Credit Constraints in the Demand for Education: Evidence from Survey Data

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Abstract

What can subjective reports of financial difficulties add to our understanding about the role of liquidity constraints in the demand for college education? Liquidity constraints in education may lead to inefficient skill allocations and perpetuate imbalances in the distribution of economic well-being. Unfortunately, empirical evidence regarding their pervasiveness in the U.S. has not been consistent in part because constraints tend to be inferred indirectly. To evaluate how a potentially more direct measure can be used to enhance our understanding of the issue, I focus on self-reports of financial difficulties available in the National Longitudinal Survey of Youth. I find that about 12 percent of college-age individuals expect to underinvest in education because of financial limitations, which is an upper-bound estimate of the fraction of liquidity-constrained students. While this paper shows that subjective indicators of credit constraints are potentially noisy, they appear to reveal important aspects of heterogeneity in the demand for education not captured by the standard measures such as, e.g. parental income.

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1 Introduction

How important are liquidity constraints in the demand for college education in the United States? What can subjective self-reports of financial limitations add to our understanding of this phenomenon?

Credit constraints in education are potentially harmful to both efficiency and equity. They lead to an inefficient allocation of resources and may work to perpetuate and widen income inequality across generations. Substantial disparities in educational attainment by family socioeconomic status have been noted in the literature.[1] Given the sharp increase in education wage premiums over the past thirty years, these disparities have worked to widen income gaps and increase inequality.[2] While theory suggests that government intervention can help eliminate the negative impacts of credit constraints, the existing educational subsidies often benefit mostly high- and middle-income groups.[3] In light of these tendencies, the question of how widespread credit constraints are has critical relevance for educational policy. In economic theory the issue of credit constraints is important because it violates one of the key economic assumptions of the life-cycle permanent income hypothesis, namely, the assumption of perfect capital markets.

Nevertheless, despite their potential importance, it is still not clear just how pervasive credit constraints are and precisely what impact they have on post-secondary education in the United States. While a wide number of microeconomic studies have addressed the issue, researchers have had to rely on theoretical insights and information on educational outcomes to infer constraints in the absence of direct measures.[4] Some studies, for example, Manski (1992) and Ellwood and Kane (2000), interpret disparities in educational attainment by family income as evidence of credit constraints. Others (e.g., Kane, 1994) infer credit constraints from the greater sensitivity of low-income students to tuition costs. Still others appeal to an observation that marginal rates of return to education appear higher than average rates (see Card, 2001). In contrast, Carneiro and Heckman (2002) argue that it is long-run family and environmental influences rather than short-

[1] See, for example, Manski (1992), Ellwood and Kane (2000), Cameron and Heckman (1998), and Carneiro and Heckman (2002).

[2] Goldin and Katz (2007).

[3] Fender and Wang (2003) provide a detailed theoretical discussion on educational policies to remedy the inefficiencies resulting from credit constraints. For a comprehensive overview of the distributional effects of financial aid programs, see Dynarski (2002).

[4] Most prominent studies include Manski (1992), Ellwood and Kane (2000), Card (2001), Carneiro and Heckman (2002), Cameron and Taber (2004), Stinebrickner and Stinebrickner (2008), and Cao (2008).

term credit constraints that largely determine educational outcomes.[5] To date, our understanding of credit constraints in college education remains limited, due in part to shortcomings of the data and differences in empirical methodologies. The first paper to evaluate the usefulness of survey responses as a more direct measure of credit constraints is a recent paper by Stinebrickner and Stinebrickner (2008). Using a unique new data from a small private college with subsidized tuition, they show that most of college attrition is unrelated to difficulties in borrowing, and, hence conclude that credit constraints do not play a significant role in determining educational attainment.

This paper contributes to the literature by focusing on self-reported difficulties financing education and assessing its validity as a more direct measure of credit constraints in a widely used, nationally representative data set, the National Longitudinal Survey of Youth 1979 (NLSY79). I broadly classify as constrained those respondents who report that they expect to receive less education than desired for financial reasons or need to work. As an indicator of credit constraints this measure is quite noisy and not precise. Similar to all subjective measures, it is likely to be influenced by a number of biases. At the same time it can help directly identify individuals whose educational choices are potentially affected by difficulties in paying for college. With these considerations in mind, I use regression analysis to determine whether the probabilities of reporting financial difficulties vary in a predictable and systematic way with individual characteristics, family resources, and educational costs. Finally, to evaluate the internal consistency and predictive power of the financial difficulties measure, I examine its relationship with the respondents' eventual educational outcomes.

About 12 percent of young adults in the sample report financial difficulties in attaining their desired level of education. This estimate can be viewed as an upper-bound estimate of the fraction of credit-constrained youths in the United States. Regression analysis shows that youths from lower-income families and those who live in areas with no universities in the vicinity are more likely to report such difficulties, as are men who come from large families and Hispanic women. Youths with financial difficulties are more likely to delay college entry and choose lower-quality colleges, and they are less likely to receive a four-year degree. Sizable differences in educational outcomes of those with self-reported difficulties persist across a wide range of schooling outcomes, even after control-

[5]By conditioning the family background, Belley and Lochner (2007) have found a dramatic increase in the effect of family income on college attendance between the early 1980s and the early 2000s, consistent with the growing importance of credit constraints.

ling for ability, parental income, and family background characteristics. While the exact relationship between self-reported financial difficulties and educational decisions is not clear, the measure developed in this paper appears to capture an important new aspect of individual heterogeneity in the demand for college education, beyond that addressed by the earlier research.

The present study addresses the growing need for more direct evidence on the role of demand-side constraints in post-secondary education. My findings are broadly consistent with a body of literature indicating that liquidity constraints have a potentially strong adverse effect on the education of a small fraction of college-age individuals in the Unites States.[6] Use of carefully designed survey questions can help identify these individuals and guide policymakers looking to craft effective recommendations to reduce persistent gaps in educational outcomes.

2 Evidence of Credit Constraints in the Literature

What evidence does the literature offer regarding the impact of liquidity constraints on the demand for college education in the United States?[7] This section summarizes the literature's most prominent findings and describes my contribution: the use of self-reported difficulties in financing education to identify potentially liquidity-constrained students. By focusing on self-reports in NLSY79, this study looks to evaluate how such information can enhance more traditional indirect evaluation strategies. Careful consideration of self-reports may help bridge the gap created by the lack of direct evidence on the role of constraints in college education.

While college education is costly, financing it is not considered the sole responsibility of students and their families (Lee, 1999; Heckman, 2000). A wide range of government and private subsidies aim to alleviate the financial burden associated with college education to encourage enrollment. To the extent that these subsidies do not fully cover education costs, students themselves are responsible to finance tuition and consumption while in school.[8] In the absence of labor

[6]Using outcome information, for example, Carneiro and Heckman (2002) have estimated the proportion of credit-constrained in the United States to be below 8 percent.

[7]Throughout the paper I use the words *liquidity constraints* synonymously with credit constraints, as does much of the related literature.

[8]Belley, Frenette, and Lochner (2008) provide a detailed discussion of out-of-pocket costs of college education in the U.S.

market earnings, they have to rely on private sector loans. As a result, children from low-income families may be less able to pay for college than children from high-income families.

A number of economic studies have documented sizable gaps in educational attainment by family income. Manski (1992) reports that only 11 percent of high school graduates from the low end of the family income distribution receive a college education within the subsequent five years. This proportion is 39 percent for students from the top of the income distribution. Similarly, Ellwood and Kane (2000) show that only 57 percent of children from the lowest-income quartile attend a post-secondary educational institution after graduating from high school, compared with 81 percent of children from the highest-income quartile. These disparities have been widely believed to provide support for the hypothesis of binding credit constraints.

An alternative explanation for these disparities comes from a strong relationship between family income and other factors, such as scholastic ability and educational preferences, that affect the decision to go to college. Well-off families have more resources to invest in their young children's development in order to boost cognitive and noncognitive skills. Children from families with higher socioeconomic status often receive better primary and secondary education, which, among other things, shapes their tastes for schooling and career expectations. As a result they are more ready for college, on average, than students from lower-income families and are more likely to receive a college education. These long-run family factors are highly correlated with parental income and may be more important in explaining the relationship between income and education than short-term borrowing constraints. In support of this alternative explanation, Carneiro and Heckman (2002) show that gaps in educational attainment across income groups almost disappear when controls for family background and scholastic abilities are introduced. Using the same empirical methodology, however, Belley and Lochner (2007) have documented a dramatic increase in the effects of family income on educational attainment between the cohorts of high school students in the early 1980s and the early 2000s. These findings are likely to renew the debate about the relationship between family income and college education.

Although current income is a convenient benchmark for assessing needs, some studies suggest that income in a given year is an imperfect measure of financial resources and the ability to pay for college (see Kane, 2004). Alternative indirect measures that perform better include wealth and short-term income fluctuations. Jappelli (1990), for example, shows that family wealth is a strong predictor of borrowing difficulties, even after controlling for family income. Mayer (1997)

finds that children whose families experience a large earnings decline within a two-year period complete fewer years of college education. Similarly, studies that examine the link between changes over time in family income distribution and educational attainment of children show that the effects of income on college attendance are greater than the effects in cross-section studies (e.g., Mayer, 1997; Acemoglu and Pischke, 2001). These findings point toward a stronger impact of credit constraints on education than is implied by studies using current income levels.

Other evidence in the empirical microeconomic literature that is potentially consistent with credit constraints includes the higher sensitivity of low-income students to tuition costs (Kane, 1994) and longer delays in college enrollment for students in high-tuition states (Kane, 1996).

In the absence of clear consensus about the pervasiveness of credit constraints, a need for more direct evidence has emerged. The first study to address this need is a recent work by Stinebrickner and Stinebrickner (2008). The authors use carefully designed survey questions to elicit information about college students' borrowing difficulties and evaluate the fraction of the drop-out rate that can be attributable to inability to borrow. While the results rely on data from a single educational institution that is very different from most other colleges in the United States, Stinebrickner and Stinebrickner (2008) provide important insights into the connection between borrowing constraints and the drop-out decisions of low-income youth.[9]

The main contribution of my paper is the use of a new subjective indicator of constraints in a standard data source. In the National Longitudinal Survey of Youth, 1979 (NLSY79), I identify potentially liquidity-constrained students using their self-reports about financial difficulties in attaining the desired level of education. The focus on self-reports is intuitively appealing as it allows to make use of the information known to a respondent, but not to the analyst. A large body of economics literature advocates this approach, suggesting that survey questions allow to directly elicit pertinent information when alternatives involve making nontrivial assumptions.[10] At the same time, a number of theoretical and practical problems arise in attempting to make causal inference relying exclusively

[9]Stinebrickner and Stinebrickner (2008) conduct their survey at Berea College, which is a small, private four-year college in Kentucky with a mission of providing an education to students from low-income backgrounds. Unlike most colleges in the United States, Berea College provides full tuition and a room/board subsidy to all incoming students.

[10]Dominitz and Manski (1996) and Dominitz (1998) are pioneering studies that discuss the use of self-reported information.

on subjective reports. I discuss these problems in details later in this paper.

Relying on a data set that has been used by a number of earlier studies to evaluate the importance of credit constraints in education allows me to view my results in a broader context. It enables me to assess what information my subjective measure adds to traditional methods of accessing financial need based on family socioeconomic status. On a broader scale, this study is aimed at evaluating how useful subjective measures can be in helping the economists better understand the role of credit constraints in the demand for education.

3 Data and Operational Definitions

To evaluate the alternative, and potentially more direct evidence about the importance of liquidity constraints in education, I use a well-studied NLSY79 data set. In this section, I describe the advantages of these data and the variables I employ to empirically identify potentially constrained individuals. I present an operational definition of constraints and discuss the assumptions and implications behind it. According to my definition, over 12 percent of respondents in the sample can be classified as financially constrained. This is an upper-bound estimate of the proportion of liquidity-constrained respondents in the NLSY79.

The NLSY79 data have been widely employed to evaluate the role of credit constraints in education (see, e.g., Carneiro and Heckman, 2002; Cameron and Taber, 2004; Belley and Lochner, 2007). It is a rich longitudinal data set that contains family background information and scholastic aptitude measures that are essential for the analysis of educational choices (Carneiro and Heckman, 2002). The NLSY79 follows the respondents for over twenty-five years, making it possible to evaluate schooling outcomes of the respondents without imposing an arbitrary cut-off age. Most importantly for this study, it elicits educational aspirations and expectations of the respondents. This information makes it possible to derive a measure of liquidity constraints that is potentially more direct than those employed in the earlier research.

The focus of this paper is young adults around the time when they make post-secondary schooling decisions. The group of interest comprises the youngest respondents in the NLSY79: those who are between ages of 13 and 17, inclusively in January 1978. In 1982, when educational aspirations and expectations were recorded, they were 17 to 21 years old. Eliminating individuals who are over 17 years old at the initial interview date ensures that retrospectively collected family background information is accurate. In addition, I exclude respondents

with missing parental income or other background and personal data.[11] The final sample size is 5,161 individuals.

As an operational definition, I broadly denote as financially-constrained those respondents who expect to receive less education than the desired level for financial reasons or the need to work. I create an indicator of constraints based on the answers they provide to three questions, asked during the 1982 wave of the survey, regarding a desired education, an expected education, and the reasons for discrepancies between the two, if such exist. The desired education is elicited by asking: *"What is the highest grade or year of regular school that you would like to complete"*? The expected education is an answer to the question: *"As things now stand, what is the highest grade or year [of schooling] you think you will actually complete"*? Those who expect to complete fewer years of schooling than desired are asked: *"What is the main reason that you expect to complete less regular schooling than you would like to complete"*? The format of the questions is multiple choice with a wide set of options, including family responsibilities, academic abilities, and financial reasons.[12] Those youths who expect to receive less than the desired amount of schooling for financial reasons or because of the need to work are denoted as constrained.

In the sample 1,175 respondents (23 percent) report that their expected education is lower than the desired level (see Table A-1 in the Appendix). Of these, 667 respondents, or about 13 percent, report financial difficulties (487 respondents, or 9.4 percent) or need to work (180 respondents or 3.5 percent) as a reason and, hence, are classified as liquidity constrained according to the definition above. The NLSY79 is a nationally representative data set that oversamples blacks, Hispanics, and economically disadvantaged youths.[13] To evaluate the proportion of the credit-constrained nationwide, one needs to correct for the oversampling by using sampling weights. When reweighted to be nationally representative, the proportion of credit-constrained respondents in the sample is only slightly smaller, about 12 percent.

The operational definition presented above is very general and not a precise definition of liquidity constraints. Ideally, one would like to see what frac-

[11]Excluding the respondents with missing information is routinely done in studies that use the NLSY79 and is unlikely to be an important source of bias. See, for example, Cameron and Taber (2004).

[12]The exact formulation and distribution of answers is presented in the Appendix. The question is somewhat restrictive as only one answer is permitted.

[13]The survey also includes 1,280 individuals who served in the military in 1978. This subsample is excluded from the study because of the age restriction I impose.

tion of potential college students forgoes education because of inability to finance tuition or consumption due to inability to borrow. This would imply that the expected returns are sufficiently positive to offset the present cost. Unfortunately such measure is not available in the NSLY79. In its absence, I use the definition above as a proxy to identify individuals potentially constrained in educational choices. This definition combines information about educational aspirations and expectations with information about financial difficulties. Hence it is important to provide some explanations about the assumptions that I make in interpreting the questions and consider potential problems of this specific definition.

While it is not clear how exactly might individuals interpret the survey questions above, following the earlier studies (e.g., Leigh and Gill, 2004), I assume that the desired level of education (educational aspirations) is the level of education that an individual would ideally like to obtain. It is reasonable to assume that in stating their desired level of education, respondents take into account expected costs and benefits of schooling. At the same time, it is not clear whether or not they are realistic in accessing the impact of all the constraints that operate on educational decisions. Hence educational aspirations are likely to be an upper-bound estimate of an optimal level of education.[14]

In this framework, expected level of education may be interpreted as an education the respondent is most likely to obtain given the current and/or expected constraints. I assume that an answer to the question about the reasons why educational expectations are lower than aspirations refers to the most important of these constraints. Under a broad definition of credit constraints in education, which encompasses the inability to obtain funds to pay college-related expenses or finance consumption while at school, the most natural way of identifying potentially constrained individuals is by focusing on people who report financial difficulties or need to work as an answer to that question.

Given these interpretations of the survey questions, a number of considerations arise. First, liquidity constraints have a potential to reduce both educational aspirations and expectations. For example, this might be the case if low-income students do not have enough information about financial aid packages and/or subsidized loans that are available to help pay for college.[15] As a result they may not consider college education as a feasible option and scale down their educational aspirations. In this case the estimated proportion of credit constrained in

[14] An *optimal level of education* refers to the schooling level that has the greatest probability of maximizing the individual's present value of lifetime income, given the constraints.

[15] Low take-up rate of Pell grant programs provides indirect support for this conjecture.

the NLSY79 would be biased downwards, underestimating the true fraction of liquidity-constrained.

Second, the respondents may overstate their financial difficulties in an attempt to justify low educational aspirations that are due to other factors, for example, lack of ability or interest in education. This phenomenon is know to economists as *justification bias*. It usually implies that additional incentives exist that make respondents more likely to report a specific condition (e.g., disability in health economics literature). However, given a wide range of socially-acceptable answers to the reasons question, it is not clear why a respondent trying to justify their low education aspirations would choose financial difficulties or a need to work over other possible answers.

Third, while the question about the reasons for having lower educational expectations relative to aspirations covers a wide range of possible explanations, it is not clear how well it can help us identify the individuals who would want to borrow to finance college education if such an opportunity presented itself. More specifically, it is not straightforward how the respondents may interpret the "financial difficulties" answer. It could imply, for example, that a person views the costs of college attendance to be too high relative to expected benefits. In this case, the person is not necessarily credit constrained in education by the standard definition. Even if he or she faces prohibitively high interest rates or lacks access to credit markets, removing these constraints may not affect their educational decisions. This consideration implies that my measure may overestimate the fraction of potential college students affected by credit constraints.

Some intuition about the importance of these factors can be obtained by comparing the average characteristics of constrained and unconstrained youths in the sample. Column (1) of Table 1 shows the characteristics of the full sample. Columns (2) and (3) present the characteristics of constrained and unconstrained youths, with t-statistics for the mean comparison between the two groups reported in column (4).

Overall, it appears that constrained youths differ from unconstrained youths in a way that might be consistent with the presence of liquidity constraints. For example, constrained youths come from larger families and are more likely to be of Hispanic origin than the unconstrained, which is generally associated with higher borrowing costs (Cameron and Taber, 2004). Parental income of the constrained is 15 percent lower than that of the unconstrained: $16,600 a year versus $19,500 a year, in 1979 dollars. While the average public tuition is only about $1,100 dollars a year, it excludes the cost of room and board, which constitutes a substantial portion of educational cost. Given that the average number of children

Table 1: Summary Statistics of the Primary Variables

	All (1)		Constrained (2)		Unconstrained (3)		T-stats[b] (4)
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.	
Female	0.498		0.487		0.499		0.582
Black	0.262		0.246		0.265		1.036
Hispanic	0.168		0.205		0.162		2.786***
Age	19.04	1.36	19.26	1.29	19.00	1.37	4.563***
Number of siblings	3.784	2.598	4.010	2.702	3.751	2.581	2.412**
Avg. public tuition	1,092	377	1,063	378	1,097	366	2.166**
Local earnings	2.460	0.502	2.452	0.495	2.461	0.503	0.428
Local college	0.851		0.868		0.848		1.326
Urban residence	0.758		0.736		0.761		1.386
Ability Test Scores							
Math	11.798	6.123	11.246	5.696	11.880	6.180	2.498**
Word	22.264	8.275	21.759	8.290	22.340	8.271	1.692*
Science	13.684	5.112	13.264	4.876	13.746	5.144	2.273**
Automotive	11.745	5.182	11.582	4.988	11.769	5.210	0.871
Combined AFQT scores	37.424	1.149	34.728	1.015	37.824	0.416	2.694***
Characteristics at Age 17							
Parental income	19,080	15,340	16,580	13,490	19,450	15,570	4.527***
Mother's education	11.981	1.873	11.788	1.782	12.000	1.884	2.422***
Father's education	12.574	2.415	12.347	2.160	12.605	2.447	2.059**
N	5161		667		4494		
Proportion	100		12.9		87.1		

Notes: a) Expressed in 1979 dollars. b) Testing the hypothesis of equality of means between the constrained and the unconstrained.

in the sample is close to five, college-related expenses may indeed prove to be too high of a financial burden for some low-income families.

At the same time, some differences point towards the potential justification bias and the possibility that the youths who report financial difficulties (constrained youths) may have lower benefits of education. More specifically, the constrained youths in the sample are more likely to come from lower-educated families and have lower average test scores than the unconstrained youths. This points towards lower college-readiness and lower demand for education among the youths who report constraints.

To provide some further evidence about the potentially lower returns to

schooling among individuals who report credit constraints, Figure 1 explores the relationship between self-reported constraints, socioeconomic background, and ability in more detail. It shows the proportion of constrained youths by parental income, and quartile on the Armed Forces Qualification Test (AFQT), which is a measure of scholastic ability.[16] Youths from wealthier families are less likely to report credit constraints than youths from poorer families across all ability quartiles. Moreover, there is strict ordering by parental income in the highest-ability quartile, where individuals usually have the highest demand for college education (Ellwood and Kane, 2000; Carneiro and Heckman, 2002).

At the same time, there is no clear ordering in the proportion of credit-constrained across the ability quartiles, which suggests that low-ability youths are not more likely to report credit constraints than high-ability youths when parental income is taken into account. If the same analysis is performed by educational aspirations groups (see Figures A-2 and A-3 in the Appendix), one can easily note that high-ability youths are more likely to report credit constraints than low-ability youths, especially at the high levels of educational aspirations (college or higher). These results are consistent with the idea that high-ability individuals have a higher demand for education, and hence, are more likely to be affected by credit constraints. Figures A-2 and A-3 imply that justification and low-returns biases may not be as important as it appears initially from looking at Table 1.

To evaluate the importance of justification bias in reporting financial difficulties, I examine educational attainment of the respondents twelve years after they reported educational expectations. If youths from lower socioeconomic backgrounds who have lower test scores are more likely to overpredict their final education levels, this would provide some evidence in favor of the justification hypothesis. Figure A-4 in the Appendix presents the fraction of individuals who report lower levels of education in 1994 than they expected in 1982, by family income and ability terciles. Consistent with evidence in the earlier literature, (e.g. Reynolds and Pemberton, 2001; Rouse, 2004), sample respondents are overly optimistic in their educational expectations. About 40 percent of youths in my sample do not achieve their expected levels of schooling. At the same time, youths from low-income families are equally likely to overpredict their final educational attainment across all ability groups. Moreover, high-ability "poor" youths are more likely to overpredict their educational attainment than high-ability "reach" youths, which is potentially consistent with the effects of credit constraints. Over-

[16]The composition of the AFQT scores and their link with the Armed Services Vocational Aptitude Battery (ASVAB) scores is described in a later section.

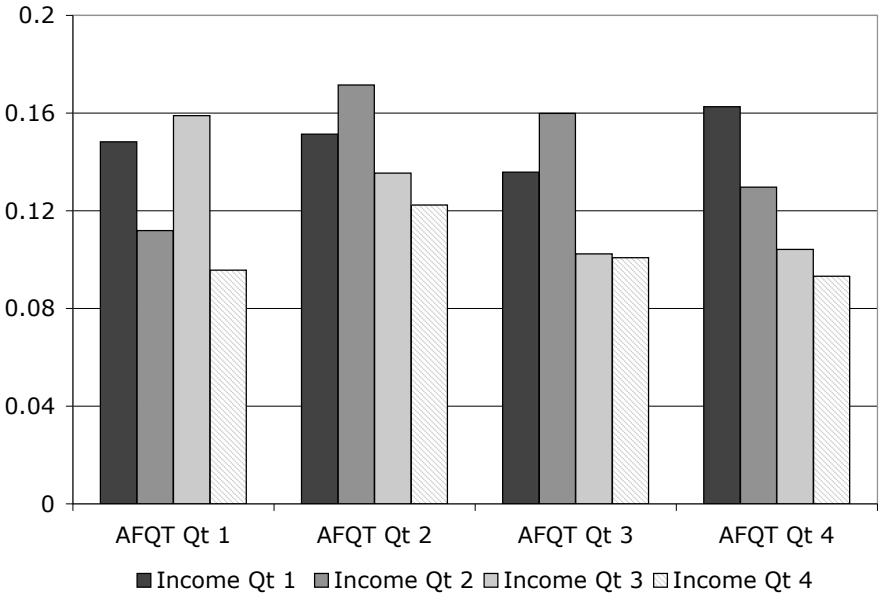

Figure 1: Distribution of Credit Constraints over Parental Income and AFQT Quartile, NLSY79

all, Figure A-4 provides no evidence in favor of high importance of the justification bias in reporting credit constraints.

The results of this section indicate that the justification bias and the low-returns to education bias do not strongly influence individual responses. At the same time, it is important to note that my measure does not exactly reflect what would happen to educational choices if financial difficulties were elevated. Hence, it is reasonable to interpret the proportion of youths who report financial difficulties as an upper-bound estimate of the true fraction of individuals whose educational decisions are affected by credit constraints. I will illustrate this point more formally in the next section. This implies that my estimates are broadly consistent with the results in Carneiro and Heckman (2002), who conclude that only up to 8 percent of the U.S. population is credit constrained in education.

4 Theoretical Framework

This section presents a conceptual definition of credit constraints using a simple two-period model of schooling choices. The purpose of this model is twofold. First, it sets up a framework for empirical analysis of the characteristics of the constrained individuals by elucidating the pertinent variables. Second, it serves as a warning concerning the extent to which we can interpret the results of this analysis. The limitations arise because binding credit constraints and the demand for education are codetermined.

In the simple model, assume that individuals are looking to maximize consumption over two periods. The value of consumption discounted back to the initial period is given as:

$$c_0 + \beta c_1 \leqslant Y_S, \tag{1}$$

where c_0 and c_1 are consumption in periods zero and one respectively, β is the time-preference rate, and Y_S is the net preset value of income with schooling S.

In the first period, an individual earns unskilled wages w_0 and can choose to attend college, for which she has to pay the direct cost q.[17] Assume that there are only two schooling choices: high school and college. Define an indicator variable $S = 1$ if college is chosen and $S = 0$ otherwise. Having a college education pays w_1 in the second period. Hence the income stream from high school education discounted to period zero at an interest rate r can be expressed as:

$$Y_0 = w_0 + \frac{1}{1+r} w_0, \tag{2}$$

and the income stream from college education as:

$$Y_1 = w_0 - q + \frac{1}{1+r} w_1. \tag{3}$$

The individual chooses a schooling option that yields a higher level of consumption.[18]

Assume that interest rates the individuals face are heterogeneous. Heterogeneity in interest rates is a common way to model credit constraints – see, for example, Willis and Rosen (1979), Card (1995a), and Cameron and Taber (2004).

[17] This model is very general and assumes that individuals can work during college and earn unschooled wages w_0. The results below do not depend on this assumption.

[18] The time-preference rate can be normalized as $\beta = \frac{1}{1+r}$ for unconstrained individuals, implying that they want to perfectly smoothen consumption across the two periods.

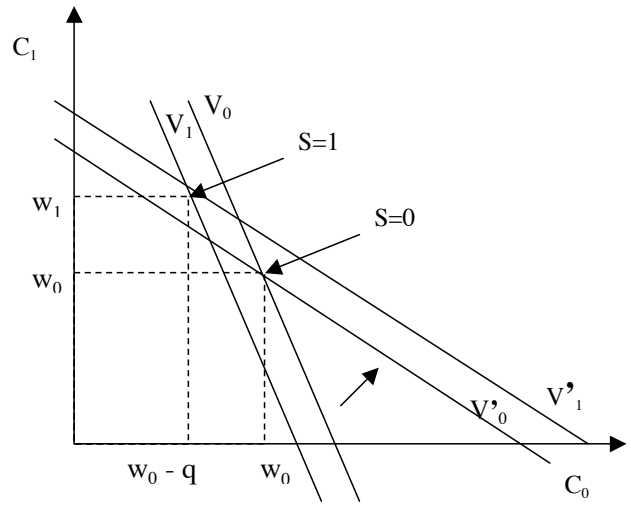

Figure 2: Binding Credit Constraints

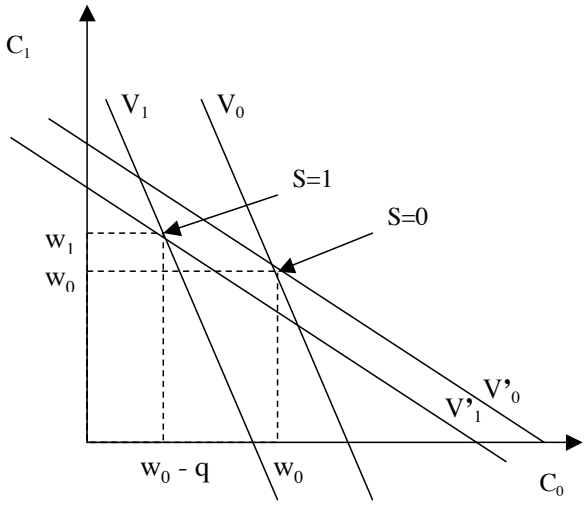

Figure 3: Non-Binding Credit Constraints

This assumption follows from a real-world observation that people have very different capabilities to collateralize loans with personal or family assets and differ in their ability to repay. Credit-constrained individuals borrow at a high interest rate, which makes educational financing even more costly.

Figure 2 shows how credit constraints defined in this way can influence the individual's demand for education. It depicts budget lines under the two alternative schooling options $S = 0$ and $S = 1$ for two interest rates, r and r', where $r > r'$. Budget lines V_0 and V_1 correspond to income streams from schooling when the interest rate is r. V_0 lies to the right of V_1, indicating that a high school education yields higher levels of consumption than a college education. When the borrowing rate is decreased to r', the corresponding budget lines are V_0' and V_1'. Under the new lower interest rate, V_1' lies to the right of V_0', implying that a college education now yields higher consumption than high school. In this example, credit constraints are binding in the sense that a change in the interest rate changes the optimal schooling level.

Assume now that w_1 and w_0 are heterogeneous in the population, so that even if the interest rate is low, it does not pay for everyone to go to college. This assumption originates from the notion of comparative advantage in the labor markets, popularized by Willis and Rosen (1979), and is consistent with heterogeneity in responses to education, which is an empirically important phenomenon (Heckman, 2000). When returns to education are heterogeneous, whether or not the constraint binds is determined by these returns. Figure 3 illustrates this proposition by showing that a decline in the interest rate does not necessarily imply a change in the budget line ordering. In this figure the benefits to education w_1 are lower and the costs of education q are higher than in Figure 2. As a result, the budget line associated with high school education is higher than the budget line for college education, for both interest rates r and r'. Since a decrease in the interest rate in this example does not affect the optimal schooling choice, the credit constraints are not binding.

This simple example demonstrates more formally an intuitive consideration discussed in the previous section: whether or not credit constraints bind depends on the costs and benefits of education. When costs are high and benefits are low, removing credit constraints may not necessarily change individual schooling decisions. In an empirical analysis of the link between credit constraints and educational attainment, it is possible to control for potential costs and benefits by conditioning on local, individual, and family background characteristics. Variables that capture these characteristics are presented below.

5 Explanatory Variables

Although I define credit constraints as heterogeneous borrowing rates, the section above shows that whether or not they are binding depends on all the factors that determine individual demand for education. Denote the probability of reporting credit constraints as P. This probability can be expressed as a function of the interest rate r, schooling costs q, and potential earnings w_0 and w_1: $P = f(w_0, w_1, q, r)$. Since none of these determinants is directly observed in the data, I rely on observable individual and labor market characteristics as proxy variables in estimating the probability P. The results can be interpreted as partial correlations and serve to provide information about the characteristics of individuals who consider themselves credit constrained.

The variables introduced in the estimation include the determinants of individual demand for education and the costs of borrowing. These are ability test scores, family financial and background information, local schooling costs, and individual characteristics. Although in most cases it is not possible to identify the impact of these explanatory variables on each of the arguments of P separately, economic intuition and findings of the earlier studies suggest the direction of relationships between the probability of reporting credit constraints and these variables.

1. Ability Test Scores. Ability plays an important role as a determinant of potential earnings w_0 and w_1. To the extent that higher abilities make learning more effective, higher scholastic aptitude may be associated with higher benefits to education.[19] Hence individuals with higher scholastic abilities should display a higher demand for education and a higher probability of reporting credit constraints. At the same time, educational institutions are looking to attract high-ability students, so they offer them substantial tuition subsidies that reduce the price of education. This implies that individuals with higher scholastic abilities should be less likely to expect credit constraints. As a result of these two contradictory influences, the anticipated relationship between the ability indicators and the probability of reporting constraints is ambiguous.

In the NLSY79, scholastic ability is captured by the Armed Forces Qualification Test (AFQT) scores. The AFQT scores have been widely used by social scientists as a measure of cognitive ability and scholastic aptitude (see, e.g., Cawley et al., 2000; Carneiro and Heckman, 2002). The score is a weighted average

[19] A wide range of studies, e.g., Willis and Rosen (1979), Cameron and Heckman (1998), Carneiro and Heckman (2002), provide indirect support for this claim by showing a strong positive correlation between scholastic ability and educational attainment.

of the Armed Services Vocational Aptitude Battery (ASVAB) test results. The ASVAB measures knowledge and skill in ten different academic and vocational areas. In this study I use the combined AFQT test scores as well as the scores from the four separate sections of the ASVAB test: math, word knowledge, science, and automotive ability. While the AFQT scores measure general scholastic aptitude and trainability, the separate test scores capture a wider range of specific abilities. Capturing specific abilities is important since they are associated with different areas of competitive advantage in the labor markets. A young person with higher automotive scores may have a stronger potential as a plumber than as a lawyer, whereas higher word knowledge scores indicate the opposite. Students in the sample took the test in the summer of 1980, when they were between 15 and 18 years old. The averages of the raw scores are presented in the first column of Table 1.

2. Family Background Characteristics. The family background characteristics that I use in this paper are parental income, parental education, and number of siblings. The probability P is expected to decrease with parental income and education, and increase with number of siblings.

Because of a well-documented link between family financial resources and children's education, parental income has received considerable attention in education research.[20] To the extent that parents are willing to provide their children with access to funds, higher parental income implies lower costs of borrowing. Moreover, parental income can serve as collateral when young adults use private lenders to borrow for school. As a result, children from poor families may face higher interest rates on private loans or may lack access to private lending sources altogether.

At the same time, parental income serves as a benchmark for financial need assessment. Need-based grants (e.g., the Federal Pell Grant Program) and subsidized loans (e.g., the Federal Perkins Loan Program) reduce the out-of-pocket cost of college education for low-income students. The amount of financial aid decreases as income increases, which implies a positive correlation between the cost of education and parental income for low- and middle-income families. Belley and Lochner (2007), however, show in their recent paper that a positive relationship between out-of-pocket schooling costs and parental income does not translate into a negative relationship between income and education if individuals are limited in the amount they can borrow. This implies that we can anticipate

[20] See Carneiro and Heckman (2003) for a detailed discussion of the link between parental income and educational outcomes.

an inverse relationship between parental income and the probability of reporting credit constraints. Parental income is measured when the respondents are age 17, to make sure they are still living with their parents.[21] Mean parental income in the sample is $19,900 in 1979 dollars, which is equivalent to $56,800 in 2007 dollars.

The expectations regarding the influence of parental education on the probability P are similar. As parental education is a good indicator of the family's socioeconomic status and the child's preferences for education, the probability of reporting credit constraints, conditional on potential benefits to education, should decrease with an increase in parental education. We can expect this because higher socioeconomic background is associated with lower costs of borrowing. Parental education is measured in years of schooling completed by the respondents' parents.

The number of siblings is expected to have a positive relationship on the probability of reporting credit constraints, conditional on potential benefits to education. The number of siblings influences the portion of the family financial resources available to an individual: having fewer siblings implies access to a bigger share.

3. Local Characteristics. Local characteristics include state public tuition costs, the presence of a two- or a four-year college in the county of residence, binary variables for Census geographic regions, and a binary variable for residence in a metropolitan statistical area. The first two variables serve as proxies for direct schooling costs. The higher the schooling costs, the more individuals may need to borrow, and the more likely they are to be affected by credit constraints. Hence the probability of reporting credit constraints is expected to increase with the average public tuition and decrease with the presence of a college in the county of residence.

Although the exact costs of college education may vary with the type and location of the university, as well as the specific financial aid package, they can be approximated by characteristics of the locality in which the person lives. Local supply-side variables should perform well in this study, as young people are likely to evaluate schooling costs using the information available to them locally and from public sources. A number of earlier studies have used average public university tuition and the presence of a college nearby to control for schooling costs.[22] State governments subsidize public universities to reduce tuition costs and

[21] For a small fraction of individuals in the sample with missing parental income at age 17, it is recorded at age 16 or earlier.

[22] Kane (1994) and Van der Klaauw (2002) used tuition costs, and Card (1995b) and Cameron and Taber (2004) used presence of a college in the county of residence.

to ensure equal access to higher education for students of all income levels. Hence average public tuition is a good proxy for individual tuition costs in the analysis of credit constraints. At the same time, living expenses account for a substantial portion of educational costs at the university level.[23] So an opportunity to live at home or with parents results in a sizable reduction of expenditures associated with college attendance, which is especially important for low- and moderate-income families.

The local schooling cost variables are merged from the Department of Education's Higher Education General Information Survey (HEGIS) using the restricted Geocodes state and county identifiers.[24] About 87 percent of individuals live in a county with a two- or a four-year accredited college nearby. Average public university tuition varies substantially across the states: from $365 per-year in Washington, D.C., to above $2,000 in Vermont, with a sample mean of about $1,100, in 1979 dollars (see Table 1).

4. Individual Characteristics. Individual characteristics included in this study are race, ethnicity, and gender. Race and ethnicity have an ambiguous relationship to the probability of reporting credit constraints. Non-white or Hispanic individuals potentially face higher costs of borrowing because of discrimination. Jappelli (1990), for example, shows that non-whites are about 5 percentage points more likely to be rejected when applying for loans than whites. If lenders ration credit more severely for these groups, we can expect to see a positive relationship between being non-white or Hispanic and the probability of reporting credit constraints. At the same time, affirmative action policies may make college education more affordable for minority groups by offering targeted financial aid packages. As a result, the relationship between self-reported credit constraints and ethnic/racial minority group membership is ambiguous.

Gender has always played an important role in educational attainment analysis. Historically, men received more years of education than women. However, the educational attainment of women has been increasing at a faster pace, and from the beginning of the 1990s more young women than men have been receiving college degrees (U.S. Census Bureau 2007). Some studies have shown that non-pecuniary motives in education are more important for women than men (Reisburg, 2000). Moreover, women's college attendance decisions have been less influenced by competing opportunities than have men's college attendance deci-

[23] Lee (1999) estimated that living expenses constitute about 70 percent of the total cost of one year at a public four-year college and over three-quarters of the cost at a public two-year institution.

[24] See the Appendix A.2 for a description of the HEGIS and the restricted Geocodes data.

Table 2: Summary Statistics, Constrained Men and Women

	Men		Women		T-stats[b]
Variables	Mean	S.D.	Mean	S.D.	
Black	0.278		0.212		1.965**
Hispanic	0.178		0.234		1.774*
Age	19.29	1.31	19.23	1.27	0.671
Number of siblings	4.246	2.880	3.763	2.480	2.313**
Avg. public tuition	1,052	364	1,074	369	0.820
Local college	0.877		0.858		0.713
Urban residence at 17	0.769		0.702		1.979**
Ability Test Scores					
Math score	10.500	5.643	12.031	5.654	3.498***
Word score	20.716	8.680	22.855	7.721	3.356***
Science score	13.377	5.177	13.145	4.541	0.269
Automotive score	13.325	5.421	9.748	3.693	9.908***
Combined AFQT score	32.029	26.123	37.560	26.014	2.736
Characteristics at Age 17					
Parental income	1,684	1,342	1,630	1,357	0.512
Mother's education	11.748	1.932	11.830	1.932	0.500
Father's education	12.271	2.219	12.422	2.103	0.719
N	342		325		
Proportion	13.19		12.65		

Notes: a) Expressed in 1979 dollars. b) Testing the hypothesis of equality of means between the constrained and the unconstrained.

sions (Averett and Burton, 1996). Table A-1 in the Appendix shows substantial gender differences in answers to the question about the aspirations-expectations gap. Women are more likely than men to report financial reasons and family responsibilities as the source of the gap, whereas men are more likely to report the need to work and difficulties in learning.

Table 2 presents summary statistics for constrained individuals by gender. It shows significant differences in the racial and ethnic composition of the two subsamples, as well as in their ability test scores. About 28 percent of constrained men are black and 19 percent are Hispanic, while among constrained women, 21 percent are black and 23 percent Hispanic. Constrained women have higher math and word knowledge test scores than unconstrained women, while automotive scores are much higher for constrained versus unconstrained men. Constrained men are also more likely to come from bigger families and to live in an urban area

than constrained women. Although the exact implications of these differences are not clear, they call for separate analyses of constrained men and women.

6 Results

The simple model presented in Section 4 shows that under certain conditions credit constraints can adversely impact individual schooling decisions. The panel nature of the NLSY79 data allows us to evaluate this prediction by focusing on educational attainment of constrained and unconstrained youths. The first part of this section presents logistic estimates of the probability of reporting constraints as a function of the explanatory variables described above. The second part examines the role of self-reported constraints as a determinant of a battery of educational outcomes. The results imply that the measure of financial difficulties developed in this paper captures the aspects individual heterogeneity pertinent to educational outcomes and potentially related to credit constraints.

6.1 Probability of Reporting Constraints

The discussion in the previous section has established that the probability of reporting credit constraints should be directly related to schooling costs and the costs of borrowing. Below I present logistic estimates of the probability of reporting constraints conditional on proxies for these factors in addition to other individual, family, and local labor market characteristics outlined above. The results are purely descriptive and do not bear causal interpretation. They can be interpreted as conditional partial correlations that reveal the characteristics of individuals who perceive themselves as credit constrained in educational choices.

Although it is not possible to establish the extent to which self-reported financial difficulties mirror the actual constrained status, the results overall accord with the economic intuition. The probability of reporting financial difficulties varies in a predictable fashion with the indicators of schooling costs and the costs of borrowing. At the same time, there are substantial gender differences in some of the determinants. For notational convenience, I refer to individuals who report financial difficulties as *credit constrained* in this section.

The regression coefficients and marginal effects estimated separately for men and women are presented in Table 3. To take into account the impact of financial aid available to low-income students, the empirical model includes a spline in parental income. Table 3 shows that for non-low-income youths the

Table 3: Estimated Probability of Reporting Credit Constraints

	Men		Women	
	Coeff.	Marg. Effect	Coeff.	Marg. Effect
Parental income/10,000	-0.117**	-0.013**	-0.114**	-0.012**
	(0.053)	(0.006)	(0.048)	(0.005)
Parental income in 1st Quartile	-0.104	-0.011	-0.215*	-0.023*
	(0.084)	(0.009)	(0.125)	(0.013)
Avg. tuition/1,000	-0.193	-0.021	-0.108	-0.011
	(0.214)	(0.023)	(0.229)	(0.024)
Local college (d)	-0.332	-0.033*	-0.486**	-0.045***
	(0.204)	(0.019)	(0.194)	(0.016)
Black (d)	-0.251	-0.026	-0.119	-0.012
	(0.187)	(0.019)	(0.183)	(0.019)
Hispanic (d)	-0.258	-0.026	0.415**	0.049**
	(0.198)	(0.019)	(0.180)	(0.023)
Math score/10	-0.311**	-0.034**	0.171	0.018
	(0.151)	(0.016)	(0.154)	(0.016)
Word score/10	0.107	0.012	0.091	0.010
	(0.139)	(0.015)	(0.150)	(0.016)
Science score/10	-0.105	-0.011	-0.179	-0.019
	(0.195)	(0.021)	(0.243)	(0.026)
Automotive score/10	0.068	0.007	0.016	0.002
	(0.152)	(0.017)	(0.240)	(0.025)
Number of siblings	0.045**	0.005**	-0.014	-0.002
	(0.022)	(0.002)	(0.026)	(0.003)
Mother's education	-0.003	-0.000	-0.049	-0.005
	(0.026)	(0.003)	(0.031)	(0.003)
Father's education	-0.019	-0.002	0.016	0.002
	(0.020)	(0.002)	(0.021)	(0.002)
Urban residence (d)	0.039	0.004	-0.549***	-0.065***
	(0.205)	(0.022)	(0.162)	(0.021)
Constant	-1.106**		-1.272***	
	(0.478)		(0.449)	
Log likelihood	-982		-953	
Pseudo R^2	0.026		0.023	
N	2,592		2,569	

NOTES: a) For binary variables, denoted as (d), marginal effects are estimated for changes from zero to one. b) Standard errors (in parentheses) are robust to arbitrary correlation across persons who live in the same county. c) Additional controls include cohort indicators and indicators for residence in the four standard census regions.

probability of reporting credit constraints decreases with parental income. A ten-thousand dollar increase in parental income is associated with a decrease of about 1.3 percentage-point in the probability of reporting credit constraints for both men and women. This is equivalent to a 10 percent change, since the proportion of credit constrained individuals in both subsamples is about 13 percent. For men in the lowest quartile of family income distribution, parental income is not a significant predictor of the probability of reporting constraints. By contrast, parental income is a strong predictor of constraints reporting for women in the lowest quartile of family income distribution. The magnitude of the marginal effect is almost twice as large relative to the rest of the income distribution. This result is not necessarily intuitive, since need-based financial aid is generally independent of gender. It indicates that men and women at the bottom of the family income distribution have different beliefs about their credit-constrained status.

Consistent with the intuition described in the previous section, living in a county with a college nearby is associated with a lower probability of reporting credit constraints. A nearby college is associated with a 3.3 percentage-point (or a 25 percent) decrease in P for men and a 4.5 percentage-point (or a 35 percent) decrease in P for women.

There are other important gender differences in the results. For example, higher math scores have a strong negative association with the probability of reporting credit constraints for men, but not for women. For women, ability test scores do not play an important role as credit-constraint determinants. Similarly, for men, having an additional sibling is associated with an increase in the probability P of about 0.5 percentage points (or 4 percent), whereas for women the number of siblings is not statistically significant. Hispanic women are about 4.8 percentage points (or 37 percent) more likely to report credit constraints than non-Hispanic women. Women living in urban areas are half as likely to report credit constraints as their counterparts in rural areas (a 6.5 percentage-point difference). At the same time, race/ethnicity and urban residence are not significant for men. These gender differences indicate that schooling expectations are formed differently for men and women. A low significance of ability scores, for example, may indicate that women put more weight on the non-pecuniary benefits of education.

6.2 Educational Outcomes of the Constrained

Below I employ an empirical framework similar to the one used by Carneiro and Heckman (2002) to evaluate the internal consistency of the credit constraints measure. I augment their model that examines the link between parental income, abil-

ity, and educational outcomes with my credit constraints indicator. While this exercise is purely descriptive, it provides some insights about the predictive power of the measure and its potential for identifying person-specific heterogeneity in borrowing costs and the ability to finance college education.

Table 4: Estimated Probability of College Enrollment at Age 20, Men

	Total	Bottom AFQT	Middle AFQT	Top AFQT
Constrained	-0.075***	-0.027*	0.003	-0.173***
	(0.025)	(0.016)	(0.044)	(0.063)
Income quartile 1	-0.149***	-0.042**	-0.107***	-0.098
	(0.024)	(0.019)	(0.041)	(0.064)
Income quartile 2	-0.089***	-0.022	-0.005	-0.120**
	(0.026)	(0.018)	(0.044)	(0.057)
Income quartile 3	-0.083***	-0.002	-0.081**	-0.098**
	(0.019)	(0.020)	(0.038)	(0.047)
Black	0.038	0.069***	0.250***	0.233***
	(0.025)	(0.022)	(0.048)	(0.048)
Hispanic	0.131***	0.049	0.305***	0.062
	(0.035)	(0.039)	(0.057)	(0.059)
Both parents	0.017	0.015	0.033	0.002
	(0.023)	(0.015)	(0.037)	(0.052)
Father's education	0.027***	-0.001	0.020***	0.021**
	(0.005)	(0.003)	(0.007)	(0.009)
Mother's education	0.025***	0.005**	0.006	0.033***
	(0.004)	(0.002)	(0.005)	(0.007)
Number of siblings	-0.023***	-0.003	-0.013**	-0.024**
	(0.004)	(0.003)	(0.007)	(0.010)
South	0.031	0.010	0.043	0.092**
	(0.023)	(0.015)	(0.034)	(0.041)
Urban residence	-0.002	-0.008	-0.038	0.013
	(0.024)	(0.018)	(0.042)	(0.045)
Log likelihood	-1,358	-207	-434	-501
Pseudo R^2	0.151	0.083	0.083	0.123
N	2,592	908	831	853

NOTES: Marginal effects, standard errors in parenthesis. Additional controls include cohort indicators.

Table 5: Estimated Probability of College Enrollment at Age 20, Women

	Total	Bottom AFQT	Middle AFQT	Top AFQT
Constrained	0.011	0.047	-0.049	0.034
	(0.029)	(0.034)	(0.047)	(0.053)
Income quartile 1	-0.234***	-0.111***	-0.128***	-0.247***
	(0.027)	(0.029)	(0.045)	(0.058)
Income quartile 2	-0.114***	-0.031	-0.043	-0.136**
	(0.029)	(0.025)	(0.047)	(0.056)
Income quartile 3	-0.089***	-0.022	-0.094**	-0.020
	(0.024)	(0.025)	(0.042)	(0.048)
Black	0.160***	0.182***	0.431***	0.207***
	(0.031)	(0.035)	(0.046)	(0.050)
Hispanic	0.153***	0.211***	0.335***	0.086
	(0.043)	(0.060)	(0.056)	(0.058)
Both parents	0.043*	0.002	0.068*	-0.018
	(0.025)	(0.019)	(0.038)	(0.053)
Father's education	0.036***	0.004	0.036***	0.034***
	(0.006)	(0.004)	(0.008)	(0.009)
Mother's education	0.022***	0.007**	-0.001	0.024***
	(0.004)	(0.003)	(0.006)	(0.007)
Number of siblings	-0.022***	-0.012***	-0.015*	-0.016*
	(0.005)	(0.004)	(0.008)	(0.009)
South	0.043	0.016	0.014	0.080**
	(0.026)	(0.019)	(0.036)	(0.038)
Urban residence	0.036	0.021	0.007	0.043
	(0.027)	(0.022)	(0.043)	(0.044)
Log likelihood	-1,404.	-289	-442	-502
Pseudo R^2	0.156	0.169	0.152	0.117
N	2,569	867	850	852

NOTES: Marginal effects, standard errors in parenthesis. Additional controls include cohort indicators.

Tables 4 and 5 report marginal effects from logistic regressions of the probability of being enrolled in a college at age 20 (or age 21 for the oldest cohort in the sample), for men and women. I adopt the specification used by Carneiro and Heckman (2002) and include my indicator of credit constraints as an additional re-

gressor. The estimates without conditioning on the ability test scores (AFQT) are presented in the first column of the tables ("Total"). The following three columns report the estimates for different AFQT score groups. Ability test scores capture the long-run differences in socioeconomic background and largely determine individual demand for education.

The results show that the credit constraints indicator is an important predictor of college enrollment for men, but not for women. Men who report credit constraints are 7.5 percentage points less likely to be enrolled in college at age 20, relative to men who do not report constraints. This relationship is even stronger for men in the top tercile of the AFQT distribution: the gap in college enrollment by self-reported credit constraints is 17.3 percentage points.

Following the same methodology, I examine the relationship between self-reported constraints and other dimensions of schooling. Credit constraints can affect individual schooling decisions on a number of margins, such as timing of enrollment, quality of the university, or employment while at school. For this study it is especially important to examine an array of schooling outcomes to evaluate internal consistency of the measure. If the measure is internally consistent, we can expect to see systematic and persistent differences between constrained and unconstrained youths along more than one outcome margin. Conditioning on family income, family background, and ability test scores allows to isolate the contribution of the constraints measure not attributable to long-run socioeconomic differences.

In addition to college enrollment, I use five other dimensions of education. These dimensions are expressed as binary outcomes to make interpretation more straightforward. They come from the 1994 wave of the survey, conducted when the respondents were between the ages of 39 to 43 and had completed the bulk of their schooling. Two binary variables capture educational attainment: an indicator for completing a four-year degree and an indicator for completing a two-year degree (for those who do not complete a four-year degree). For those who received a two- or a four-year degree, another binary indicates if the degree was received without a delay. Quality of education is captured by two indicators: enrollment in a four-year versus a two-year college, and enrollment in a college with competitive admissions standards.[25] Raw and adjusted gaps ("Beta") in these outcomes between constrained and unconstrained men and women, including the gaps in college enrollment, are presented in Tables 6 and 7 respectively. The adjusted

[25]Competitive admissions standards is a measure unique to this study. It is the one measure out of six that does not appear in Carneiro and Heckman (2002).

gaps are marginal effects from logistic regressions with the same covariates as in Tables 4 and 5.[26]

Table 6: Gaps in Educational Outcomes of Constrained Men

Total		Bottom AFQT		Middle AFQT		Top AFQT	
Raw	Beta	Raw	Beta	Raw	Beta	Raw	Beta
Panel A - Enrollment in College							
-0.100***	-0.075**	-0.034	-0.027*	-0.013	0.003	-0.163***	-0.173***
(0.026)	(0.025)	(0.022)	(0.016)	(0.041)	(0.044)	(0.057)	(0.063)
Panel B - Complete 4-Year College							
-0.097***	-0.054***	-0.014	-0.009	-0.072**	-0.047***	-0.121**	-0.100*
(0.022)	(0.015)	(0.010)	(0.006)	(0.029)	(0.016)	(0.057)	(0.058)
Panel C - Complete 2-Year College							
-0.047**	-0.032*	-0.018	-0.013	-0.032	-0.027	-0.062	-0.047
(0.021)	(0.018)	(0.019)	(0.010)	(0.033)	(0.027)	(0.052)	(0.050)
Panel D - Proportion of People not Delaying College							
-0.090*	-0.062	-0.111	-0.059	-0.004	-0.033	-0.133**	-0.093
(0.049	(0.051)	(0.092)	(0.095)	(0.082)	(0.089)	(0.059)	(0.094)
Panel E - Enrollment in a 4-Year versus 2-Year College							
-0.067	-0.056	-0.018	-0.007	-0.046	-0.023	-0.086	-0.084
(0.046)	(0.048)	(0.071)	(0.073)	(0.082)	(0.087)	(0.081)	(0.090)
Panel F - Enrollment in a Competitive College							
-0.063	-0.037	-0.077	0.064	-0.082	-0.034	-0.166*	-0.160*
(0.044)	(0.043)	(0.059)	(0.060)	(0.074)	(0.074)	(0.093)	(0.095)

NOTES: Standard errors in parenthesis. All results are presented relative to the unconstrained men. Beta, or adjusted gaps, are marginal effects from logit regressions.

The results of Table 6 show substantial differences between constrained and unconstrained men along most of the schooling outcome dimensions. The first two columns of the table present the gaps estimated for all men ("Total"). They appear substantial, varying between 5 and 10 percentage points for different outcomes. All the raw gaps, except for the gaps in school quality, are statistically significant at conventional levels, indicating that men who report credit constraints are less likely to receive a two-year or a four-year degree, and are more likely to delay enrollment. Conditioning on individual and family background characteristics reduces these gaps, but does not eliminate them. The gaps in college enrollment and completion remain statistically significant. Self-reported credit

[26]The full regression results are available from the author upon request.

Table 7: Gaps in Educational Outcomes of Constrained Women

Total		Bottom AFQT		Middle AFQT		Top AFQT	
Raw	Beta	Raw	Beta	Raw	Beta	Raw	Beta
Panel A - Enrollment in College							
-0.026	0.009	0.041	0.059	-0.043	-0.053	-0.077	-0.017
(0.028)	(0.031)	(0.033)	(0.036)	(0.047)	(0.047)	(0.051)	(0.052)
Panel B - Complete 4-Year College							
-0.036	-0.012	0.033	0.015	-0.014	-0.004	-0.128***	-0.086*
(0.023)	(0.018)	(0.019)	(0.012)	(0.033)	(0.028)	(0.051)	0.052
Panel C - Complete 2-Year College							
0.006	0.013	0.012	0.035	-0.014	-0.007	-0.016	-0.012
(0.024)	(0.024)	(0.030)	(0.029)	(0.042)	(0.038)	(0.049)	(0.051)
Panel D - Proportion of People not Delaying College							
-0.074**	-0.027	0.016	0.052	-0.155***	-0.103	-0.068	-0.001
(0.038)	(0.036)	(0.074)	(0.064)	(0.062)	(0.071)	(0.054)	(0.031)
Panel E - Enrollment in a 4-Year versus 2-Year College							
-0.103***	-0.088**	-0.066	-0.066	-0.159**	-0.165**	-0.099*	-0.056
(0.039)	(0.042)	(0.066)	(0.065)	(0.071)	(0.072)	(0.060)	(0.065)
Panel F - Enrollment in a Competitive College							
0.042	0.075	0.043	0.055	0.083	0.095	0.001	0.055
(0.036)	(0.040)	(0.052)	(0.055)	(0.064)	(0.072)	(0.067)	(0.075)

NOTES: Standard errors in parenthesis. All results are presented relative to the unconstrained women. Beta, or adjusted gaps, are marginal effects from logit regressions.

constraints account for a 5 percentage-point gap in a 4-year college completion and a 3 percentage-point gap in a 2-year college completion.

The rest of Table 6 presents the gaps estimated by the AFQT terciles. Depending on their location in the AFQT distribution, individuals vary in their demand for education and perception of credit constraints. Unsurprisingly, there are no gaps in schooling outcomes for men at the bottom of the AFQT distribution. Low-ability individuals have a low demand for college education and hence are less likely to be affected by credit constraints. At the same time, there are large and significant gaps in college enrollment, completion, and quality for high-ability men. Constrained men at the top of the AFQT distribution are 16 percentage points less likely to be enrolled in college at age 20, and 13 percentage points more likely to delay if they do choose to enroll. They are also 12 percentage points less likely to complete a four-year degree and 17 percentage points less likely to enroll in a competitive university. Controlling for individual and back-

ground characteristics does not reduce the gaps in college enrollment and quality. The persistence of these gaps indicates that the self-reported credit constraints reveal important information about the college choices of men, beyond that captured by parental income and ability measures.

For women the picture is less clear. As Table 7 shows, constrained and unconstrained women statistically differ only in college delays and enrollment in a four- versus two-year college. Similar to the results for men, credit constraints have a somewhat stronger predictive power for women at the top of the AFQT distribution. Constrained women in the highest AFQT tercile are 10 percentage points less likely to enroll in a four-year institution and 13 percentage points less likely to complete a four-year degree than unconstrained women. Overall the results indicate that self-reported credit constraints are not a strong predictor of educational outcomes for women when controls for parental income and family background are introduced (except for a four-year degree completion for high-ability women).

7 Conclusions

The results of this study indicate that up to 12 percent of college-age youths in the NLSY79 are potentially constrained in their educational choices. Because of the noisy nature of my measure, this proportion is an upper-bound estimated of the true fraction of liquidity-constrained. Hence my results are generally consistent with the earlier conclusions based on the NLSY79 that credit constraints play only a small role in determining the demand for education in the United States.

However, my subjective measures of financial difficulties reveal some important aspects of heterogeneity in the demand for education, not captured by the standard socioeconomic variables. A comparison of educational outcomes across a wide number of dimensions shows that the measure is internally consistent, at least for men. Men who report constraints are less likely to enroll in college, more likely to delay enrollment, and are less likely to graduate with a four-year degree than their unconstrained counterparts. These differences are larger for youths at the top of the ability distribution and persist when controls for parental income and family background are introduced.

On a broader scale the results in this paper suggest that although self-reported constraints need to be treated with caution, they can serve as a valuable source of information regarding individual decision making. Subjective measures allow researchers to observe additional aspects of population heterogeneity that

facilitate econometric analysis and reduce the need for arbitrary assumptions.

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Appendices

A.1 Survey Questions

Question S03D0766: Reason highest grade completed respondent expects is less than respondent would like. What is the main reason that you expect to complete less regular schooling than you would like to complete?

Table A-1: Distribution of Answers to Question S03D0766.

	Men		Women		Difference
Answer	N	Percent	N	Percent	T-stats.
Financial reasons	228	0.396	259	0.432	1.395
Family responsibilities	25	0.043	121	0.202	8.552***
School too difficult	38	0.066	16	0.027	3.195***
Have to work	114	0.198	66	0.110	4.149***
Health problems	1	0.002	0	0.000	1.015
Not necessary for job	27	0.047	19	0.032	1.311
Don't like school	38	0.066	31	0.052	1.002
Other	105	0.182	87	0.145	2.129**
Total	576	1.000	599	1.000	

A.2 The National Longitudinal Survey of Youth Geocodes Restricted-Access Data Supplement

In this project, the Geocodes Restricted-Access data are used to identify state and county of residence of the respondents at age 17. These data contain sensitive information that makes it possible to identify individual respondents. To ensure confidentiality, the Bureau of Labor Statistics (BLS) only grants access to Geocodes data to researchers in the United States who agree in writing to adhere to the BLS confidentiality policy. To gain access to the data, an application must be submitted to the BLS describing the project's goals, methodology, and security policies to protect the data. After the application is approved, Geocodes data can be used to conduct statistical analysis, but never to identify individual respondents.

A.3 Higher Education General Information Survey Data

The Higher Education General Information Survey (HEGIS) was designed to provide comprehensive information on various aspects of post-secondary education in the United States. The study domain includes all post-secondary institutions operating in the United States and its territories. The data used in this paper come from the Institutional Characteristics module. The module contains annual data on type of institution, tuition, location, and other characteristics of colleges and universities in the United States. The study excluded federal institutions and colleges with enrollment of fewer than 100 students. The data are available from University of Michigan data repository, and can be accessed at *http://www.icpsr.umich.edu/cocoon/IAED-SERIES/00030.xml?token=6*.

A.4 Additional Figures

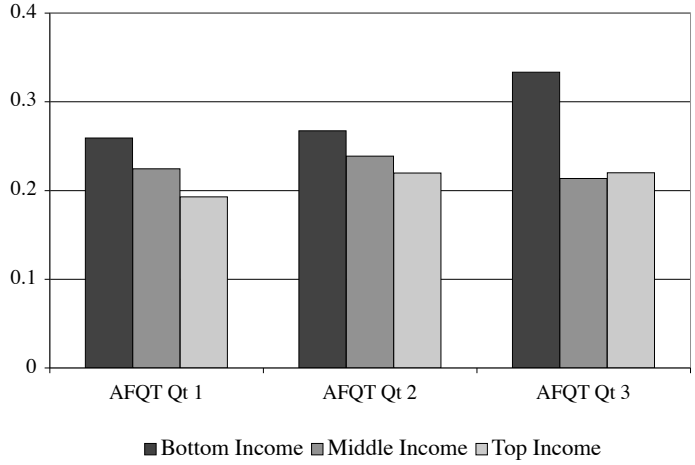

Figure A-2: Distribution of Credit Constraints by Parental Income and AFQT Tercile, NLSY79. Expected Education – Some College.

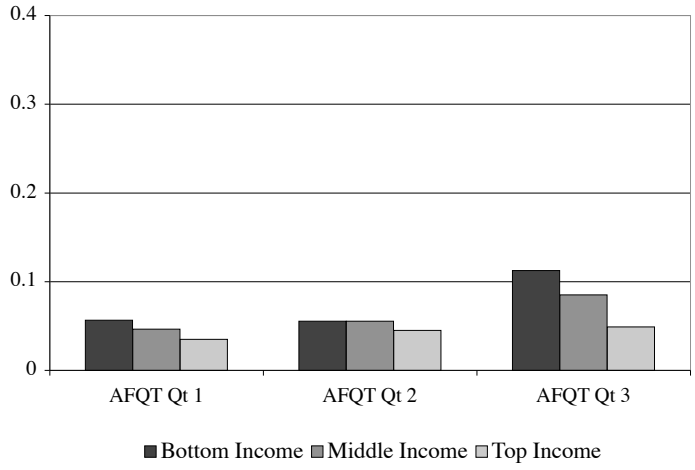

Figure A-3: Distribution of Credit Constraints by Parental Income and AFQT Tercile, NLSY79. Expected Education – College Degree or Higher

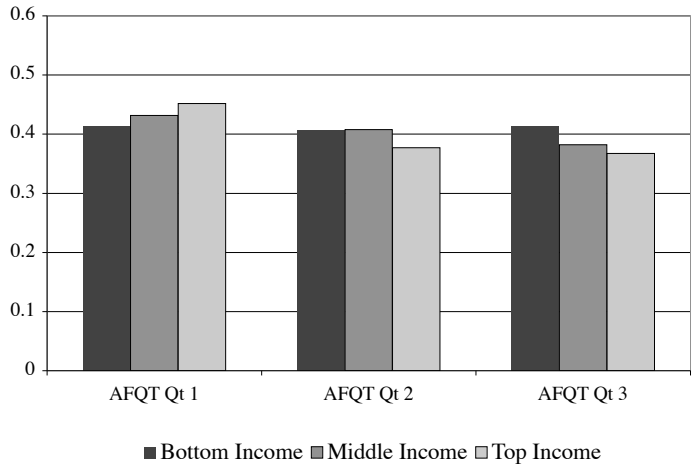

Figure A-4: Probability to Overpredict Education by Parental Income and AFQT Tercile, NLSY79