Education and Default Incentives with Government Student Loan Programs*

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Abstract

This paper examines data on student loan default from the *Baccalaureate and Beyond Survey*. The main findings include: (1) conditional on debt, the probability of default is declining in both predicted and actual post-school earnings; (2) conditional on earnings, the probability of default is increasing in debt; (3) default rates vary across undergraduate majors, but those differences disappear when controlling for debt and earnings; and most interestingly, (4) there is a U-shaped relationship between ability and the probability of default even after controlling for debt and earnings.

We next develop a model of human capital investment and default that attempts to replicate these facts. The model incorporates a lending scheme like that of the U.S. student loan program by tying borrowing limits to investment in schooling; it does not make repayments explicitly contingent on the subsequent earnings of borrowers. Punishments on borrowers who default follow those in practice under the government student loan program, and limits on those punishments cause some borrowers to choose default over repayment. Within the context of the model, we ask the following questions: (1) what types of heterogeneity and market shocks explain our empirical findings? (2) Given the answer to the first question, how different are consumption and investment under the current program with respect to the optimal (uncontingent) lending program? More generally, the model is useful for studying the interaction between borrowing constraints, default, and investment in human capital. In contrast to conventional wisdom, the model suggests that credit constraints do not necessarily imply under-investment in human capital given the current lending system.

1 Introduction

In the 2000-01 academic year, over 9 million American college students borrowed a total of more than $38 billion from federal student loan programs to help finance their education (The College Board [4]). Given recent trends, one in twenty of those borrowers will default on their federal student loans within the first two years of re-payment. Overall, the total amount outstanding from defaulted student loans

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stands at $25 billion (US Dept. of Education [16]). While default rates have declined considerably since reaching their peak of 22% in 1990, they are still quite high and entail substantial sums of money.

In this paper, we empirically examine patterns in student loan default among college graduates and develop a model consistent with those patterns. Using panel data from the Baccalaureate and Beyond Surveys (BB), which follows a random sample of 1992-93 college graduates through 1997, we analyze the relationship between individual background and ability, choice of college major, student borrowing, post-graduate employment and earnings, and loan default. Interesting empirical patterns include:[1]

1. Conditional on education debt, default rates are generally declining in both predicted and actual post-school earnings.

2. Conditional on actual post-school earnings, default rates are generally increasing in education debt.

3. Default rates are U-shaped in SAT/ACT scores, even after controlling for actual post-school earnings and education debt.

4. Default rates vary across students with different undergraduate majors, but those differences largely disappear after controlling for actual post-school earnings and education debt.

5. Blacks and hispanics default at significantly higher rates than whites and Asians, even after controlling for actual post-school earnings and education debt.

To understand these relationships, we model the accumulation of human capital in an environment with incomplete credit markets and limited enforcement of loan contracts. Instead of studying *constrained efficient allocations* as in our previous work (Lochner and Monge [15]), we consider an economy in which young agents face a lending environment similar to the federal student loan system (e.g. the Perkins, William D. Ford Federal Direct Student Loan (FDSL), and Federal Family Education Loan (FFEL) programs). Specifically, loan amounts are limited to the cost of a student's schooling and cannot exceed an upper limit set by the government. Repayment of loans is not explicitly contingent on post-school earnings, though it effectively is through the decision to default or re-pay.

In the model, individuals not only choose their level of human capital investment, but they also choose their type of study (or college major). This choice is determined by both the expected earnings associated with each choice and individual tastes or interests. Post-graduation earnings are determined by human capital investments, choice of major, and unpredictable shocks.

[1] Dynarski [9], Greene [10], and Wilms, et. al [17] also find evidence that student background characteristics like race, family income, and high school graduation are correlated with student loan default. Dynarski [9] further examines the relationship between earnings two years after completing college and default, finding a negative correlation.

Once any shocks to earnings have been realized, individuals decide whether or not to re-pay their loans. This decision will depend on the amount owed (including the interest rates on any loans) as well as the costs of default. These costs are primarily determined by the amount of earnings the government can seize from borrowers who default.[2]

Because creditors (both the government and private institutions) are restricted in the punishments they can impose on individuals that default, some borrowers may find it privately optimal to do so. When creditors can seize a fraction of earnings above some minimum amount, default should be a function of both post-school earnings and the amount of education debt. When conditioning on both, the model predicts that default should be declining in earnings and increasing in debt, consistent with empirical findings 1 and 2 above.

The option to default will affect schooling decisions. Individuals with a high probability of future default (i.e. less able individuals choosing low-paying careers) are likely to over-invest in their human capital to the extent that the punishment of default increases less with investment than the benefit does. This is the case whenever punishments only depend on whether or not an individual defaults and not the amount of the loan that is defaulted on. At the other extreme, limits on borrowing may restrict more able students choosing lucrative careers from borrowing as much as they would like causing them to under-invest in their human capital. For the vast majority of student borrowers in the U.S., however, it is likely that constraints on their borrowing have no affect on the amount of human capital investment they make. This is because the federal student lending program offers loans that cover most investment costs, though they may not cover desired levels of consumption. As a result, many students may be able to borrow enough to finance efficient levels of investment, though they are forced to consume less than they would otherwise choose if they were completely unconstrained. Taken as a whole, knowing an individual is borrowing constrained says nothing about the efficiency of his schooling choice under the current lending system.

Our work is closely related to the literature on credit constraints and schooling. In the standard economic framework, credit limits are fixed and independent of the observable characteristics and decisions of individuals (e.g. Aiyagari, Greenwood, and Seshadri [1], Caucutt and Kumar [8], Hanushek, Yilmaz, and Leung, [11], and Keane and Wolpin [12]). Alternatively, credit 'constraints' are sometimes represented by interest rates that increase with the amount borrowed or that exogenously vary in the population (Becker [3], Cameron and Taber [5] and Card [6]). In either case, credit constraints limit the amount of human capital investment undertaken by students from poorer families. Based on these ideas, an empirical literature has developed that focuses on two tests of credit constraints in the

[2]The ability of creditors to seize assets can also be incorporated but it is largely unimportant for student borrowers. Reporting to credit bureaus may have some additional effects that are not directly studied here (see Lochner and Monge [15]). To the extent that the effects of such a punishment are a function of post-graduation earnings, they can be roughly approximated within our framework.

market for human capital. One branch of the literature tests whether individuals from different family income levels have different college enrollment rates conditional on ability and other variables that may influence tastes for schooling or the ability to attend. The second branch compares the returns to schooling for individuals who are expected to face different interest rates or constraints on their borrowing. (See Carniero and Heckman [7] for a recent synthesis of this research.)

Our model casts serious doubts on the basis for these tests, since we find that schooling decisions may be independent of initial assets (or family income) even among constrained borrowers. As noted earlier, the current U.S. student loan system links borrowing limits to schooling investments. As a result, credit constraints limit consumption among poor students without necessarily affecting their investment decisions.

There are many potential shortcomings of the current lending system. For example, we show that the current system encourages less able individuals and those choosing careers with low earnings potential to over-invest and default on their loans while it may limit the borrowing and investments of more able individuals choosing high paying careers. Given the system's apparent weaknesses, it is important to ask whether (and how) the current lending system can be improved upon. In answering this question, we build on our earlier paper, Lochner and Monge [15], and the work by Alvarez and Jermann [2], Kehoe and Levine [13], and Kocherlakota, [14] to determine an optimal student lending system with uncontingent loans and limited enforcement. We first discuss how optimal loan limits and interest rates should vary across different students, taking current punishment and enforcement strategies as given. The implied borrowing, investment, and default decisions can be compared with those of the current system, as can changes in social welfare. Finally, we discuss the effects of changes in the punishments faced by defaulting borrowers on the optimal environment, focusing on changes in borrowing, investment, default, and social welfare.

The paper proceeds as follows. Section 2 summarizes major features of the federal student lending system. Data from the Baccalaureate and Beyond Surveys are used to analyze student borrowing and default in Section 3. We then develop a model of human capital investment, student lending, and default in Section 4 to better understand the empirical patterns we uncover. Section 5 discusses how a more efficient lending environment would look, and Section 6 concludes.

2 Federal Student Lending Programs

From the 1990-91 academic year to that of 2000-01, the percent of total federal student aid provided through government loans rose from 48 to 58 percent. By any measure, student loans are an important source of financing for higher education. In this section, we briefly discuss important features of the federal student loan system.

Historically, private lenders have provided the capital to student borrowers and the government

has guaranteed those loans with a promise to cover any unpaid amounts (and, in some cases, interest payments while students are in school), now referred to as the Federal Family Education Loan Program (FFEL). Since the 1994-95 academic year, the federal government has begun to directly provide loans to students through the William D. Ford Federal Direct Student Loan (FDSL) program.[3] Regardless of the source of funds, the rules governing these two programs are the same. Both offer Subsidized and Unsubsidized Stafford Loans as well as Parent Loans to Undergraduate Students (PLUS). 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.

The distinction between subsidized and unsubsidized loans hinges on the treatment of interest on loans while students are enrolled. Students are not charged interest on subsidized loans as long as they are enrolled in school (the government pays the interest), while interest accrues on unsubsidized loans. In order to qualify for subsidized loans, students must demonstrate financial need, which depends on family income, dependency status, and the cost of the institution attended. Unsubsidized loans may be obtained without any show of 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. See Table 1 for a basic description of the main federal student loan programs, since the 1987-88 academic year.

Dependency status and class level determine the total amount of loans a student is eligible for as seen in Table 2. Through 1992-93, dependent undergraduate students could borrow up to a total of $17,250 over a five year period, while that limit was raised to $23,000 in subsequent years. Interestingly, dependent students finishing college within four years are eligible for $4,000 or $5,500 (depending on the time period) less than those enrolled for five years. Independent students can borrow roughly twice those amounts, though most traditional undergraduates do not fall into this category.

Finally, we discuss issues related to re-payment and default. Re-payment of Stafford Loans begins six months after finishing school. Borrowers that are having difficulties making payments and that can establish financial hardship may qualify for either a forbearance or deferment, which will temporarily delay payments.[4] 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' re-payment when he does not qualify for a deferment or forbearance is to simply stop making payments, 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 (up to 25% of the balance due) may be added to the amount outstanding. Up to 10% of the borrower's wages can be garnished (15% can be garnished by the Department of Education if it becomes involved

[3]Perkins Loans, which charge low interest rates and are only available for students most in need, are quite limited in scope.

[4]Interest continues to accrue during a forbearance, but it does not during a deferment.

Table 1: Major Federal Student Loan Programs from 1987-88 to the Present

Academic Years	Loan Type	Eligible Students	Federal Program	Source of Funds
1987-88 to 1992-93	Stafford Loans (subsidized)	Dependent and Independent Students	Guaranteed Student Loan Program (GSL)	Private Lenders
	SLS Loans (unsubsidized)	Primarily Independent Students	Supplemental Loans to Students	Private Lenders
1993-94 to present	Subsidized Stafford Loans	Dependent and Independent Students Showing Need	Federal Family Education Loan Program (FFEL)	Private Lenders
			William D. Ford Direct Loan Program (FDSL)	U.S. Department of Education
	Unsubsidized Stafford Loans	Dependent and Independent Students	Federal Family Education Loan Program (FFEL)	Private Lenders
			William D. Ford Direct Loan Program (FDSL)	U.S. Department of Education

in the collection process), and federal tax refunds can be seized and applied toward the balance.[5] In practice, these sanctions are sometimes limited by the inability of institutions to locate those who have defaulted. Wage garnishments are ineffective against defaulting borrowers 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 times the federal minimum wage, or if the garnishment would otherwise result in an extreme financial hardship.

3 Empirical Patterns in Default on Student Loans

We use the Baccalaureate and Beyond Surveys (BB) to analyze patterns in default on student loans by college graduates a few years out of college. The survey has followed a random sample of about 11,000 individuals who received their baccalaureate degree during the 1992-93 academic year through

[5]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 begun to punish educational institutions with high student default rates by making their students ineligible to borrow from federal lending programs.

Table 2: Loan Limits for Undergraduate Borrowers

	1987-88 to 1992-93		1992-93 to present	
Class Level	Dependent Students	Independent Students	Dependent Students	Independent Students
First Year	$2,625	$6,625	$2,625	$6,625
Second Year	2,625	6,625	3,500	7,500
Third Year	4,000	8,000	5,500	10,500
Fourth Year	4,000	8,000	5,500	10,500
Fifth Year	4,000	8,000	5,500	10,500
Cumulative Total	17,250	37,250	23,000	46,000

Notes:
Amounts include Subsidized and Unsubsidized Stafford Loans and SLS Loans.
Yearly limits sum to less than cumulative totals in the later period.

1997 (with surveys in 1993, 1994, and 1997).[6] We also disregard individuals receiving their BA at age 30 or later to focus on the traditional college student (less than 15% received their BA at such late ages). Because those continuing on to graduate school are eligible for deferments in their loan re-payment, we do not observe the default choices of individuals enrolling in graduate school for more than a short time. We, therefore, focus on U.S. citizens receiving no more than 9 months of graduate education and who are no longer enrolled in any form of school as of the 1997 survey (maintaining about two-thirds of the sample).

Approximately 50% of these graduates report having borrowed money for their schooling, and we focus on them. Our main sample, therefore, consists of 2,796 undergraduate borrowers who graduated from college in the 1992-93 academic year and did not pursue more than 9 months of post-graduate education.

To measure default, we determine whether or not an individual defaulted on (and did not subsequently re-pay) or expunged through bankruptcy any federal student loan through early 1998.[7] Loan amounts are based on survey responses in 1997 and include any borrowing from federal or private sources (including the family). The 1994 and 1997 surveys ask respondents about their earnings at their current job. We calculate their annual earnings and wage rates for the job at which they were employed at the time of these surveys. Respondents also reported household income for the year prior

[6]The BB sample is a subsample consisting of all graduating respondents from the 1993 National Postsecondary Student Aid Study (NPSAS), a nationally representative sample of all postsecondary students in the U.S. All averages in the following tables are weighted to reflect the stratified sampling scheme of the original NPSAS survey as well as any attrition in later surveys.

[7]These data, collected for the BB, are based on individual loan records from the National Student Loan Data System (NSLDS) as of 1998. They report the status of each federal student loan taken out by all borrowers in the sample.

to the 1994 and 1997 surveys.

Table A-1 of the Appendix reports background characteristics for our sample of borrowers. It is nearly equally split along gender lines, with more than 80% white. About one-fourth of the sample majored in business and management. Table 3 reports the extent of borrowing and post-school earnings/employment. Among the borrowers in this sample, average undergraduate loans totaled about $10,500, while graduate loans were negligible (reflecting our sample requirement that they have no more than 9 months of graduate study). Approximately 27% had taken out loans of less than $5,000, and 24% had loans of $15,000 or more. When spousal loans are added on for those who were married, average family educational borrowing was nearly $13,000. Four years after receiving their BA, these borrowers still owed more than $4,500 on their own student loans and their families owed a total of almost $6,000. Nearly 6% of these borrowers had defaulted on (and not subsequently re-paid) at least one of their college loans.

Average earnings for the sample of borrowers one year out of college was $20,790 (1994), increasing to $31,599 four years after graduation (1997).[8] Wage rates in the 1997 job averaged $14.77, and most had experienced little if any time unemployed. Household income averaged about $45,000 in 1996. Since low incomes may indicate an inability to make loan payments, it is instructive to note that 36% of the college graduates earned less than $25,000 in 1997 while slightly less than 20% had total family income below that level during the previous year.

Table 4 reports information about student borrowing and default by gender, ethnicity, and SAT/ACT quartile for all borrowers in the sample. The final column of the table reports whether individuals had a family income above $25,000 in either 1993 or 1996, since this is likely to reflect an ability (if not desire) to make timely loan payments. Default rates for men and women are nearly identical, as are the amounts borrowed for school and the amount still owed. Among the Asian borrowers, only 2.2% had defaulted on their loans within four years of graduating, despite the fact that their average loan size was nearly $14,000. About 81% had a family income above $25,000 in at least one of the post-graduation years. In stark contrast, black borrowers defaulted at an astonishing rate of 21%, despite taking out loans that averaged more than $3,000 less. These high rates may, at least partially, reflect an inability to maintain payments, since 29% of all black borrowers in our sample had incomes below $25,000 in both 1993 and 1996. Earnings were noticeably lower for blacks than for all other ethnic groups. Hispanics borrowed the least, approximately $8,000 on average, and defaulted about 12% of the time. White borrowers defaulted 3.7% of the time, having taken out loans averaging $10,800. They owed the least ($4,406) on their student loans four years after graduating. Across all ethnic groups, borrowers owed about one-half of their original loan amounts four years after graduating.

Turning to comparisons across SAT/ACT test score quartiles, we find an interesting pattern.[9]

[8] These measures include those with zero earnings–only a very small fraction of the sample.

[9] SAT/ACT quartile represents the individual's quartile in the test distribution of all sample SAT scores if available.

Table 3: Debt and Earnings for Undergraduate Borrowers

Variable	Mean	Standard Deviation
(a) Debt/Loans (as of 1997):		
Any graduate loans	0.012	0.108
Any outstanding loan balance	0.649	0.477
Any family outstanding loan balance	0.682	0.466
Any other debt	0.970	0.171
Total undergraduate loan amount	10,527	9,238
Total loan amount	10,687	9,493
Educational debt $1-4,999	0.265	0.441
Educational debt $5,000-9,999	0.275	0.446
Educational debt $10,000-14,999	0.216	0.411
Educational debt $15,000-19,999	0.125	0.331
Educational debt $20,000 +	0.119	0.324
Total family loan amount	12,598	12,121
Amount still owed on loans	4,562	5,904
Amount family still owes on loans	5,910	8,572
Amount of other debt	956	578
Tuition paid for 1992-93 year	4,484	4,721
Default (without re-payment)	0.056	0.231
(b) Earnings and Employment:		
1994 earnings	20,790	39,131
longest unemployment spell from BA to 1994 survey (months)	1.502	3.048
1997 earnings	31,599	21,514
longest unemployment spell from BA to 1997 survey (months)	2.651	5.211
1997 wage rate	14.77	13.79
1996 family income	44,984	27,157
1997 earnings less than $25,000	0.360	0.480
1996 family income less than $25,000	0.196	0.397
Family income less than $25,000 in 1993 or 1996	0.680	0.466
Family income higher than $25,000 in 1993 or 1996	0.819	0.385
Ratio of total education loans to 1997 earnings	3.405	196.800
Ratio of family education loans to 1996 income	1.771	97.236

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, received their BA prior to age 30, and borrowed money for their education.

Table 4: Borrowing and Default by Gender, Ethnicity, and SAT/ACT Scores

Characteristic	Default	Total Education Loan Amount	Amount Owed	1993 or 1996 family income > $25,000
(a) Full Sample (N=1,252)	0.056	10,687	4,562	0.819
	(0.005)	(180)	(115)	(0.008)
(b) Gender:				
Male (N=1,252)	0.057	10,890	4,334	0.844
	(0.007)	(284)	(164)	(0.011)
Female (N=1,544)	0.056	10,504	4,769	0.796
	(0.006)	(228)	(162)	(0.011)
(c) Ethnicity:				
Asian (N=80)	0.022	13,848	5,864	0.813
	(0.019)	(1,566)	(1,225)	(0.049)
Black (N=204)	0.210	10,517	5,979	0.712
	(0.030)	(578)	(456)	(0.037)
Hispanic (N=172)	0.118	8,184	3,953	0.812
	(0.027)	(511)	(386)	(0.033)
White (N=2,308)	0.037	10,771	4,406	0.829
	(0.004)	(199)	(122)	(0.009)
(d) SAT/ACT Quartile:				
Quartile 1 (N=687)	0.075	11,444	4,716	0.806
	(0.011)	(420)	(220)	(0.017)
Quartile 2 (N=687)	0.050	10,384	4,093	0.804
	(0.009)	(359)	(204)	(0.017)
Quartile 3 (N=595)	0.024	10,190	4,532	0.812
	(0.007)	(312)	(234)	(0.017)
Quartile 4 (N=495)	0.086	10,816	4,727	0.862
	(0.014)	(468)	(340)	(0.017)

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, received their BA prior to age 30, and borrowed money for their education.

Default rates are highest for the *most* able (quartile 4) at 8.6%, followed closely by the lowest ability quartile, which had a default rate of 7.5%. Default among those in the third ability quartile was by far the lowest with only 2.4% choosing not to re-pay their loans. Total loan amounts were quite similar across ability quartiles, with the the least able borrowing the most at $11,425 (about $1,000 more than all other ability categories). Despite the non-monotonic relationship between ability and default, family income is positively correlated with ability as shown in the final column. Fewer than 14% of all high ability borrowers had family income levels below $25,000 in both 1993 and 1996, while more than 19% of the lowest ability borrowers did.

Table 5 reports borrowing and default rates by undergraduate major. While small sample sizes within each category make it difficult to statistically identify differences across many majors, a few patterns are worth mentioning. First, average total loan amounts differ by less than $2,000 across most major categories (health profession majors are the clear exception). Second, the likelihood of default varies considerably, from a low of 2.1% for those in health profession majors to a high of almost 12% for those in humanities majors. Default rates are below 4% in majors such as education, engineering, and health professions, while they are above 9.0% in public affairs and social service majors, math and sciences, and humanities. Third, there is no obvious pattern between post-graduate earnings and default rates when looking across majors. While borrowers majoring in math and sciences are very unlikely to earn less than $25,000 after graduating, they have a very high default rate. On the other hand, those majoring in engineering and health professions are also likely to earn more than $25,000, but they have very low default rates.

Default should be increasing in the cost of re-payment (alternatively, the benefit of defaulting). Since the cost of re-payment is simply the amount owed, default rates should be increasing in the amount borrowed. Table 6 supports this prediction. Default rates are around 4-5% for those borrowing less than $10,000, increasing to more than 9% for those borrowing $20,000 or more. This relationship continues to hold after controlling for post-graduation earnings as we show below.

Since individuals with lower earnings are less able to make their loan payments, we might expect to observe a strong negative correlation between earnings and default. This does not appear to be the case as seen in panel (a) of Table 7, which reports on the relationship between 1997 earnings and default. Among those earning less than $10,000 (less than 10% of the sample), fewer than four percent defaulted. However, among those earning $10,000-20,000, default rates are as high as 12%. The likelihood of default then declines with earnings to 2.6% for those earning between $40,000 and $50,000, but it then rises again to nearly 5% for those earning $50,000 or more.

The low default rates among those at the bottom of the earnings distribution may reflect the ability of these individuals to receive a deferment or forbearance on their loans, which temporarily

If the individual did not take the SAT, then the quartile was similarly determined from his ACT score.

Table 5: Borrowing and Default by Undergraduate Major

Undergraduate Major	Default	Total Education Loan Amount	Amount Owed	1993 or 1996 family income > $25,000
Business/management (N=379)	0.048	10,756	4,433	0.818
	(0.012)	(539)	(319)	(0.022)
Education (N=425)	0.038	10,658	4,663	0.768
	(0.010)	(429)	(280)	(0.023)
Engineering (N=222)	0.031	10,961	4,380	0.977
	(0.013)	(571)	(354)	(0.011)
Health professions (N=248)	0.021	13,109	5,183	0.946
	(0.010)	(685)	(430)	(0.016)
Public affairs/social serv. (N=120)	0.090	9,416	4,323	0.825
	(0.028)	(673)	(424)	(0.038)
Biological sciences (N=117)	0.043	9,937	4,218	0.734
	(0.020)	(695)	(553)	(0.043)
Math & science (N=186)	0.095	9,830	4,091	0.917
	(0.024)	(631)	(506)	(0.022)
Social science (N=261)	0.051	9,564	4,556	0.823
	(0.015)	(450)	(321)	(0.026)
History (N=50)	0.061	9,664	3,844	0.759
	(0.037)	(1,385)	(899)	(0.066)
Humanities (N=274)	0.117	10,558	4,775	0.655
	(0.021)	(475)	(313)	(0.032)
Psychology (N=87)	0.041	10,351	5,349	0.850
	(0.023)	(782)	(670)	(0.043)
Other (N=426)	0.067	10,846	4,633	0.780
	(0.013)	(532)	(331)	(0.022)

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, received their BA prior to age 30, and borrowed money for their education.

Table 6: Default by Total Education Loan Amount

Loan Amount	N	Default Rate	Standard Error
$1-4,999	696	0.051	0.009
$5,000-9,999	756	0.042	0.008
$10,000-14,999	662	0.059	0.010
$15,000-19,999	351	0.062	0.014
$20,000 +	330	0.094	0.018

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of currently graduate education, were not enrolled in school, received their BA prior to age 30, and borrowed money for their education.

Table 7: Default by Actual and Predicted 1997 Earnings and 1996 Family Income

	Earnings/Income Category:					
	$0-9,999	$10,000-19,999	$20,000-29,999	$30,000-39,999	$40,000-49,999	$50,000 +
(a) Actual 1997 Earnings						
Default Rate	0.037	0.121	0.058	0.041	0.026	0.049
(Std. Error)	(0.012)	(0.018)	(0.009)	(0.009)	(0.011)	(0.016)
N	265	399	813	568	247	234
(b) Predicted 1997 Earnings						
Default Rate		0.041	0.070	0.059	0.029	
(Std. Error)		(0.012)	(0.010)	(0.008)	(0.010)	
N		331	792	983	344	
(c) 1996 Family Income						
Default Rate	0.170	0.119	0.065	0.052	0.014	0.042
(Std. Error)	(0.054)	(0.021)	(0.011)	(0.011)	(0.007)	(0.008)
N	59	279	551	503	335	792

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, received their BA prior to age 30, and borrowed money for their education. Predicted earnings based on a Tobit specification that controls for SAT/ACT quartile, major, ethnicity, and months of graduate education.

delays payments for borrowers experiencing severe financial difficulties. In some sense, this is simply a labelling issue, since it reflects non-payment. More importantly, family income levels tend to be *higher* among those earning less than $10,000 (78% had family income above $25,000 in 1993 or 1996) than they are for those earning $10,000-20,000 (only 51% had high family incomes in 1993 or 1996), so income from spousal employment may help reduce pressures to default for these borrowers. Turning to panel (c) we observe that default rates among those with very low family incomes are higher than among those with incomes ranging from ten to twenty thousand dollars. Default rates are monotonically declining in family income until the highest income category is reached.

Those with high earnings (above $50,000) also tend to have borrowed more for their education than all other income groups – on average, those earning more than fifty thousand dollars borrowed nearly $4,000 more than those earning twenty to fifty thousand dollars. Their higher earnings should make re-payment easier, but their substantial debts may more than offset this effect. To explore this issue further, we estimate the probability of default as a function of both 1997 earnings and the total amount borrowed using a probit specification for default as a function of polynomials in both earnings and educational borrowing.[10] Figure 1 graphs the predicted probability of default by 1997 earnings for someone with the average level of educational borrowing. While the graph shows a steep increase in the probability of default at the very low end of the earnings distribution (note that 90% of the sample earned more than $12,000 in 1997), default is generally decreasing in earnings once we control for the amount borrowed. This suggests that the high default rates among those at the top end of the earnings distribution are the result of higher levels of education debt. Figure 2 shows that the probability of default is monotonically increasing in education debt after controlling for earnings.

Because earnings vary predictably with individual background and choice of college major and because earnings affect default, many individuals may know whether or not they are likely to default on their loans far before they do so. That is, black men with low SAT scores who choose to major in humanities ought to recognize that their post-graduation earnings will be low and that they are likely to be unable or unwilling to re-pay their loans. To examine this further, we estimate annual earnings in 1997 based on SAT/ACT quartile, undergraduate major, ethnicity, and the number of months of graduate school (still considering those with no more than 9 months of graduate education but extending the sample to include non-borrowers as well) using a standard Tobit procedure. (See Appendix Table A-2 for the estimates.) We then form predicted 1997 earnings for each individual based on their characteristics. Panel (b) of Table 7 reports the relationship between default and this predicted earnings measure. Default rates increase from the $10-20,000 to the $20-30,000 income category, but then decline thereafter. It is impossible to know whether default rates would increase

[10]We estimate the model using polynomial terms through order six for both debt and earnings, since likelihood ratio tests did not reject that this specification fit the data better than lower order polynomials while tests rejected the inclusion of higher order polynomials.

Figure 1: Predicted probability of default by 1997 earnings (with average education debt)

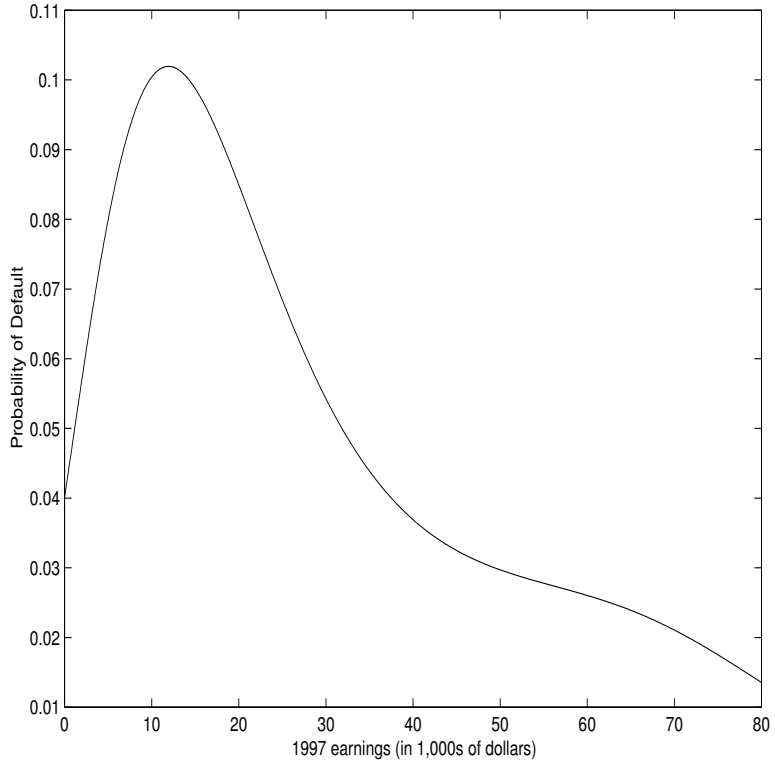
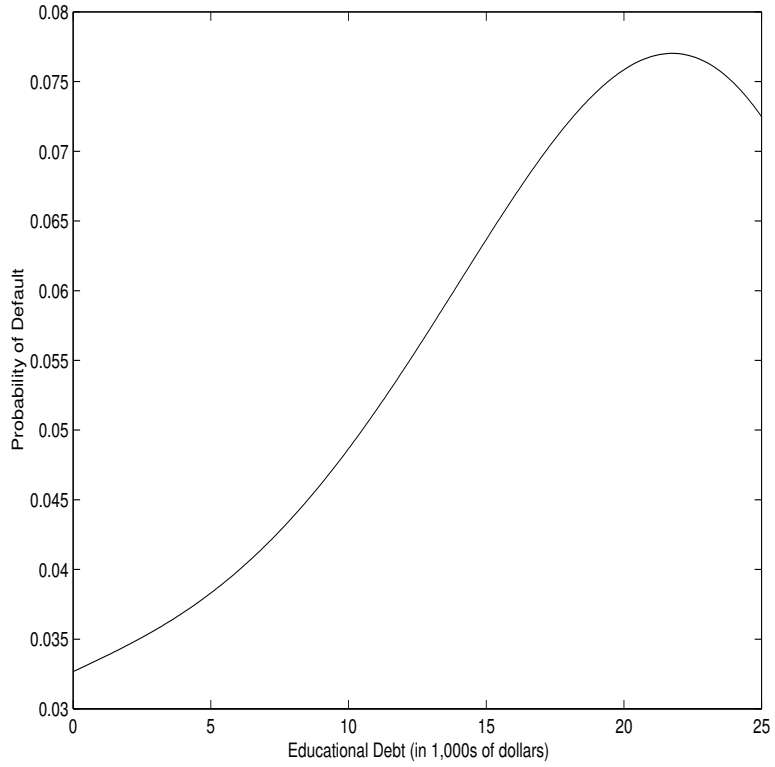


Figure 2: Predicted probability of default by education debt (with average 1997 earnings)



for borrowers with predicted earnings above $50,000 (as is the case with actual earnings), since none of our sample members are predicted to have earnings that high.

Finally, we examine the relationship between gender, race, SAT/ACT scores, college major, and default conditional on actual earnings and total education loan amounts in Table 8. Specification (1) does not control for earnings or debt and serves as a baseline. The differences across groups shown in Tables 4 and 5 remain. All remaining specifications in the table control for sixth order polynomials in 1997 earnings and student loan amounts. Even after controlling for earnings and student debt in columns (2) and (3), default is U-shaped in SAT/ACT test scores and default rates are higher among blacks and hispanics. While there is some variation in the effects of college major on default rates, most differences are insignificant. Two obvious exceptions are math/science and humanities majors, which show the highest default rates conditional on race, gender, test scores, earnings, and debt. It is somewhat surprising how little most coefficient estimates change when we control for earnings and debt. Columns (4) and (5) condition on 1994 earnings in addition to 1997 earnings and education debt, which should help alleviate any biases due to measurement error in earnings and should help account for any effects that growth in earnings may have on default. The qualitative features with respect to test scores, race, and college major remain.

We also examine whether predicted earnings continue to affect default rates conditional on actual earnings and debt. Controlling for polynomials in debt and 1997 earnings, the estimated coefficient on predicted earnings is insignificant (-0.007 with a standard error of 0.006).

4 A Model of Schooling and Default

We develop a simple model of optimal human capital investment and default in an environment based on the U.S. federal student loan program. The model begins to address the link between credit constraints, schooling decisions, and default, reproducing some of the empirical patterns in default just discussed. To start, we ignore the college major decision and stigma of default, returning to these issues below.

Individuals are endowed with initial assets a (primarily reflecting parental transfers) that they may use for consumption, c, or investment in human capital, y. At the time of human capital investment, preferences are given by

$$u(c) + \beta \int v(A(z))dF(z). \tag{1}$$

Here, $u(\cdot)$ is the utility of consumption during the time of investment (youth), and $v(\cdot)$ represents the expected discounted utility after investment decisions have been made. Both are increasing, concave, and twice continuously differentiable functions. The parameter β represents the time discount factor, and $A(z)$ represents net resources available to the agent in the second period who has received a shock

Table 8: The Effect of Background Characteristics on Default
(Probit Coefficient Estimates)

Variable	(1)	(2)	(3)	(4)	(5)
Male	0.105	0.127	0.132	0.141	0.160
	(0.101)	(0.112)	(0.107)	(0.116)	(0.111)
SAT/ACT Quartile 2	-0.173	-0.214	-0.193	-0.201	-0.183
	(0.128)	(0.137)	(0.134)	(0.144)	(0.140)
SAT/ACT Quartile 3	-0.443	-0.523	-0.437	-0.481	-0.396
	(0.154)	(0.171)	(0.163)	(0.175)	(0.167)
SAT/ACT Quartile 4	0.020	0.006	0.102	-0.044	0.065
	(0.140)	(0.152)	(0.143)	(0.159)	(0.149)
Black	0.848	0.788	0.813	0.842	0.878
	(0.135)	(0.147)	(0.141)	(0.153)	(0.147)
Hispanic	0.408	0.475	0.531	0.418	0.489
	(0.179)	(0.188)	(0.182)	(0.200)	(0.192)
Asian	-0.024	0.216	0.301	-0.127	-0.035
	(0.343)	(0.358)	(0.338)	(0.461)	(0.439)
Business/management	0.110	0.264		0.308	
	(0.183)	(0.199)		(0.209)	
Education	0.136	0.229		0.210	
	(0.182)	(0.202)		(0.211)	
Engineering	-0.329	-0.052		-0.001	
	(0.275)	(0.301)		(0.325)	
Health professions	-0.423	-0.384		-0.571	
	(0.278)	(0.330)		(0.375)	
Public affairs/social services	0.048	0.176		0.180	
	(0.275)	(0.289)		(0.296)	
Biological sciences	0.124	0.096		0.001	
	(0.258)	(0.288)		(0.324)	
Math & science	0.347	0.574		0.651	
	(0.206)	(0.222)		(0.232)	
Social science	0.017	-0.042		-0.023	
	(0.209)	(0.234)		(0.242)	
History	0.424	0.225		0.289	
	(0.334)	(0.417)		(0.426)	
Humanities	0.508	0.594		0.568	
	(0.179)	(0.195)		(0.205)	
Psychology	0.060	-0.020		-0.011	
	(0.304)	(0.350)		(0.359)	
Log Likelihood	-392.12	-342.99	-355.05	-316.53	-329.05
Number of Observations	2,071	1,876	1,876	1,790	1,790
Earnings & Debt Controls:					
Total Education Loan Amount	No	Yes	Yes	Yes	Yes
1997 Earnings	No	Yes	Yes	Yes	Yes
1994 Earnings	No	No	No	Yes	Yes

Notes:
Standard errors in parentheses. Specifications controlling for earnings and and total loan amounts, include sixth order polynomials in those variables. All specifications control for months of graduate school.

of z (with cdf $F(z)$). These shocks may take place during or after the education process, but they are not realized until *after* investment decisions have been made. A low z may, therefore, represent a worse than expected educational experience or a poor employment outcome.

While individuals may choose to save some of their initial assets, we focus attention on youth choosing to borrow from the federal loan program. We, therefore, assume that to finance their investments, individuals can borrow an amount d not to exceed the amount of investment or an upper limit on borrowing, $\hat{d}$. These constraints on borrowing reflect two important features of the current government lending environment: (1) loans are provided to cover schooling costs (with some provision for modest living expenses) and not consumption, and (2) students face an upper limit on the amount they can borrow. Notice that the first characteristic of U.S. government lending programs has been ignored in previous studies of credit constraints and schooling; yet, this program feature generates new and interesting results that contradict conventional thinking about borrowing constraints and the efficiency of investment decisions. An interest rate of R is charged on these loans, which may or may not be subsidized.

Given investment y, an individual of known ability e will earn a second period income of

$$w(z, e, y) = zey^{\alpha}, \tag{2}$$

where $\alpha \in (0, 1)$ and z is the education/labor market shock. The important features of the earnings process are: (1) expected earnings are increasing in human capital investments (where y may represent a greater quantity or quality of schooling), (2) expected earnings are increasing in known ability e, (3) ability and investment are complements, and (4) future earnings may be risky at the time of investment, as reflected in $z \geq 0$.

Once investments have been made and z is realized, individuals can decide whether or not to default on their loan obligations. If they choose to default, we assume that any of their earnings above some minimum amount $\underline{w}$ can be garnished at the rate τ. Thus, the effective garnishment schedule is given by $\max\{0, \tau(zey^{\alpha} - \underline{w})\}$. One could also assume that assets can be seized from defaulting agents, however, this will not play a role in our analysis of constrained borrowers who will have non-positive assets at the conclusion of their schooling.

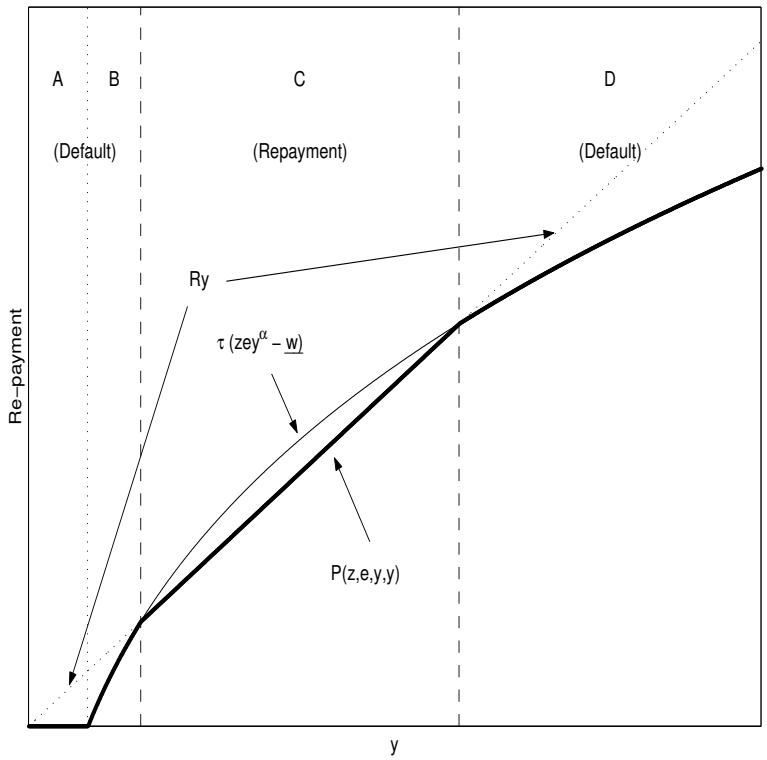
For borrowers, the decision to default simply involves comparing the cost of re-payment, Rd with the cost of default. The re-payment decision is, therefore,

$$P(z, e, y, d) = \min\{Rd, \max\{0, \tau(zey^{\alpha} - \underline{w})\}\}.$$

Among constrained agents (i.e. low a), the amount borrowed equals the amount invested ($d = y$) and

$$P(z, e, y, y) = \min\{Ry, \max\{0, \tau(zey^{\alpha} - \underline{w})\}\}.$$

Figure 3: Re-payment as a function of y given (z, e) when default occurs at extremes



For large $\hat{d}$, Figure 3 graphically represents a re-payment schedule as a function of y (assuming $d = y$) given (z, e). Notice that effective re-payment (dark solid line) is the lower envelope of the default (light solid line) and no-default (dotted line) payment schedules. Interestingly, given z, default occurs at the extremes – regions A, B, and D. Because of the limit on garnishments for earnings below $\underline{w}$, individuals with low investment and debt (regions A and B) are able to keep all, or at least most, of their earnings when they default. Thus, they are better off defaulting than re-paying their loans. Due to diminishing marginal returns to investment, the re-payment obligations of individuals with very high levels of investment/debt (region D) exceed the garnishments they face, and they, too, are also better off defaulting. Only individuals with mid-level investment and earnings (region C) find it in their best interest to re-pay their loans.

If $\underline{w}$ were reduced to zero (and if τ is sufficiently large), there would be no default among those investing very little as the re-payment curve in Figure 3 would shift leftward to the origin. At the other extreme, $\underline{w}$ may be high enough or τ low enough so that the middle region of re-payment completely disappears. In this case, everyone would choose to default regardless of his debt and investment.

By choosing a sufficiently low $\hat{d}$, the government can eliminate the upper default region altogether, but this must come at the expense of constraining investment. It is important to note that this upper region depends on observed ability, e, and unobserved shocks, z. While it is certainly feasible to

condition upper loan limits on observed ability levels, it is not possible to condition those limits on z. Unless the range of shocks is quite limited, it would seem difficult to completely eliminate default at the upper end without seriously curtailing investment.

With uncertainty about z, most individuals will default with some probability even after conditioning on their ability, debt, and human capital investment. Consider an agent with ability e who has made an investment y and owes debt d. Repayment is optimal only if $\tau(zey^{\alpha} - \underline{w}) \geq Rd$, or $z \geq z_1(e, y, d) \equiv \frac{Rd+\underline{w}}{\tau e y^{\alpha}}$. The probability of default for this person is, therefore, $Pr(z \leq z_1(e, y, d)) = F\left(\frac{Rd+\underline{w}}{\tau e y^{\alpha}}\right)$.

Conditional on true earnings and total debt, individuals either default or repay with probability one. However, if earnings are measured with error – either due to simple measurement error or due to the fact that we typically only observe earnings for a limited amount of time while default is likely to depend on a more permanent measure of earnings – then for any observed level of earnings and debt, the probability of default will be in $[0, 1]$. Suppose observed earnings, w, mis-measure true earnings, w^*, according to $w = w^* - \varepsilon$ and that $\varepsilon \sim N(0, \sigma_{\varepsilon}^2)$. In this case,

$$Pr(default) = \Phi\left[\left(\frac{\underline{w}}{\sigma_{\varepsilon}}\right) + \left(\frac{R/\tau}{\sigma_{\varepsilon}}\right) d - \left(\frac{1}{\sigma_{\varepsilon}}\right) w\right],$$

where $\Phi(\cdot)$ is the standard normal cdf. With data on earnings, w, and total debt, d, one can consistently estimate σ_{ε}, R/τ, and $\underline{w}$. To the extent that interest rates are known, τ can be separately identified.

Given the above characterization, a simple probit specification for default as a linear function of debt and observed earnings should yield a positive coefficient on debt and a negative coefficient on earnings. When this model is estimated, we obtain parameter estimates for coefficients on earnings and debt that are of the predicted signs; however, the estimated intercept is negative, which is inconsistent with a non-negative $\underline{w}$.[11] The fact that higher order polynomials in debt and earnings are preferred to this linear specification (see the discussion of Figures 1 and 2), implies a more complex punishment schedule than the simple linear garnishment used here. Still, the general theoretical prediction that default should be decreasing in earnings and increasing in debt is supported empirically. The fact that SAT/ACT quartile and race empirically affect default probabilities even after controlling for debt and earnings suggests an important shortcoming of this basic model, which we discuss further below.

Given optimal re-payment decisions, we can determine investment, borrowing, and consumption decisions during the first period. Second period assets are given by

$$A(z, e, y, d) = w(z, e, y) - P(z, e, y, d). \tag{3}$$

Individuals, therefore, choose investment and consumption to maximize (1) subject to (2), (3) and $d \leq \min\{y, \hat{d}\}$.

[11] The estimated coefficient on earnings (in thousands of dollars) is -.0057 and the coefficient on debt (in thousands of dollars) is .0081. The estimated intercept is -1.518.

Again focusing on constrained agents with low initial assets, the optimal investment decision maximizes expected utility for the next period. With low assets, young individuals want to borrow to enhance consumption and investment. But, loans are limited to the amount of investment, so poor individuals are forced to consume from their initial assets and borrow to pay for their schooling (i.e. $c = a$ and $d = y$).

The option of default generates a non-convexity. To find the optimum, we must consider interior optima as well as corner solutions for investment. Assuming z has an atomless distribution, the first order condition for an interior optimum is

$$\alpha e y^{\alpha-1} \int z v'(A(z,e,y,y)) dF(z) = \int v'(A(z,e,y,y)) \frac{\partial P(z,e,y,y)}{\partial y} dF(z). \tag{4}$$

At most, one value of y can satisfy this condition. To find the globally optimal investment, one must compare the value attained from this local optimum with the one attained by investing the maximum, $y = \hat{d}$. This comparison must be made, because individuals who invest an amount such that they will default with probability one are always better off investing and borrowing as much as possible, then defaulting. This will become more apparent below.

The interior first order condition shows how the option to default affects optimal investment choices. Returning to Figure 3, four distinct re-payment regions characterize the marginal cost of borrowing and investment conditional on (z, e). In region C, observe that the marginal cost of borrowing is given by $\frac{\partial P(z,e,y,y)}{\partial y} = R$. If the distribution of z is such that a borrower's optimal investment always places him in region C, then the option of default has no effect on investment, and in this case, investment is efficient (ignoring the possibility of income-contingent loans, which may provide some added insurance for borrowers). Still, credit constraints are binding as students would prefer to borrow more to increase their consumption when in school. While consumption will be suboptimal, the federal lending program may encourage efficient schooling among borrowers. This is generally consistent with the results of Keane and Wolpin (2001) who find that individuals are severely constrained in their borrowing but that relaxing those constraints would have little effect on chosen schooling levels.

Optimal Investment without Uncertainty

To simplify the discussion of investment decisions, begin with the case where z is known before investment decisions are made (and individuals are constrained borrowers). In this case, human capital investment entails no risk and agents maximize their private net financial return, regardless of the utility function $v(\cdot)$.

As noted above, optimal investment may be either an interior solution or at a corner, $y = \hat{d}$. The interior optimum is characterized by equality between private marginal costs and benefits. The marginal returns to investment are given by $MR(y) = \alpha z e y^{\alpha-1}$. Marginal costs are given by the derivative of $P(z, e, y, y)$ with respect to y, which is slightly more complicated as it incorporates the

optimal default decision. In general, there are several regions for marginal costs. In the case underlying Figure 3, the marginal cost of investment is zero in region A, $\tau\alpha z e y^{\alpha-1}$ in regions B and D, and R in region C. As long as $\tau < 1$ the marginal return to investment is strictly greater than the marginal cost throughout regions A, B, and D. Thus, with full certainty, we will never observe investment levels within regions A or B, and investments in region D will be at the maximum allowable amount, $\hat{d}$. Investments in region C will be socially optimal, equating the marginal return to the gross interest rate. The socially optimal investment level is given by

$$y^s = \left(\frac{\alpha z e}{R}\right)^{1/(1-\alpha)}.$$

Privately optimal investment and default can be characterized in terms of ability. To simplify matters, assume $\underline{w} = 0$ so there is no minimum amount of earnings safe from creditors. In this case, define $\underline{e}$ as the ability level that equates the net earnings for investing $\hat{d}$ and defaulting with that associated with investing y^s and re-payment. Individuals with ability less than $\underline{e}$ will borrow $\hat{d}$ and default. Now, define $\bar{e}$ as the ability level for which $y^s = \hat{d}$ (i.e. the person who would optimally invest $\hat{d}$ when they intend to re-pay their loans). A person with ability above $\bar{e}$ is constrained from borrowing as much as he would like. Finally, let $\hat{e}$ represent the ability level for which someone is indifferent between re-paying and defaulting on a loan of size $\hat{d}$. Those with ability above $\hat{e}$ will re-pay a loan of size $\hat{d}$.[12]

If $\tau \leq \alpha$, then $\bar{e} \leq \underline{e} \leq \hat{e}$ and all individuals will invest and borrow the maximum $y^*(e) = \hat{d}$; those with ability below $\hat{e}$ default while those above this cutoff re-pay their loans. Borrowers with ability less than $\bar{e}$ over-invest, while those with ability above that threshold under-invest relative to the socially efficient amount. Interestingly, since $\bar{e} \leq \hat{e}$, middle ability individuals who choose to default – those with $e \in (\bar{e}, \hat{e})$ – actually under-invest relative to the socially efficient amount.[13]

The more interesting case arises when $\tau > \alpha$. In this case, $\underline{e} < \hat{e} < \bar{e}$ and

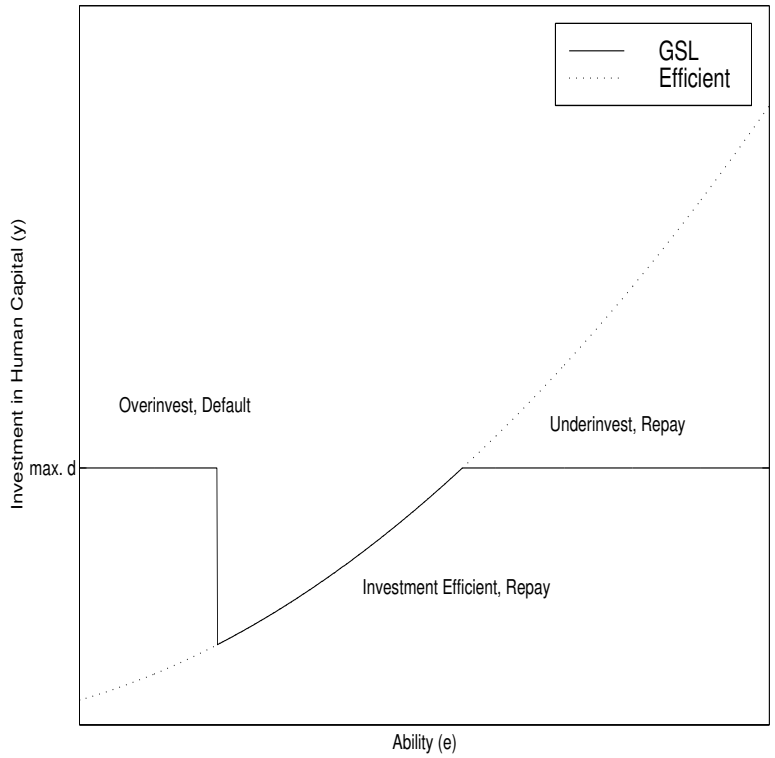
$$y^*(e) = \begin{cases} \hat{d} & \text{if } e \leq \underline{e} \quad \text{(Default)} \\ y^s & \text{if } e \in (\underline{e}, \bar{e}) \quad \text{(Re-pay)} \\ \hat{d} & \text{if } e \geq \bar{e} \quad \text{(Re-pay).} \end{cases}$$

Figure 4 graphically represents this case. Investment is clearly a discontinuous non-monotonic function of ability with three distinct regions. Only the very low ability students default after borrowing the maximum. Middle ability students borrow the efficient amount and re-pay their loans. High ability students are limited to borrowing $\hat{d}$, and they re-pay their loans. Again, we observe over-investment among the least able and under-investment among the most able. Despite being constrained from

[12] These ability thresholds are mathematically given by $\underline{e} = \left(\frac{R}{\alpha z}\right)\left(\frac{1-\tau}{1-\alpha}\right)^{(1-\alpha)/\alpha}\hat{d}^{1-\alpha}$, $\bar{e} = \left(\frac{R}{\alpha z}\right)\hat{d}^{1-\alpha}$, and $\hat{e} = \left(\frac{R}{\tau z}\right)\hat{d}^{1-\alpha}$.

[13] When $\tau = \alpha$, then $\underline{e} = \bar{e} = \hat{e}$ and all individuals will invest and borrow $y^*(e) = \hat{d}$; those with ability below the unique cutoff over-invest and default while those above the cutoff under-invest and re-pay.

Figure 4: Optimal Investment and Default Decisions by Ability



borrowing as much as they would like, middle ability students invest optimally and independent of their assets. Constraints manifest themselves in a student's inability to borrow enough to consume as much as they want given their future earnings prospects.

The introduction of $\underline{w} > 0$ will increase both $\underline{e}$ and $\hat{e}$, increasing default rates. When $\tau > \alpha$, the fraction of people over-investing increases. However, when $\tau \leq \alpha$, investment levels are unaffected and so there is no change in the efficiency of investment decisions. Once $\underline{w}$ becomes sufficiently large, all individuals borrow the maximum and default.

Optimal Investment with Uncertainty

Now, consider the investment decision when there is uncertainty about the returns to human capital investment. This problem does not have an analytical solution, but it can be solved numerically. Again, the value of the interior optimum must be compared with the value of a corner solution, $y = \hat{d}$.

For any $\hat{d}$, agents with very low ability, e, may know they will default with almost certainty for any level of investment. This can cause them to make substantial investments, borrowing the maximum, since it is no more costly to default on the maximum than it is to default on a lesser amount. On the other hand, for high ability agents, the maximum loan amount may be less than they wish to invest. In this case, optimal investment may also equal $\hat{d}$ but for very different reasons. These agents will

repay with very high probability. The model predicts that agents with extremely low and extremely high ability will both invest the maximum amount, but those with high ability will almost certainly repay while those with low ability will almost certainly default.

Does the probability of default then decline monotonically with ability? Not necessarily. Monotonicity of the probability of default is determined by monotonicity of the cutoff z_1 evaluated at the optimum,

$$z_1^*(e) \equiv \frac{Ry^*(e) - \underline{w}}{\tau e(y^*(e))^\alpha}.$$

This threshold may be non-monotonic in e, since $y^*(e)$ is typically increasing in e. For any given investment/debt level, more able agents are more likely to repay, since the punishment of default is increasing in earnings conditional on investment. However, more able agents generally choose to borrow and invest more, making repayment more costly. As a result, the net effect of ability on default is ambiguous.

At this point, it is clear that the current model is limited in its ability to generate a U-shaped pattern for default in ability as seen in the data. If optimal levels of debt/investment are sensitive enough to ability, the model could, in principle, generate the desired default pattern. However, the high levels of default would be accompanied by much higher levels of debt and investment among the most able, which is not the case empirically (see Table 4). More simply, the model suggests that ability should not affect default after conditioning on earnings and debt; however, the probit estimates discussed earlier contradict this result.

Reconciling Theory and Data (note: this section is incomplete)

It is not easy to extend the model in ways that are likely to generate a U-shape pattern for default in ability. Simply adding stigma, honesty, or fixed costs associated with default (that are uncorrelated with ability, debt, and earnings) will not change the main patterns predicted by our base model above. Nor will adding out-of-pocket schooling expenses (e.g. foregone earnings) that are uncovered by student loans. Relaxing the assumption that punishments are imposed with certainty so that they are instead imposed with some probability (that is independent of ability, debt, or earnings) will affect the overall level of default but not the basic patterns. What can be done to reconcile our theory with the data?

We offer two possibilities. First, the U-shape pattern of default in ability can be generated from a model in which individuals may pay a fixed cost to avoid punishment. There are a number of reasons to think that this may be an important possibility. Borrowers may have the option to hire lawyers to get them out of their loan obligations or to mitigate the effects of potential punishments. They can start their own businesses, in which case lenders cannot garnish their wages. Or, they may move abroad or re-locate frequently to prevent creditors from finding them. Regardless of the underlying

reason, the possibility of paying a fixed cost to avoid punishment for default implies that individuals with high enough earnings may choose to pay that cost and default. To the extent that more able individuals are more likely to reach the high earnings region in which default becomes optimal, they will be more likely to default than individuals of intermediate ability. Of course, low ability individuals default at a high rate for the reasons discussed earlier. Unconditional default rates should, therefore, be U-shaped in ability. Combining a fixed cost for avoiding punishment with stigma for default may also generate a U-shape ability-default pattern conditional on post-school earnings and the amount borrowed.

The second possibility for reconciling our theory with the data recognizes that our sample used to compute default rates is based on individuals who selected not to attend graduate school. If a large fraction of middle ability individuals choosing to attend graduate school are (for whatever reason) 'dishonest' but the same is not true of high ability individuals, then default rates may be higher among the more able when the sample is limited to those not attending graduate school. Generally speaking, dishonest individuals (or those with a lower negative stigma value for default) will choose to invest more in their human capital, since they do not intend to re-pay their loans. This should be true of all ability types. But, for any given investment threshold (e.g. attend graduate school), it is more likely that an honest high ability individual will invest beyond the threshold than will an honest individual of lesser ability. Thus, it may be the case that many of the intermediate ability individuals attending graduate school are dishonest and likely to default while high ability individuals attending graduate school tend to be more honest, on average. This can create the impression that default rates increase from middle to high ability students, since we only examine those choosing not to pursue a graduate degree. Most low ability individuals are unlikely to attend graduate school. Thus, our low ability sample of college graduates without additional schooling is quite representative and should have higher default rates than a sample of intermediate individuals that does not include dishonest borrowers. Taken as a whole, the sample limitations we use in our empirical analysis may generate a U-shape pattern in observed default that is not inconsistent with our theory above.

5 An Efficient Lending System

To be done.

6 Conclusions

This paper is clearly a work in progress. Thus far, we have uncovered some interesting patterns in student loan default among college graduates. Our base model of default and human capital investment is able to explain some of those patterns (the decline in default associated with earnings and increase

associated with debt), but fails to explain others (namely, the effects of race and ability conditional on earnings and debt). We have offered a possible extension to the theory that can explain the ability-default patterns and have discussed reasons why the empirical U-shaped pattern for default as a function of ability may be at least partially caused by our sample selection rule.

The model we have developed offers a number of important insights. It suggests that constrained borrowers may optimally invest in their human capital. In other words, family wealth does not necessarily affect education decisions among constrained borrowers. Instead, students from poor backgrounds may simply consume less while in school than their counterparts from wealthier families. This contradicts conventional wisdom and raises concerns about recent empirical tests for credit constraints in the education literature. We also show that the structure of the current lending system can lead to both over-investment and under-investment in human capital. The option to default on loan obligations encourages the least able and those choosing careers with low economic returns to treat loans as subsidies and over-invest relative to the social optimum. On the other hand, high ability individuals may be constrained by the fixed cap on student loans. As a result, they may under-invest in their human capital.

It is important to remember, however, that default is not necessarily a bad option, since it offers a form of insurance against bad economic outcomes. In this sense, the current loan system offers a limited form of income contingent lending. This line of thinking leads to the natural question: what is the optimal rate of default in an economy. More generally, how should borrowing limits be set and how should punishments be enforced by the government? And, what is the optimal mix of loans and subsidies for schooling, and how do the two financial instruments interact? Once we begin to think seriously about the lending environment and the nature of borrowing constraints, many interesting questions arise. This paper only begins to help answer some of those questions.

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Table A-1: Sample Background Characteristics for Undergraduate Borrowers

Variable	N	Mean	Standard Error
Male	2,796	0.474	0.009
White	2,783	0.825	0.007
Black	2,783	0.079	0.005
Hispanic	2,783	0.061	0.005
Asian	2,783	0.029	0.003
SAT/ACT Quartile 1	2,464	0.277	0.009
SAT/ACT Quartile 2	2,464	0.290	0.009
SAT/ACT Quartile 3	2,464	0.241	0.009
SAT/ACT Quartile 4	2,464	0.193	0.008
Major: business/management	2,795	0.248	0.008
Major: education	2,795	0.125	0.006
Major: engineering	2,795	0.074	0.005
Major: health professions	2,795	0.076	0.005
Major: public affairs/social services	2,795	0.031	0.003
Major: biological sciences	2,795	0.037	0.004
Major: math & science	2,795	0.062	0.005
Major: social science	2,795	0.078	0.005
Major: history	2,795	0.015	0.002
Major: humanities	2,795	0.076	0.005
Major: psychology	2,795	0.028	0.003
Major: other	2,795	0.151	0.007

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, received their BA prior to age 30, and borrowed money for their education.

Table A-2: Tobit Estimates for 1997 Earnings

Variable	Estimate	Standard Error
Intercept	24,214	1,032
Male	8,376	695
SAT/ACT Quartile 2	938	903
SAT/ACT Quartile 3	3,348	945
SAT/ACT Quartile 4	3,544	1,005
Black	-1,553	1,475
Hispanic	-3,993	1,606
Asian	5,065	1,893
Business/management	4,637	1,177
Education	-15,442	1,200
Engineering	10,036	1,483
Health professions	7,909	1,412
Public affairs/social services	1,149	1,862
Biological sciences	-5,118	1,800
Math & science	5,765	1,556
Social science	2,899	1,272
History	-6,025	2,460
Humanities	-3,311	1,300
Psychology	-1,259	2,006
Months of Graduate School	-2	232

Notes:
Sample includes all U.S. citizens who did not report a disability, had no more than 9 months of graduate education, were not currently enrolled in school, and received their BA prior to age 30. There are 4,019 observations and the log likelihood value is -42,364.