the likelihood ratio $l(z) < 1$, so successful students are rewarded with an increase in their consumption.

Even with this specific functional form, it is not possible to say much about the shape of $c_1(z)$ except that it is increasing. Likewise, except for the fact that $D(z)$ might be negative at low values of z, little more can be said regarding its shape unless more information is available on the distribution of labor market outcomes and the risk preferences of borrowers. In fact, not even the monotonicity of $D(z)$ can be established. A reliable empirical characterization of risks and preferences is necessary to characterize even the most general features of optimal student loan programs.

Thus far, we have emphasized the case in which high effort is optimal. This need not be the case if, for example, either a or W is so low that most of the resources generated by investment need to be repaid to the lender, leaving little for the borrower to consume. Low effort might also be efficient for very high wealth individuals, who place more value on leisure (ie, low effort) than the extra consumption that comes from exerting higher effort. If low effort is optimal, then investment for those exerting low effort is set to the first best under low effort: $af'(h)E[z|e_{\mathrm{L}}] = q^{-1}$; since the ICC is not binding, $\mu = 0$ and full insurance is provided (ie, $c_1(z) = c_0$ for all z). The problem of moral hazard only distorts investment choices for those who are discouraged from putting forth high effort when it would otherwise be optimal. Since utility associated with high effort is distorted due to imperfect insurance while utility associated with low effort is not, there will be a set of (W,a) values for which effort and investment choices are distorted by moral hazard.

The sharp result that *conditional on effort* investment is not distorted (relative to the first best) generalizes to any number of potential effort choices. Additionally, if any two individuals with the same ability end up exerting the same effort, then they will also make the same educational investment yielding the same distribution for labor earnings, regardless of their family wealth.[70] However, the finding that either consumption or investment is distorted, but not both simultaneously, is special to the model with two effort levels. With a continuum of effort levels (and some regularity conditions), effort will generally be discouraged and the optimal contract will distort both investment and consumption relative to the first best.

Rather than exploring a richer structure for moral hazard, we now direct our discussion to the less explored environments in which moral hazard co-exists with other primal incentive problems, CSV and limited commitment.

6.6 Multiple Incentive Problems

In this section, we examine the optimal design of student loan programs in environments in which multiple incentive problems co-exist.

6.6.1 Costly State Verification and Moral Hazard

Consider now the case in which both the effort e of the student cannot be observed by the lender and the actual labor market outcome can only be verified by the lender at a cost $\vartheta > 0$. The loan contract must be designed to address both of these information frictions to provide as much insurance as possible to the borrower while making sure the creditor is repaid in expectation.

Because of the cost ϑ, the optimal verification policy will preserve the threshold property of Section 6.4: If the borrower realizes a labor market outcome z below a threshold $\bar{z}$, the lender will verify the outcome at cost ϑ and request repayment $D(z)$ (which can be negative) that is contingent on z. Otherwise, if $z \geq \bar{z}$, the lender will not bother to verify and the borrower repays a fixed amount $\bar{D}$. In both cases, the repayment can be set as a function of previously determined and known variables such as d, a, and h; however, we leave this conditioning implicit. Expressions for the lender's participation constraint (Eq. 11) and borrower's expected utility (Eq. 12) are the same as for the CSV model above.

[70] Similarly, suppose two individuals possess the same ability level but one lives in an environment with moral hazard and the other does not. If their wealth levels are such that they both end up exerting the same effort level, they will both make the same investment.

The contract must also induce the optimal level of effort. If low effort e_L is optimal, then there is no moral hazard problem and the optimal contracts are of the pure CSV case studied in Section 6.4. However, if high effort e_H is to be induced, then the contract must satisfy an ICC modified by the threshold property of the verification policy. That is, the expected discounted gains from better labor market outcomes should more than compensate the student for the cost of effort:

$$\beta\left[\int_0^{\bar{z}} u[zaf(h)-D(z)]\left[\phi_{e_H}(z)-\phi_{e_L}(z)\right]dz+\int_{\bar{z}}^{\infty} u[zaf(h)-\bar{D}]\left[\phi_{e_H}(z)-\phi_{e_L}(z)\right]dz\right] \geq v(e_H)-v(e_L). \tag{18}$$

Given a student's ability a and wealth W, the optimal loan contract sets d, h, $\bar{z}$, $\bar{D}$, and $D(z)$ for $z<\bar{z}$ aiming to maximize Eq. (12) subject to the break-even constraint (Eq. 11) and the ICC (Eq. 18). As argued in the pure CSV case, consumption should not jump at the threshold of verification, so $c_1(\bar{z})=\bar{z}af(h)-\bar{D}$. Therefore, we can write $\bar{D}=\bar{z}af(h)-c_1(\bar{z})$, and solve for it as a function of the threshold $\bar{z}$.

The first-order conditions for the amount of credit d and repayments $D(z)$ in a state of verification imply

$$u'[c_1(z)][1+\mu(1-l(z))]=u'(c_0) \quad \text{for all} \quad z<\bar{z}, \tag{19}$$

where μ is the Lagrange multiplier on Eq. (18). When verification occurs, we recover exactly the same relationship between marginal utilities of consumption (and, therefore, consumption distortions) as in the pure moral hazard case (given μ).[71] Here, verification does not generally yield full consumption smoothing (as in the CSV model) due to the need to incentivize effort. However, if the conditional distributions of low-income realizations (ie, $z<\bar{z}$) are quite similar across effort levels, then $l(z)$ will be relatively flat in the relevant region and considerable consumption insurance can be provided at the low end of the income distribution. Moral hazard is less of a concern at high income realizations, since verification does not take place and payments are independent of income for $z \geq \bar{z}$. For high z, consumption allocations are such that $u'[c_1(z)][1+\mu(1-l(z))]<u'(c_0)$.

The first-order condition for $\bar{z}$ implies that the threshold is set according to the condition

$$\frac{\partial \bar{D}}{\partial \bar{z}}=\vartheta\eta(\bar{z}|e_H)\left[\frac{u'(c_0)}{u'(c_0)-E[u'(c_1(z))(1+\mu[1-l(z)])\mid z\geq\bar{z};\, e_H]}\right], \tag{20}$$

where $\eta(\cdot|e_H)$ is again the hazard function as defined above (evaluated at $\bar{z}$ here) conditional on high effort. The left-hand side represents the increased fixed payment $\bar{D}$ needed when setting a higher verification threshold; the right-hand side compounds the increased

[71] However, note that the values of μ, c_0 and the range of z for which Eq. (19) holds now depend on the verification cost ϑ.

expected cost of verification with a measure of the consumption distortion outside the verification region. For $\vartheta > 0$, the latter (term in brackets) is greater than zero but less than one.

Finally, with respect to the optimal investment in human capital, the first-order condition for h can be written as

$$E[z|e_{\mathrm{H}}]af'(h)\left[\frac{E[\min\{z,\bar{z}\}|e_{\mathrm{H}}]}{E[z|e_{\mathrm{H}}]}+\frac{E\{[z-\bar{z}]u'[c_1(z)][1+\mu(1-l(z))]|z\geq\bar{z};\, e_{\mathrm{H}}\}}{E[z|e_{\mathrm{H}}]u'(c_0)}\right]$$
$$=q^{-1}, \tag{21}$$

which is derived using condition (19) for $z<\bar{z}$. Verification costs leave upside risk uninsured, so the term inside brackets is strictly less than one, and investments in this environment are lower than the first best.

The combination of CSV and moral hazard produces a useful benchmark for the design of optimal student loan arrangements. On the one hand, this framework incorporates the desire to save on verification and other administrative costs. When income verification is costly, it should only occur when labor market outcomes are particularly low. In these cases, the commitment of lenders to verify some of the lower reports by the borrower provides them with the right incentives to truthfully report those states to reduce their payments. Doing so, the program can provide at least some insurance for the worst labor market realizations, precisely when borrower's are most in need of it. On the other hand, moral hazard implies that even for these unlucky borrowers the optimal arrangements must sacrifice some insurance and consumption smoothing in order to incentivize effort. Moral hazard also reduces the value of verification itself, since the ability to provide insurance is limited.

While the optimality conditions can be algebraically cumbersome, the general structure of the optimal contract is quite simple. To illustrate this point, consider the CRRA specification used earlier. For some positive values μ, c_0, and $\bar{z}$ (which should depend on a borrower's ability and wealth), the loan repayment is

$$D(z)=\begin{cases} zaf(h)-c_0[1+\mu(1-l(z))]^{1/\sigma}-\vartheta & \text{if } z<\bar{z} \\ \bar{D} & \text{if } z\geq\bar{z} \end{cases}$$

yielding postschool consumption

$$c_1(z)=\begin{cases} c_0[1+\mu(1-l(z))]^{1/\sigma} & \text{if } z<\bar{z} \\ zaf(h)-\bar{D} & \text{if } z\geq\bar{z}. \end{cases}$$

Above a certain threshold, the borrower absorbs all upside risk, paying a constant amount independent of z; however, downside risk is shared between the borrower and the lender. Absent moral hazard concerns, risk neutral lenders would absorb all downside risk; however, with moral hazard, it is optimal to make borrowers bear some of the downside risk to help incentivize effort. If low realizations are the smoking gun of low effort, then little insurance can be provided.

Finally, it is important to recognize that even if the contract is optimally designed, insurance may be quite limited and human capital will be lower than under full insurance in the first best. This naturally implies that human capital investments will be responsive to family wealth W among borrowers. Yet, such a relationship does not necessarily imply an inefficiency in existing credit arrangements, but instead it may signal that information or commitment frictions are important in the student loan market.

6.6.2 Limited Commitment: Default or Additional Constraints?

The previous arrangement was derived under the assumption that both the borrower and the lender could fully commit to any postschool payments. As we saw in the pure limited commitment model above, relaxing this assumption can have important implications for the optimal student loan arrangement. We now explore the interactions between limited commitment, moral hazard, and CSV — the three main credit market frictions we have considered. As above, assume that the borrower can always default on the repayment to the lender, but that doing so entails a cost that is proportional to his income. In addition to the lender's break-even or participation constraint and the incentive compatibility constraint, the contract must also respect the no-default restrictions $D(z) \leq \kappa z a f(h)$ for all z if default is to be avoided. As discussed below, however, default may sometimes be an optimal feature of contracts with costly verification.

Consider first the case with costless income verification ($\vartheta = 0$), but when both moral hazard and limited commitment constrain contracts. The optimal contract maximizes Eq. (1) subject to the participation condition for the lender (Eq. 2), the ICC condition (Eq. 15), and the no-default constraints (Eq. 7). As above, let μ be the Lagrange multiplier associated with the ICC and $\lambda(z)$ the multiplier associated with Eq. (7) for each z.

Following the same steps as in the previous models, the optimal allocation of consumption must satisfy

$$u'[c_1(z)][1+\mu(1-l(z))+\lambda(z)] = u'(c_0).$$

For those states in which Eq. (7) does not bind, $\lambda(z)=0$ and consumption smoothing is distorted only to induce high effort as in the pure moral hazard case. On the contrary, if the no-default constraint (Eq. 7) does bind, then $c_1(z) = (1-\kappa) z a f(h)$ and the impact of $\lambda(z) > 0$ and $\mu > 0$ must be accommodated via lower borrowing d (and school-age consumption c_0) and lower human capital investment h, which must now satisfy the condition

$$E\left[z \left(\frac{1+\mu(1-l(z))+\kappa\lambda(z)}{1+\mu(1-l(z))+\lambda(z)} \right) \middle| e_H \right] a f'(h) = q^{-1},$$

where the term in brackets is less than $E[z|e_H]$ if the no-default constraint binds for any z. Thus, incorporating limits on contract enforceability produces under-investment in human capital when there is moral hazard even if the efficient amount of ability is induced. As in the case without moral hazard (see Section 6.3.1), individuals under-invest, because they cannot spread the rewards from investment in very high-income states to other states nor can they fully borrow against these states. Moral hazard can further reduce investment relative to the pure limited commitment case, especially for individuals who are not induced to provide the efficient amount of effort.

Importantly, when $\vartheta = 0$, the ability to set $D(z)$ fully contingent on the realization z rules out default in equilibrium. Any contract that involves default in some states can always be replicated by a contract in which the borrower repays $\kappa zaf(h)$ in those states, which would make the lender strictly better off and the borrower no worse off. The fact that the lender can be made better off implies that he can also offer a better contract to the borrower that eliminates default.

This is not necessarily true when verification is costly (ie, $\vartheta > 0$). With costly verification, there will be some z for which the lender verifies the borrower's announced outcome (denoted by the indicator function $\chi(z) = 1$) and others for which he does not ($\chi(z) = 0$). In the latter case, the repayment is a constant amount $\bar{D}$ independent of z. For the set of all other realizations, the lender verifies and requests a payment of $D(z)$. Altogether, the borrower has three options once he observes z: (i) repay $\bar{D}$ without asking for verification; (ii) request verification and pay/receive an amount $D(z)$ that depends on z; or (iii) default and forfeit a fraction $\kappa zaf(h)$ of his income. In case (iii), the lender receives nothing.

Given repayment contract $\{D(z), \bar{D}\}$, the borrower will choose to default whenever $\kappa zaf(h) < D(z)$ in verification states and $\kappa zaf(h) < \bar{D}$ in nonverification states. Yet, lenders know this and will take it into account when designing contracts. On the one hand, it is possible that the optimal contract would set both $\bar{D}$ and $D(z)$ below $\kappa zaf(h)$ for all relevant values of z, thereby precluding default as when $\vartheta = 0$. On the other hand, with nonnegligible verification costs, it is possible that default is preferred by both borrower and lender alike for some realizations of z.

Under what conditions might default arise under optimal contacts? To answer this question, it is useful to think about default as just another repayment state or as part of a contract. For default to occur in equilibrium, it has to be that *both* borrowers and lenders would be better off if the borrower opts to default. For borrowers to prefer defaulting, repayment must be more costly than default, $D(z) > \kappa zaf(h)$. For lenders to prefer default, the cost of verification ϑ must exceed payments under verification. Taken together, default is only possible (though not assured) when $\vartheta > \kappa zaf(h)$.

Default becomes more attractive to lenders if they can capture some of the defaulting borrowers losses. To explore this possibility, suppose the borrower still loses a fraction κ of his income upon default, but assume that the lender can recover a fraction $\kappa^0 \leq \kappa$ of those losses.[72] That is, lenders recover $\kappa^0 zaf(h)$ from defaulted loans. If the lender chooses to verify, at most he would receive a payoff of $\kappa zaf(h) - \vartheta$ once verification costs are subtracted. Ex post, the lender would prefer to be defaulted upon if z falls below a threshold z^A defined by

[72] For example, it may be easier for lenders to collect penalties from defaulters with high income even if they do not actually verify their income.

$$z^A = \frac{\vartheta}{(\kappa - \kappa^0) af(h)}.$$

Among other things, this threshold reiterates the fact that default should not occur if verification is costless, since this implies $z^A = 0$. An alternative extreme arises when $\vartheta > 0$ and the lender captures all default losses, $\kappa^0 = \kappa$. If so, $z^A \to \infty$, and a lender would ex post always prefer to abandon the lending contract rather than verify it. However, this does not mean that verification never occurs. Ex ante, the lender may want to offer and *commit to deliver on* a contract in which $D(z)$ is low, or even negative for some z, in order to provide valuable insurance.

Default should be seen as an option for the lender in his design of the repayment function $D(z)$. The lender can always set the value of $D(z)$ below the cost of default and preclude that action by the borrower. The option of setting the repayment $D(z)$ above the default cost $\kappa z af(h)$ for some z, allows the lender to avoid having to pay the verification cost. This option can be used to save on verification costs and ultimately, allow lenders to offer better contracts to borrowers.

Altogether, the design of the optimal repayment function $\{\bar{D}, D(z)\}$ must meet a number of constraints and objectives: it must ensure that the expected repayment less any verification costs (plus any amounts received in the case of default) cover the lender's cost of funds; it must balance the provision of insurance with incentives to encourage effort by the student; and it must properly weigh the costs of verification with losses associated with default.[73] Like verification, default is one possible tool or option for the lender.

[73] Recall $\chi : Z \to \{0,1\}$ is an indicator function if there is verification ($\chi = 1$) or not ($\chi = 0$). Similarly, let $\xi : Z \to \{0,1\}$ be the indicator function of whether the participation condition of the borrower is binding ($\xi = 1$) or not ($\xi = 0$). Then, the break-even condition of the lender becomes

$$d \le q \int_Z \{(1-\xi)[\chi(D(z) - \vartheta) + (1-\chi)\bar{D}] + \xi\kappa^0 z af(h)\}\phi_{e_H}(z)\ dz. \tag{22}$$

It can be shown that full repayment must occur for an upper interval $[\bar{z}, \infty)$. Hence, the expected discounted utility of the borrower is given by

$$u(c_0) + \beta\left[\int_0^{\bar{z}} \{\xi u[c^D(z)] + \chi u[c^V(z)]\}\phi_{e_H}(z)\ dz + \int_{\bar{z}}^{\infty} u[z af(h) - \bar{D}]\phi_{e_H}(z)\ dz\right], \tag{23}$$

where $c^D(z) = (1-\kappa)z af(h)$ and $c^V(z) = z af(h) - D(z)$, are the consumption levels in the cases of default and verification, respectively. Finally, using Eq. (23), we can derive the relevant ICC for the optimal contracting problem.

The optimal contract maximizes initial utility (Eq. 23) subject to the break-even constraint (Eq. 22) of the financial intermediary, and subject to the relevant ICC (not derived here). Without loss of generality, we assume that contracted payments satisfy the participation constraints (Eq. 7) even in cases of default. However, in this case, default occurs whenever the constraints (Eq. 7) bind, because the borrower is indifferent between requesting verification or defaulting and the lender is strictly better off not having to verify. In those cases, $D(z) = \kappa z af(h)$. On the other hand, when Eq. (7) are slack and there is verification, then $D(z)$ is set according to the condition (19) as in the model when limited commitment is not a binding constraint. The threshold $\bar{z}$ for full repayment and the human capital investment level are set according to similar expressions as Eqs. (20) and (21) but with corrections for the regions of default.

In practice, optimal student loan contracts in this environment could be specified in different ways. Most simply, a student loan contract would specify a fixed payment $\bar{D}$; however, a borrower could always request a reduced repayment, have his income verified, and then pay the income-based amount $D(z)$. A borrower who fails to repay or ask for the income-based payment would be considered in default, triggering the specified punishments. This general structure characterizes the US and Canadian Government student loan programs as discussed in Section 3; however, these programs do not condition repayments explicitly on ability a and investment h as the optimal contract would.

We now discuss repayment patterns in terms of verification (V), default (D), and full repayment (R). We consider the most tractable case in which $\kappa^0 \rightarrow \kappa$, and $\vartheta > 0$, so $z^A = \infty$. The shape of the likelihood function $l(z)$ can give rise to a number of possibilities as shown in Fig. 10. In all four cases, the horizontal axis represents labor income realized after school, $zaf(h)$. The vertical axis reflects the level of consumption for

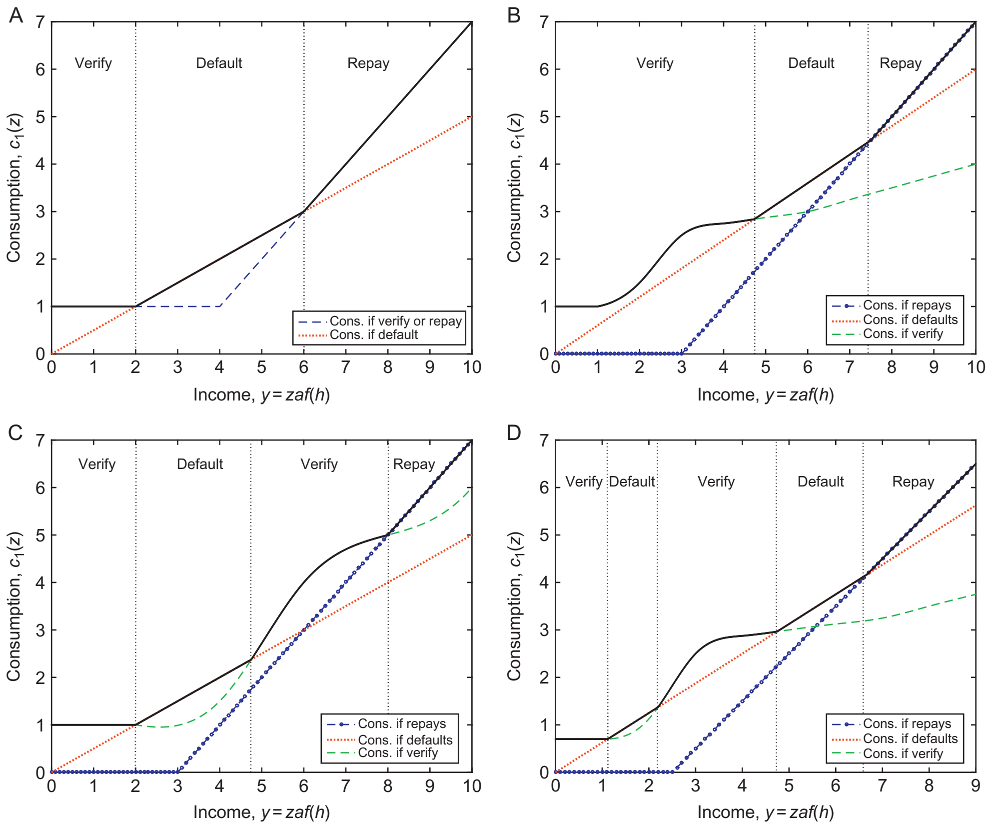

Figure 10 Consumption patterns and verification (V), default (D), and repayment (R) behavior in a model with costly state verification, moral hazard, and limited commitment. (A) No moral hazard: V, D, R. (B) Moral hazard: V, D, R. (C) Moral hazard: V, D, V, R. (D) moral hazard: V, D, V, D, R.

alternative responses of the borrower: fully repay (dashed line), default (dotted line) or partial payment $D(z) < \bar{D}$ based on verification (dash-dot line) as given by condition (19). The continuous line in each graph represents the upper envelope of these different responses (ie, the equilibrium postschool consumption level for the borrower).

Panel (A) reflects the case without moral hazard. In this case, the borrower asks for verification when earnings are low, triggering a repayment/transfer designed to yield him the same consumption as during school. For high earnings, he would rather just repay the constant amount $\bar{D}$. If default occurs, it is only for intermediate labor market outcomes. A similar pattern can arise when moral hazard is present, as shown in panel (B). Because higher effort is associated with better outcomes in the labor market, consumption under verification is strictly increasing in realized income, as required by the ICC on effort.

Panel (C) of Fig. 10, shows that a very different pattern can also emerge. If the function $l(z)$ is relatively flat at the low end of outcomes but particularly steep in the intermediate range (ie, effort has weak effects on the likelihood of low-income realizations but strong effects on the likelihood of intermediate realizations), then there can be two separate verification regions separated by a region of default. In this case, the region of default includes low to intermediate outcomes. Finally, as shown by panel (D), multiple regions of verification and default can alternate before reaching the full repayment region. This could happen when the function $l(z)$ switches multiple times from convex to concave and multiple steep regions of consumption under partial repayment lead to multiple crossings of this function with consumption under default.

Notice that for all possibilities, verification occurs at the low end of income realizations. This highlights two crucial aspects of the optimal contract. First, providing insurance for the worst income realizations is quite valuable. Second, default can be a useful but imperfect insurance tool that is always dominated by partial insurance at the very low end. Also, notice that full repayment is always the preferred option for high labor market outcomes. When labor market outcomes are very high, the marginal value of insurance is quite low. Given the desire to save on verification costs, a constant repayment amount is preferred to providing additional insurance and paying those costs. Furthermore, the losses associated with default grow with income, making a constant payment preferable to both borrower and lender.

6.7 Extensions With Multiple Labor Market Periods

Our two-period model abstracts from a number of interesting issues that would arise in a dynamic lifecycle setting in which loans are repaid over multiple periods after schooling. These issues arise when the incentive problems discussed in our two-period model remain active after borrowers finish school and enter labor markets. An extensive literature has studied variants of these dynamic incentive problems (eg, Chapters 20 and 22 in the textbook of Sargent and Lungqvist (2012)), although most of this literature has abstracted from the endogenous formation of human capital. We now briefly overview the main results from this literature and draw implications for the optimal design of student loan repayment. Throughout this discussion, we maintain the assumption that borrowers and lenders have the same rate of discount.

Begin by considering a multi-period extension of our model with no postschooling incentive problems. In particular, assume that after the exertion of effort e and investment h during school, both the borrower and lender observe the parameters and initial draw of the stochastic process $\{z_t\}_{t=1}^{T}$ that governs labor market and other risks during postschool years. With complete contracts, the structure of the contract will be essentially the same as in our two-period model. Since repayments in every period can be made fully contingent on the earnings realization, the borrower will be perfectly insured, consuming a constant amount every period. All risk is absorbed by the lender, who must receive a flow of repayments that fully covers the loan (in expected present value). Next, consider incomplete markets. In this case, the consumption allocation is given by a permanent income model in which the so-called natural borrowing limit — the maximum amount of debt that can always be repaid, even under the worst case realizations of $\{z_t\}_{t=1}^{T}$ — is determined by the amount invested in human capital.

Now, consider environments with limited commitment. As in the two-period model, the amount of repayments — and initial debt — may be limited by the outside option of the borrower, which might now be a concern in multiple periods. Generalizing our results on consumption allocations with complete markets, if the temptation to default is slack for some realization in any postschooling period, then consumption must equal that of the previous period. Yet, consumption smoothing is imperfect, since consumption must increase whenever the option to default is binding. Hence, consumption follows a nondecreasing path. In general, the set of states of the world for which consumption smoothing holds grows over time. Indeed, it is possible that at some point before retirement, consumption is fully smooth for all possible realizations of labor market risk. Repayments are designed so that the lender absorbs as much risk as possible — all of it when the participation constraint does not bind. In expectation, repayments must be declining over time, since they are permanently lowered every time the participation constraint binds.

Things can be quite different when moral hazard (hidden action) associated with labor market participation limits insurance. The optimal design of repayments will seek to use current and future consumption allocations to induce the borrower to exert optimal effort. In general, the ICCs bind when the borrower has the temptation to exert lower effort or to request a reduced repayment (or higher transfer from the lender). In these cases, the ICCs prescribe that the higher current consumption today must come at the cost of a reduction in all future consumption levels. On average, the borrower's consumption must be decreasing over time. Put another way, repayments to the lender must be increasing, on average, over time. This is commonly referred to as the "immiseration result."

There are cases in which the trend to higher repayments ends, such that consumption and repayments converge to a constant. In a paper that we discuss further below, Monge-Naranjo (2016) extend the model of unemployment insurance with moral hazard of Hopenhayn and Nicolini (1997) by allowing for a previous period of investment in human capital (with or without moral hazard during school). Thus, the model is designed to analyze how student loans should cope with a major risk for educational investments: unemployment following graduation from school. Monge-Naranjo (2016) demonstrate that the optimal credit arrangement should provide insurance to the borrower immediately after school, during the first period of unemployment, by providing transfers while the student finds a (suitable) job. However, those transfers should be declining as the unemployment spell continues. In this simple environment, all jobs are permanent, so as soon as the student finds employment, he should start repaying the lender a constant amount. The repayment amount should be set higher the longer the student had been unemployed. These two features of the optimal student loan contract provide some insurance to students while properly incentivizing them to look for jobs soon after graduation. In principle, the optimal contract could greatly enhance investments in human capital and improve the welfare of youth in need of financing to attend college.

6.8 Related Literature

Our model generates a number of lessons on how to design student loans that are self-financed, provide insurance, and optimally address a number of incentive problems, including limited commitment, moral hazard, and CSV. This framework not only generates endogenously restricted borrowing, but it also produces interesting patterns in terms of repayment and default. Some of these aspects deserve further exploration. Our analysis also omits a number of important incentive problems and the potential interactions of student loans with other public and private institutions. In particular, we have abstracted from issues of adverse selection (prior private information of borrowers about their potential returns on human capital or their willingness to repay), taxes, subsidies and other government interventions in credit markets, as well as social welfare programs like unemployment insurance. Rather than trying to tackle all of these issues within our framework above, we review recent and ongoing work in each of these areas.[74] For reasons of space, we only discuss the research most closely related to our objectives in this monograph.

[74] Friedman and Kuznets (1945) first raise the issue of income-contingent loans to deal with uncertainty and limited commitment problems, while Nerlove (1975) offers an early analysis of ex ante adverse selection and ex post moral hazard in reference to such loans.

A series of papers by Ionescu (2008, 2009, 2011), analyzes models with contractual frictions and incentive problems. The primary objective of these papers is to study college enrollment, borrowing, and default decisions when credit is subject to limited commitment and moral hazard. The analysis is directed specifically to existing government student loan programs and suggests that default rates are not generally higher among individuals that are most financially constrained. Instead, those that are constrained appear to be more restricted in terms of investment and borrowing. Most interestingly, she considers the impact of various forms of repayment flexibility (eg, lock-in low interest rates, switching to income-contingent repayments, or alternative bankruptcy discharges) in calibrated versions of her models. Consistent with our analysis above, she finds that the degree to which contingencies (repayment flexibilities) can be incorporated into student loan repayment schemes can have significant effects on schooling and welfare. More than hard borrowing constraints, the lack of insurance can be the limiting factor for schooling decisions.

Chatterjee and Ionescu (2012) consider student loans that offer insurance against the risk of failing college, a nontrivial risk for recent US college cohorts. Using a model that accounts for both adverse selection and moral hazard, their quantitative analysis suggests that offering loan forgiveness when a student fails college can lead to significant welfare gains without adverse impacts on enrollment or graduation rates. If forgiveness is also provided to students that choose to leave college without necessarily failing, the welfare gains are still positive but lower than under conditional forgiveness. Unconditional forgiveness raises enrollment and graduation but is less efficient because of the adverse incentives it produces.

Related and complementary work by Eckwert and Zilcha (2012) and Hanushek et al. (2014) studies the impacts of alternative repayment arrangements and government interventions in the market for student loans. Eckwert and Zilcha (2012) consider different repayment contracts in a model where individuals' abilities are heterogeneous and publicly known, but there is also exogenous labor market risk.[75] They abstract from borrowing for consumption purposes and from family transfers, further requiring that all investment expenditures must be borrowed. Using a three-period-lived overlapping generations (OLG) model, they contrast the resulting human capital, welfare and growth outcomes from three different student loan repayment schemes: (i) standard loan with fixed interest rate (ie, no insurance); (ii) insurance with pooling across abilities (ie, payments are a function of realized income but not initial ability), so there is cross-subsidization from high to low ability types; and (iii) insurance within ability groups, so there is no ex ante cross-subsidization. Their analysis produces two important conclusions. First, providing insurance conditional on ability (regime iii) is better for human capital investment, growth and welfare relative to a standard loan scheme (regime i).

[75] Alternatively, we can think of initial ability as a signal of true ability realized upon labor market entry.

Second, risk-pooling conditional on ability (regime iii), relative to unconditional pooling (regime ii), improves educational outcomes and also improves welfare as long as individuals are not too risk averse. Both of these conclusions highlight the importance of insurance and its counterbalance with proper incentives.

Hanushek et al. (2014) use a three-period-lived OLG environment with heterogeneity in ability, exogenous borrowing constraints, and intergenerational bequests to evaluate the implications of different stylized education policies for economic efficiency, inequality, and intergenerational mobility. In their framework, interventions can be welfare improving due to the borrowing constraint and the lack of insurance against uncertain labor market outcomes. They consider uniform education subsidies, merit-based subsidies, need-based subsidies, and loans with income-contingent repayment. Regarding the latter, students are restricted to borrow the full cost of college (or not at all) and must repay a constant fraction of their postschool income. While this structure, like that of government student loan programs in many countries, provides a limited form of insurance, it can also generate an adverse selection problem by encouraging lower ability students to attend (and borrow) for college even if their labor market returns are low. Their calibrated model produces a number of interesting results. First, merit aid performs poorly in terms of both equity and efficiency, because parental income and ability are highly correlated. Second, an income-contingent loan may end up subsidizing low ability children from well-off parents at the cost of high ability children from poor parents, because the latter repay more than the former. This highlights the problems with loan programs that effectively pool individuals of different abilities with ex ante cross-subsidization. Third, while income-contingent loans can perform quite well in providing insurance and reducing inequality, a sizeable need-based aid program can perform better in terms of equity and efficiency. Finally, they demonstrate that general equilibrium responses to policy through changing skill prices are nontrivial.

Abbott et al. (2013) also study education subsidies and standard student loan programs (with debt-based repayments and no default) in a richer OLG general equilibrium environment with full lifecycles, incomplete markets, postschool labor market uncertainty, and inter vivos transfers. Based on their calibrated model, they conclude that current student loan programs in the USA improve welfare over the alternative of no government lending. However, further expansions of traditional student loans (without any income-contingencies) would have very minor effects on education choices and welfare.[76] Contrary to Hanushek et al. (2014), Abbott et al. (2013) do not consider different student loan repayment schemes; however, they do find that general equilibrium responses are important in evaluating policies.

[76] Keane and Wolpin (2001) and Johnson (2013) also find modest effects of expanding current loan limits (without income contingencies), while Navarro (2010) finds that expanding both loan limits and extending full insurance could have very large effects on enrollment decisions.

Adverse selection is the central focus of Del Rey and Verheyden (2013). They consider a number of policy interventions in an economy with competitive credit contracts under limited commitment, adverse selection (due to heterogeneous unobserved ability), and labor market risk. Different equilibria may arise depending on the degree of contract enforcement, for example, separating equilibria with some insurance if enforcement is high; pooling equilibria with no insurance (but with ex post default) with moderate punishments. The student loan market collapses if enforcement is too weak.

Del Rey and Verheyden (2013) highlight a number of policy insights. For example, a government subsidy to banks can lead to some credit in equilibrium even when enforcement is so weak that student credit markets would not survive in laissez faire. Also, by requiring universal participation and limiting private competition, the government might be able to enforce pooling across individuals of different ability/risk and provide partial insurance. However, as in Eckwert and Zilcha (2012), this would entail taxing high ability students to subsidize those of low ability. One concern is the extremely stylized nature of their model, binary choices and outcomes for nearly every dimension (eg, invest/not invest, successful/failure in school, high/low ability, borrow full schooling costs vs no investment/borrowing) and the extent to which their main results would hold in more realistic environments.

The papers mentioned thus far consider specific policy interventions without necessarily deriving optimal policies. Related to this, it is relevant to recall that the traditional problem of optimally designing taxes and other government transfer programs has been revisited over the last 15 years by the "New Dynamic Public Finance" literature, which has moved away from the Ramsey tradition (taking a set of taxes as given) toward the Mirrleesian tradition (deriving optimal taxes from an incentive-constrained contracting problem).[77] A few papers in this tradition (Bohacek and Kapicka, 2008; Bovenberg and Jacobs, 2011; Kapicka, 2014; Kapicka and Neira, 2014; Stantcheva, 2014) have included endogenous human capital formation in their analyses of optimal taxation, considering education subsidies as instruments to cope with tax distortions.

Most papers within the Mirrleesian paradigm derive optimal nonlinear taxes in environments in which labor income is observed but the underlying combination of ability, effort and human capital is not observed. Therefore, taxes must be set entirely as a function of observed earnings even if it would have been desirable to tax effort, ability, and human capital separately (the latter may or may not be observed). Taxes are set to maximize a welfare function, typically utilitarian, subject to an incentive compatibility constraint on each individual, to ensure that high ability (and/or human capital if unobserved) types do not exert low effort and impersonate a low ability (and/or human capital) type.

[77] See Golosov et al. (2007) for an overview of this literature.

Within the Mirless tradition, Stantcheva (2014) considers a model in which human capital is accumulated with both, real resources (eg, tuition) and training time (eg, on-the-job training). Labor market earnings are determined by not only human capital and labor effort, but also a stochastic yet persistent ability term. Her model allows for fairly general wage functions, which can change over time. Stantcheva (2014) assumes that the government does not observe ability (neither its initial realization nor its lifetime evolution).

In Stantcheva's framework, it is optimal for the government to subsidize human capital expenses, counterbalancing distortions on the taxation of wage and capital income, encouraging labor supply, and providing insurance against adverse draws of productivity in the labor market. Whether full deductibility of education expenses is optimal depends on whether the ability elasticity of wages is increasing in education. Similarly, whether training time must be deducted from taxes depends on whether labor effort raises (learning-by-doing) or lowers (on-the-job training) future earnings. While the optimal taxation program is quite complex, Stantcheva (2014) reports numerical results which suggest that simple linear age-dependent policies can come fairly close to the second best and that full deductibility of expenses might be close to optimal.

The public finance literature with optimal education subsidies and progressive taxes tackles the same basic economic problem as our optimal contracting formulation, namely, transferring resources across time (postschool to the schooling period) and across different postschool earnings realizations. Despite sharing similar objectives, the two formulations have notable differences in their emphases. First, the Mirrleesian problem assumes a utilitarian objective, such that redistribution across ex ante heterogeneous but unobserved abilities is an important aspect of the optimal policy. In our optimal contract formulation above, ability and wealth are observable and each loan must be paid in expectation. Therefore, the resulting allocations can be implemented by private markets or by the government. Moreover, it is straightforward to handle observed wealth heterogeneity in the optimal contracting formulation.[78] Some of the optimal allocations in the Mirrleesian framework may require the authority to tax or to regulate participation in markets, since as illustrated by the failure of the "Yale Plan" discussed above, students with the best earnings prospects may simply not join or find a way to drop out. Second, the public finance literature uses as instruments grants or deductions and progressive taxes, while the optimal contract formulation specifies loan amounts and their implied repayments. The bridge between the two formulations is illustrated by recent work by Findeisen and Sachs (2013, 2014) and Gary-Bobo and Trannoy (2014). They use a Mirrleesian problem to derive the optimal repayment for different loans from a menu available to borrowers. The menu of loans must be designed to deal with adverse

[78] In this respect, see the work of Mestieri (2012) that considers unobserved heterogeneity in both wealth and ability, giving rise to a role for entry exams.

selection and moral hazard (ex ante and ex post heterogeneity) including unobserved effort exertion while in the labor market.

The work by these two sets of authors is highly complementary. Gary-Bobo and Trannoy (2014) consider a more stylized environment (two ability types) and are able to prove that the optimal arrangement entails incomplete insurance (because of moral hazard as in our model) and typically involves cross-subsidization across students of ex ante different ability levels. More interestingly, loan repayments cannot be decomposed as the sum of an income tax (depending only on ex post earnings) and a loan repayment (depending only on student debt). Therefore, optimal loan repayments must be income-contingent, or equivalently, income tax must comprise a student loan tax.[79] Findeisen and Sachs (2013) consider a richer environment with a continuum of types.[80] Their numerical results also point to income-contingent repayment of loans. Most interestingly, they find that optimal repayment schemes for college loans can be well-approximated by a schedule that is linearly increasing in income up to a threshold and constant afterwards. This is somewhat similar to our model of moral hazard with CSV, but it is driven by the provision of ex ante incentives as opposed to saving on verification costs. The results of Findeisen and Sachs (2013) support our main conclusion that the welfare gains from optimally designed income-contingent repayment can be significant.

The work of Findeisen and Sachs (2013, 2014) and Gary-Bobo and Trannoy (2014) complements that of Hanushek et al. (2014) by characterizing the optimal repayment of loans given the specified economic environment. However, these papers abstract from risk and other life-cycle aspects that modern quantitative macro models consider essential. In this respect, Krueger and Ludwig (2013a,b) restrict attention to a class of parameterized taxes (constant marginal taxes with nonzero deductions) and uniform subsidies in order to find the best tax scheme within a richer life-cycle environment. Specifically, Krueger and Ludwig (2013a,b) use a model that allows for endogenous human capital formation, borrowing constraints and income risks with (exogenously) incomplete financial markets and no default.[81] Krueger and Ludwig find that the degree of tax progressivity and the education subsidy that would maximize a utilitarian welfare function are larger than in the current US status quo.

In addition to income taxes, there are a number of other government and private institutions that may also interact with student loan programs. In ongoing work (eg, Monge-Naranjo, 2016), we study the design of optimal student loan programs with and without the integration of unemployment insurance. This work considers a framework with an initial schooling investment choice and a multi-period postschool labor market with search frictions. After leaving school, individuals face labor market risk in

[79] Unfortunately, their analysis does not include differences in family wealth.
[80] Findeisen and Sachs (2014) enrich this setting further to deal with multiple dimensions of heterogeneity.
[81] They abstract from parents' inter vivos transfers and from wealth effects in labor supply.

terms of unemployment duration and moral hazard in job search as in Hopenhayn and Nicolini (1997). School success can also be distorted by hidden effort.

As in the models analyzed above, borrowing and investment are increasing in ability and optimal borrowing helps finance consumption during school. A number of interesting considerations and results arise from the optimal contract. First, borrowing and investments are set trying to minimize the possibility of "debt overhang," that is, situations in which debt is so high relative to potential income that it discourages the borrower from seeking (and maintaining) employment so much that it reduces expected payoffs for both the borrower and lender. Second, insurance is provided not only in the form of positive transfers to the unemployed but also in the form of time-varying repayment as a function of unemployment duration. The repayment must increase (in present value) with the duration of unemployment to encourage job seeking by the borrower. Third, the optimal contract delivers higher investments and (potentially greatly) higher welfare than other suboptimal arrangements, such as autarky, unemployment insurance alone, or the case in which unemployment insurance is not integrated with student loan repayment.[82] Finally, the optimal arrangement that arises from this environment highlights the importance of properly handling inter-temporal incentives. In particular, it suggests that as formulated, the debt-forgiveness component of current and newly proposed income-contingent repayments (eg, Dynarski and Kreisman, 2013), can unravel the incentives of young indebted workers early on. If so, arbitrary time-dependent debt forgiveness can reduce the capacity for optimally designed student loan contracts to provide incentives and insurance, and ultimately, credit.

7. KEY PRINCIPLES AND POLICY GUIDANCE

Our characterization and overview of optimal student loan arrangements under both information and commitment frictions produce a number of lessons that can help guide policy. We begin with three basic principles that should form the foundation of any efficient student loan program. We then discuss a number of specific lessons regarding the optimal structure of loan repayments, the costs of income verification, repayment enforcement and default, and borrowing limits.

7.1 Three Key Principles in the Design of Student Loan Programs

Three key principles are central to any well-designed student loan program, public or private.

[82] Earlier work by Moen (1998) shows that reducing interest payments during unemployment can help achieve efficient investment in human capital. His results derive from very different economic reasons related to a hold-up problem on the side of firms for the investment in human capital of the worker.

First, *insurance is a central aspect in the design of student loans*. School itself may be risky as many students fail to complete their desired course of study. Even successful graduates, as highlighted by the recent recession, can struggle to find a well-paying job, or any job at all, after leaving college. An efficient lending contract ought to provide as much insurance as feasible through income-contingent repayments. Even if the provision of contingencies involves nontrivial costs, it is always efficient to provide considerable insurance in terms of reduced payments or even transfers to borrowers experiencing the worst labor market outcomes. In the extreme, when contracts cannot be made contingent on income at all (ie, limited commitment with incomplete contracts), default serves as an implicit and imperfect form of insurance at the bottom of the income distribution. Inasmuch as lenders can pool loans across many borrowers or can engage in other forms of hedging, they should act as risk-fee entities, providing insurance to students against idiosyncratic risk in their educational investments but pricing the cost of that insurance in the terms of the loan.

Second, *incentive problems must be recognized and properly addressed*. Due to private information and repayment problems associated with limited enforcement mechanisms, the amount and nature of consumption insurance is limited. An optimal contract must address many often conflicting goals, such as providing the student with the appropriate incentives to study hard, search for a job, report their income, and repay their loans. Incentive problems are not only relevant for low earnings states, but they can also limit the income-contingency of repayments at the high end. Because of moral hazard and limited commitment, lenders rely on charging high repayments for lucky students. Moreover, incentive problems can vary over different stages of the loan, with adverse selection concerns prominent at the time of signing, hidden action problems and moral hazard concerns during school and in the labor market, and income verification and commitment problems during repayment. A central challenge in practice is to properly assess the nature and severity of these incentive problems in order to provide the right incentives to align the interests of the student and creditor.

A third practical principle is that *borrowers should fully repay the lender in expectation*. This does not mean that every borrower always repays in full. Borrowers will sometimes make only partial payments or may default entirely on the loan, while others end up paying more than the present value of the debt evaluated at the risk-free rate. Although there may be considerable uncertainty at the time borrowers take out their loans, contracts should be designed such that borrowers expect to repay loans in full when averaging across all possible outcomes and associated repayment amounts. This zero expected profit condition is natural in the case of competitive private loan contracts; however, governments could choose to subsidize student loans (paid for via tax revenue) as a way to subsidize higher education, motivated, possibly, by fiscal and human capital externalities.[83]

[83] See Lange and Topel (2006) and Lochner (2011) for recent surveys.

While this is feasible, we believe that any desired subsidies could be more efficiently offered directly in the form of grants, scholarships, or tuition reductions, all of which can be more easily targeted (across need and merit groups), are more transparent, and may entail lower administrative costs. Similarly, efforts to redistribute resources across different types of students are likely to be more efficiently achieved through direct transfers rather than via student loan programs, especially if the socially desirable investments are not entirely aligned with the borrowing and repayment incentives of individuals. Furthermore, efforts by government lenders to systematically extract profits from some borrowers to subsidize losses on others (based on ex ante known information) are likely to be undermined by competitive private creditors who would aim to poach the profitable ones.[84] For these reasons, as a practical guide, we advocate loan contracts, public or private, that lead to zero expected profits from all borrowers, assuming any government subsidies for education are provided directly rather than through government loan programs.

Altogether, an optimal student lending arrangement must strike the right balance between providing insurance and incentives to borrowers, while ensuring the lender is repaid in expectation.

7.2 The Optimal Structure of Loan Repayments

The optimal student loan arrangement must exhibit a flexible income-based repayment schedule to provide the maximal amount of insurance while ensuring proper incentives for borrowers to exert effort and honestly report their income. In practice, the income-contingent repayment schemes observed in the USA and other countries (see Section 3) offer some insurance to borrowers. Yet, optimal contracts are likely to look quite different. Students of different abilities, making different investments, and borrowing different amounts should generally face different repayment schedules. The optimal contract is unlikely to be characterized by a single income threshold below which payments are zero for all borrowers or by a single constant repayment rate as a fraction of income above the threshold. Indeed, the optimal contract may allow for additional transfers to borrowers experiencing the worst postschool outcomes.[85]

[84] Del Rey and Verheyden (2013) provide an interesting and provocative exception when adverse selection problems are so severe that a competitive separating equilibrium (with revenue neutral contracts) cannot be supported. As discussed, it may be optimal in this case for the government to support a student loan program with net expected losses if such a program can deter enough poaching by private lenders. While interesting, the empirical relevance of their case needs to be established.

[85] As we discuss further below, other forms of social insurance (eg, welfare, unemployment insurance, disability insurance) may provide for minimal consumption levels, eliminating the need for student loan repayment plans to provide additional transfers to borrowers earning very little after school. However, as we also discussed above, the optimal student loan should integrate in its design the presence of such programs.

An important lesson from our analysis is that the optimal contract aims to provide the greatest insurance at the bottom of the outcome distribution where it is most valuable. Absent moral hazard problems, consumption and not payments would be constant across all low income levels. At the same time, repayments may be considerably higher than the amount borrowed plus interest (with a modest risk premium) for the luckiest borrowers who experience very high earnings realizations; however, when income is costly to verify, repayments should be constant across all high income realizations, a feature that is typically observed in practice for student loans and other forms of debt. Relative to standard repayment schemes, the optimal design of repayments can lead to important gains in welfare and efficiency by providing additional consumption smoothing, by properly encouraging effort and income reporting, and by yielding efficient investments in education. We demonstrate that default can arise even under the optimal contract, an interesting feature not well-established in the literature. However, we argue that default should occur infrequently and not among those with the worst labor market outcomes, because insurance is better provided with verification and income-contingent repayment.

The optimal structure of repayments can be summarized as follows. In the absence of hidden effort, consumption would be smooth and repayments increasing one-for-one in income across states of the world for which income is observed (ie, verified) by the lender. The presence of moral hazard limits the amount of insurance that can be provided, because effort must be incentivized by linking payments and consumption to income levels. The more difficult it is to encourage proper effort, the less insurance can be provided and the less payments should increase with earnings.[86] When income is costly for the lender to observe, it is inefficient to write contracts fully contingent on high earnings levels. Instead, borrowers with sufficiently high earnings should be asked to pay a fixed amount and avoid going through the verification process. In this case, moral hazard is primarily a concern for low income realizations. Finally, imperfect enforcement mechanisms mean that lenders cannot always enforce high payments from lucky borrowers. This can be especially limiting when verification is quite costly and moral hazard problems are modest, because contracts would ideally specify high payments from those with high labor incomes. The combination of costly verification and limited commitment can also lead to default in equilibrium for low- to middle-income borrowers, though not the most unfortunate. It is important to note that these market frictions not only limit consumption smoothing across postschool earnings realizations, but they also limit the amount students can borrow for college and discourage educational investments. Credible evidence on the extent of these information and enforcement frictions is crucial if they are to be addressed appropriately.

[86] As a corollary, lenders should absorb all risk beyond the borrower's control (eg, aggregate unemployment risk due to business cycle fluctuations).

Because earnings tend to be low immediately after school and grow quickly at the beginning of workers' careers, average payments will also tend to start low and grow over time if loan programs are efficiently designed. However, this does not mean that efficiency can be obtained with a simple repayment schedule that exogenously increases payment amounts with time since leaving school (eg, the US *Graduated Repayment Plan*). While age-dependent repayment plans can help with intertemporal consumption smoothing, they cannot address labor market risks, including the possibility of extended periods of unemployment or unexpectedly low income later in workers' careers. Labor market risks can only be addressed with explicit income contingencies. Efficiency also requires that repayments be contingent (on current as well as past income) throughout worker careers, even if labor market risks eventually subside. As discussed in Section 6.7, it is optimal to link later repayments to earlier earnings reports to help encourage honest reporting and efficient effort by borrowers at those earlier ages. The efficiency gains from fully flexible, but potentially complex, repayment schedules relative to simpler but less flexible schemes can only be assessed with a greater empirical understanding of the extent of moral hazard and the dynamics of income risk.

7.3 Reducing the Costs of Income Verification

Income verification costs change the nature of the contract by limiting the contingency of repayments on income for high earnings states. With high enough costs, it may become too costly to link repayments to income over a broad range of income realizations. This can severely limit insurance and increase the likelihood of default. Together, these lead to reductions in credit and can discourage educational investments. Consequently, institutional reforms that lower the costs of verifying income and that facilitate the linking of payments to income can improve the flexibility of contracts to enhance consumption insurance, allow for greater borrowing, and increase investments. If verification costs can be reduced enough, default can be eliminated entirely.

These lessons favor integrating the monitoring of income and payment collection efforts with, for example, the collection of social security taxes, unemployment insurance contributions, or income taxes as suggested in the recent proposal by Dynarski and Kreisman (2013). Indeed, this is a key feature of income-contingent lending schemes in countries like Australia, New Zealand, and the United Kingdom (Chapman, 2006). By eliminating the duplication of costs, better terms can be offered to students. This also highlights one key advantage governments have over private lenders and educational institutions in the provision of student loans. As stressed above, the integration of student loan programs with other social insurance institutions such as unemployment insurance, can go well beyond the reduction of verification costs, and can include additional mechanisms to provide insurance and incentives.

7.4 Enforcing Repayment and the Potential for Default

When student loan contracts are designed optimally, default is just one of many "repayment" states. Although the potential for default can severely limit the amount of credit students receive, it can also provide a valuable source of insurance and collection when it is costly to incorporate contingencies into repayment contracts.

For extremely high verification costs, default may be the least expensive way to effectively provide insurance against some subpar labor market outcomes. At the other extreme, if income verification costs are low and contracts can efficiently be made contingent on all, or at least most, income levels, then flexible repayment schedules that link payments to income will always dominate default. As long as verification costs do not preclude any form of income-contingency, default should never occur in the very best or very worst states. Contracts should always be designed to ensure repayment from the highest earners, and they can better provide insurance than default at the low end with explicit contingencies.[87]

Default becomes a more attractive feature of loan contracts when lenders can capture some of the losses from defaulters (eg, wage garnishments). Indeed, better collection efforts that increase the amount creditors can seize in the event of default can theoretically lead to more not less default in equilibrium, as contracts would optimally adjust to take advantage of lower default losses.

Finally, it is important to recognize that the existence (or extent) of default need not imply any inefficiencies, especially if verification costs are high relative to the losses associated with default. Different labor market risks and their dependence on the exertion of effort by the student can lead to complex patterns in the incidence of default, verification and full repayment of loans in the optimal contract. In practice, of course, default is also more likely when contracts are not properly designed, especially in accounting for imperfect enforcement. If so, unusually high levels of default associated with poor ex post labor market outcomes would signal inefficiencies in the way that student credit is allocated and/or repayments are structured. More generally, the basic principle that lenders should be repaid in expectation demands that borrower types with high observed default rates make higher standard payments (when repaying) to offset the losses associated with default. The evidence discussed in Section 5 suggests that this is not the case with current government student loan programs.

7.5 Setting Borrowing Limits

The different credit contracts derived in Section 6 specify repayment functions, borrowing amounts, and investment levels as functions of all observable borrower characteristics (especially their family wealth and ability) and other factors that might affect the returns

[87] Default may be the efficient response for the lowest set of income realizations if other forms of social insurance provide a high enough consumption floor.

on their investments (eg, postsecondary institution, course of study). In those contracts, it was not necessary to impose a maximum credit amount, since the financial feasibility constraint was always imposed. Then, the amount of credit would also adjust to the initial characteristics of the individual and proposed investment and consumption decisions, and the lender was always repaid in expectation.

In practice, student loan programs specify repayment schedules as functions of the amount borrowed, the amount invested, and other relevant characteristics. In this case, we can think about the borrowing levels d specified by our contracts as limits lenders might place on different borrowers.

Given substantial heterogeneity in postsecondary institutions and college majors in terms of costs and postschool earnings distributions, the efficient loan scheme would link maximum loan amounts to college and major choices, as well as other relevant observed characteristics of the borrower (eg, student ability as measured by grades or aptitude tests). With asymmetric information, it might also be optimal to condition the amount of lending on the own contribution of the student and his family toward the cost of college. Section 5 documents the extent to which many of these factors affect default rates and expected repayment amounts under current government student loan programs. The considerable variation in default rates across many ex ante observable factors suggests that either loan limits or repayment rates need to be adjusted to better equalize expected returns across borrowers and to improve the efficiency of these programs.

7.6 Other Considerations

Our discussion has largely assumed that student loan programs themselves are the only source of insurance against adverse labor market outcomes. Yet, most countries have a broad social safety net, including welfare, unemployment insurance, and disability insurance in developed countries and informal family arrangements in both developed and developing countries. The optimal student loan contract should be designed with these in mind. For example, if other social programs provide a modest consumption floor for all workers, then it is unlikely that any postschool transfers from the lender to unlucky borrowers would be needed. Default may also be optimal for the most unlucky of borrowers when verification costs are nonnegligible, since there is no need for insurance through the loan contract. More generally, student loan contracts should take into consideration the provision of insurance and incentive effects of other social insurance mechanisms. Given dramatic differences across countries and even states within the USA, we might expect very different contracts to arise optimally in different locations.

The general environments and contracts we have discussed apply equally to public and private lenders. Yet, governments have some advantages over private creditors in terms of income verification, collection, and sometimes enforcement penalties; although, some of these advantages are not necessarily inherent. Private lenders can be given similar enforcement powers as in the 2005 changes to US bankruptcy regulations, and they may also be quite efficient at collection in some markets. Additionally, private credit markets may be more nimble and responsive to economic and technological changes. Adverse selection problems pose a particular concern with competitive lending markets, since they may prevent the market from forming for some types of students. Governments may be able to enforce participation in student loan markets to minimize adverse selection concerns or to form pooling equilibria where one would not arise in a competitive market. In these cases, it may be desirable to reduce competitive pressures, which might otherwise unravel markets. Of course, it can be very difficult to "enforce" full participation, unless governments are prepared to eliminate self-financing by requiring that all students borrow the same amount.

In the USA and Canada, both government and private student loan programs co-exist. In these cases, it is important for governments to account for the response of private lenders. For example, government programs that attempt to (or inadvertently) pool borrowers of different ex ante risk levels may be undercut by private creditors, leaving government loan programs with only the unprofitable ones.[88] A different form of adverse selection problem can also arise for specific schools or even states that try to provide flexible income-contingent loan programs for their students or residents: even if all students are forced to participate in the program, better students (or those enrolling in more financially lucrative programs) may choose to enroll elsewhere. For these reasons, federal student loan programs are likely to be more successful at overcoming adverse selection problems than state- or institution-based programs.

8. CONCLUSIONS

The rising costs of and returns to college have increased the demand for student loans in the USA, as well as many other countries. While borrowing and debt levels have risen for recent students, more and more appear to be constrained by government student loan limits that have not kept pace with rising credit needs. At the same time, rising labor market instability/uncertainty, even for highly educated workers, has made the repayment of higher student debt levels more precarious for a growing number of students. These trends have led to a peculiar situation where, ex ante, some students appear to receive too little credit, while ex post, others appear to have accumulated too much relative to their ability to repay. Together, these patterns suggest inefficiencies in the current student lending environment, making it more important than ever to carefully reconsider its design.

[88] As documented in Section 5, expected loan losses and default rates vary considerably based on ex ante observable factors. This suggests that government student loan programs do pool risk groups, which leaves them open to these concerns.

Optimal student credit arrangements must perform a difficult balancing act. They must provide students with access to credit while in school and help insure them against adverse labor market outcomes after school; however, they must also provide incentives for students to accurately report their income, exert efficient levels of effort during and after school, and generally honor their debts. They must also ensure that creditors are repaid in expectation.

We have shown how student loan programs can most efficiently address these objectives. When postschool incomes are costly to verify, optimal repayment plans will specify a fixed debt-based payment for high income realizations and income-based payments for all others. Absent moral hazard concerns, all but the luckiest borrowers should receive full insurance (ie, their payments should adjust one-for-one with income to maintain a fixed consumption level). More realistically, when moral hazard concerns are important such that borrowers must be provided with incentives to work hard in school and in the labor market, payments should typically increase (less than one-for-one) in income among those experiencing all but the best income realizations. The fact that loan contracts cannot always be fully enforced means that some borrowers may wish to default on their obligations, which further limits the contracts that can be written. When income verification costs are negligible, contracts should be written to avoid default, since the provision of explicit insurance would always be better. By contrast, high verification costs leave room for default as an efficient outcome for some income realizations, since it may be a relatively inexpensive way to provide partial insurance that does not require outlays to verify income. Importantly, we show that default is generally inefficient for borrowers experiencing the worst income realizations, since explicit insurance that can be provided with income verification always dominates in these cases. Yet, an important conclusion from our analysis is that the existence of default for some borrowers is not prima facie evidence of any inefficiency in student lending arrangements. We have also shown that optimal student loan programs will generally lead to lower educational investments for borrowers (relative to nonborrowers) when information and commitment concerns limit the loan contracts. The inability to fully insure all risk discourages investment, more so for students with fewer family resources to draw on.

We have also summarized a small but growing literature that examines the determinants of student loan default and other forms of nonpayment. While the existence of default itself does not necessarily imply inefficiencies in the system, the fact that expected losses associated with nonpayment appear to be quite high among some borrowers is inconsistent with the basic principle that lenders should be repaid in expectation. Fairly high default rates for some types of borrowers also suggest inefficiencies in terms of either inappropriately high loan limits (for them) or inadequate insurance for borrowers who experience very poor labor market outcomes. At the other extreme, it is possible that loan limits are too low for some student types that rarely default.

Finally, we have provided practical guidance for re-designing student loan programs to more efficiently provide insurance while addressing information and commitment frictions in the market. While some recommendations are relatively easy to make (eg, lowering verification costs by linking student loan collection/repayment to social security, tax, or unemployment collections), others require better empirical evidence on important features of the economic environment. In particular, the optimal design of income-based repayment amounts depends critically on the extent of moral hazard in the market, yet we know very little about how student effort responds to incentives. The literature on optimal unemployment insurance and labor supply can be helpful for determining the value of incentives in the labor market. Additional information on ex ante uncertainty, repayment enforcement technologies, and the costs of verification are also needed to design optimal student loan programs. Here, new data sources on education and borrowing behavior, labor market outcomes, and student loan repayment/default can be useful; however, these data will need to be analyzed with these objectives in mind.

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