Borrowing Constraints, College Enrollment, and Delayed Entry*

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Abstract

In this paper I propose and estimate a dynamic model of education, borrowing, and work decisions of high school graduates. I examine the effect of relaxing borrowing constraints on educational attainment by simulating increases in the amount students are permitted to borrow from government sponsored loan programs. My results indicate that borrowing constraints have a small impact on college completion: the removal of education related borrowing constraints increases degree completion by 1.1 percentage points. Tuition subsidies have much larger impacts. I find that increased subsidies for middle income households are the most cost effective method to raise degree completion.

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1 Introduction

The large increase in the college wage premium that has taken place since the 1980s has been accompanied by a relatively modest increase in college completion.[1] Two possible explanations for this disparity are the fact that the price of college has approximately doubled while the availability of student loans has declined, and the possibility that few students are close to the margin of college graduation.[2]

In this paper I propose a dynamic model of college enrollment and completion, labor force participation, and saving to ascertain the plausibility of the above explanations. First, with the objective of understanding the role of borrowing constraints, the model incorporates the details of the Guaranteed Student Loan program (henceforth GSL) and the various grants available to college students. This allows me to examine the extent to which borrowing constraints bind for youths and affect decisions about college completion. Second, with the objective of exploring the importance of heterogeneity, the model recognizes that students differ in observed and unobserved ability, parental income and transfers, asset holdings at age 18, and in the tuition costs they face. It is important to account for the substantial heterogeneity among students considering entry to college since it will determine how many students are near the margin of college completion and who is affected by changes in higher education policy. Third, the model incorporates uncertainty about degree completion and labor market opportunities because uncertainty may importantly affect the responsiveness of risk averse individuals to changes in the price of college and availability of loans. The model is estimated on individual-level longitudinal data from the NLSY97 which pertain to a cohort aged 18 in 1999-2003. The estimated model is then used to evaluate the effects on enrollment and degree completion of increasing the maximum students may borrow from the GSL program, increasing tuition subsidies, and changing the dependence of loans and tuition subsidies on parental income.

How might borrowing constraints affect educational decisions? Outside of loans the main avenues available for students to finance their college education are transfers from their parents, grants, and labor earnings. For many students these three sources of income are not enough to pay for the costs of college, which leads them to take out loans. If insufficient loans are available to a student attending college he may not be able to smooth consumption between college years and the future as much he desires. Lack of loans could also cause a student close to the margin of enrollment to delay entry to college while he works and accumulates savings. Indeed, a large fraction of students who eventually enroll in college do so after delaying by a semester or more despite the fact that delayed entry to college causes losses in lifetime income and is associated with less favorable educational outcomes. This paper will test borrowing constraints as a possible explanation for delayed entry to college.

My results show that borrowing constraints have a small impact on college enrollment, degree completion, and delayed entry. The removal of education related borrowing constraints increases degree completion by only 1.1 percentage points. It is interesting to note that even though I find borrowing constraints to be tight, removing them has only a small impact on educational attainment. I argue that a precautionary savings motive (Carroll (1997)) can explain the reluctance of youths to borrow against higher future incomes because they are concerned about building a buffer stock of savings to insure against potential unemployment and low wage shocks.

In addition to explaining the role played by borrowing constraints in the education decisions of

[1] The college wage premium for younger workers increased from 31% in 1983 to 54% in 2003 (Fortin (2006)). During this time period the percentage of the population between ages 25 and 29 with a bachelor's degree increased from 21% to 28% (Stoops (2004)).

[2] The average cost of tuition, room, and board at 4-year colleges has increased from \$9,000 in 1983 to \$16,000 in 2003 (2004 dollars) while the amount first year undergraduates can borrow through the Stafford loan program has shrunk from \$4,700 to \$2,700. All dollar amounts in this paper are expressed in 2004 dollars.

students, my model has important implications for higher education policies. The federal and state governments in the US currently spend approximately $120 billion each year to promote higher education. With such large amounts of money at stake, it is important for the government to know which programs are the most cost effective at increasing the educational attainment of college students. This is a very difficult empirical question to answer since it depends on which students are close to the margin of college enrollment and how they respond to different incentives. Since my model incorporates multiple sources of heterogeneity among students, I can answer this question by simulating changes in loan limits and tuition subsidies. I hold constant the cost of a policy change and evaluate the magnitude of the effects of relaxing borrowing constraints and of targeting tuition subsidies toward various groups. I find that to implement small increases in degree completion relaxing borrowing constraints is the most cost-effective policy for the government. Tuition subsidies are necessary to cause larger increases in educational attainment. I show that tuition subsidies targeted toward households in the middle third of the parental income distribution are the most cost-effective method of increasing degree completion in the population.

I also use my model to examine the effects on college completion of the changes in the market for higher education over the past two decades. I compare bachelor's degree completion across the NLSY79 and NLSY97 cohorts. I show that if the costs of college were held constant at today's level and the returns to education were reduced to the level in the early 1980s, bachelor's degree completion rates would be substantially lower. Conversely if the returns to education were held constant while the costs of college were decreased to the level in the 1980s, degree completion would be higher. When both changes are considered together the effects in part cancel out, although the increase in the college wage premium dominates leading to the modest increase in degree completion noted previously.

The final issue explored in this paper is the link between parental income and educational attainment. Even after controlling for ability and family background, parental income is positively correlated with college outcomes. Some recent papers such as Belley and Lochner (2007) and Lochner and Monge-Naranjo (2008) have suggested that this correlation is evidence that borrowing constraints are affecting the educational decisions of youths from low income households. This interpretation conflicts with the findings of this paper that borrowing constraints have a very small impact on degree completion. I reconcile these two findings by showing that a large fraction of the disparity in degree completion between students from high and low income households can be explained by the fact that students from high income households receive larger transfers from their parents while they are enrolled in college.

This paper is organized as follows. Section 2 discusses the relevant literature. The model is presented in Section 3. The data and descriptive statistics are shown in Section 4. The solution and estimation methods are discussed in Sections 5 and 6. Identification issues are discussed in Section 7. The fit of the model is displayed in Section 8 and the results are contained in Section 9. Section 10 concludes.

2 Related Literature

There is a large literature related to borrowing constraints and educational attainment. With reference to the NLSY79 cohort Keane and Wolpin (2001), Carneiro and Heckman (2002), and Cameron and Taber (2004) do not find evidence that borrowing constraints affect the educational attainment of youths attending college in the early 1980s. Keane and Wolpin (2001) estimate a structural model and show that relaxing borrowing constraints has no effect on the average highest grade completed. Carneiro and Heckman (2002) examine whether, after controlling for ability and family background, the parental income of the NLSY79 youths matters for outcomes along various dimensions of college enrollment and educational attainment. They argue that youths with parents in the highest income quartile are not credit constrained. Thus, given ability, a significant differences in educational attainment across parental income quartiles would be evidence of credit constraints. However, they find that after controlling for ability there is little or no difference in educational outcomes across parental income quartiles. Cameron and Taber (2004) use an instrumental variables approach to test whether the estimated returns to schooling change when an instrument that should differentially affect students who are and are not credit constrained is compared to an instrument that should affect all students equally. They find no evidence that borrowing constraints affect educational attainment.

In recent years there has been renewed interest in whether borrowing constraints have an impact on educational attainment. Belley and Lochner (2007) use the methods in Carneiro and Heckman (2002) and compare results across the NLSY79 and NLSY97. They find that, conditional on ability and family background, parental income matters much more for educational attainment during recent years. Lochner and Monge-Naranjo (2008) build a 3-period model of human capital formation and show that the empirical findings of Belley and Lochner (2007) are consistent with the importance of borrowing constraints in determining educational attainment. However, they do not model labor market uncertainty, the labor supply decision while enrolled in school, or the choice between college types, which makes it difficult to accurately assess the magnitude of the effect of borrowing constraints on educational attainment.

Rothstein and Rouse (2008) suggest that graduates from elite universities may be credit constrained early in the life cycle. Ionescu (2009) extends a Ben-Porath type model to include borrowing constraints in human capital accumulation and analyzes the effect of the design of the GSL program on default incentives for students. Ionescu (2008) extends this model to include risk in degree completion and labor market outcomes. These papers, however, have a coarse measure of educational attainment (the only measure is the amount of human capital) and do not use individual level data to evaluate the decisions and outcomes of agents.[3]

Stinebrickner and Stinebrickner (2008) adopt a more direct approach to examine the effects of borrowing constraints on the decisions of youths; they ask a group of low income students at Berea college if they are constrained in their borrowing decisions. They question students if they would take up a loan offered to them at the market interest rate. The authors find that the vast majority of students would not take up the loan and that borrowing constraints do not explain most of the drop-out decisions. However, approximately half of all Berea college students drop out of school and 67% of these students cite not having enough money as part of the reason for dropping out. It is puzzling that these students with upward sloping income profiles are so reluctant to borrow against future earnings even though their current marginal utility of income seems to be quite high.

In this paper I also find that borrowing constraints have a very small effect on educational attainment, mainly because of the reluctance of students to borrow. I argue that the precautionary savings motive explored in Carroll (1997) and Carroll et al. (2003) is a possible explanation for this behavior. Students are reluctant to borrow during college because they are uncertain about future labor market outcomes such as unemployment and negative wage shocks. Therefore even though the amount students are able to borrow while in school may be small relative to the costs of college, relaxing borrowing constraints has little impact on educational attainment because the amount students desire to borrow is also small.

Delayed entry to college is potentially closely related to borrowing constraints. However, there are

[3]There are also a number of papers that use general equilibrium models and address borrowing constraints and educational attainment. Some examples include Akyol and Athreya (2005), Gallipoli et al. (2007), Garriga and Keightley (2007), and Winter (2009). These models account for the changes in relative prices which occur as a result of large adjustments to the structure of higher education. For smaller changes in loan limits or tuition subsidies, a model like the one I use in this paper provides a more accurate assessment of the effects because I can model student decisions at a finer level and include more sources of heterogeneity.

very few papers that address delay and those that do find conflicting evidence about the role credit constraints may play in the timing of college entry. Both Carneiro and Heckman (2002) and Belley and Lochner (2007) find only a small correlation between parental income and delayed entry to college after controlling for ability, indicating that borrowing constraints may not affect college timing decisions. However, Kane (1996) finds that delayed entry to college is more common in states with higher average tuitions, especially among low income students. This is suggestive evidence that borrowing constraints may affect the timing of college entry.

In terms of the model in this paper, my approach builds on Keane and Wolpin (2001) (hereafter KW). I propose a number of important extensions of their model. First, I explicitly model the choice between 2-year and 4-year colleges as well as degree completion. College choice and degree completion are important to model since borrowing constraints can potentially alter these outcomes and changes in them have important consequences for future wages. Only years of completed schooling enter the KW model, however, and there is no notion of degree completion. Second, I incorporate a richer model of grants and loans and I use the rules of the GSL program when I model the borrowing constraints students face. This extension is important because the GSL program is the one most often altered when the government implements policies to relax borrowing constraints. Third, I explicitly look at delayed entry to college.[4] Finally, I enrich their model modeling of labor market uncertainty by including a probability of unemployment. In the KW model agents receive a random wage draw each period but always have the option to work. It is important to model employment opportunities because when an agent is unemployed the opportunity cost of schooling is lower and there can be important interactions with delayed entry. Also, future labor market uncertainty affects how much agents will choose to borrow while enrolled in college and how much precautionary savings agents accumulate.[5]

3 Model

The model presented in this section is designed to capture important features of the postsecondary education system that are necessary for understanding the relationship between borrowing constraints and educational attainment. The model allows for a rich set of choices to be made by students and incorporates multiple sources of heterogeneity in ability, family resources, and parental transfers.

The decision period begins when an individual graduates from high school. Each year consists of three decision periods: a fall, spring, and summer semester. The lengths of the fall and spring semesters are five months and the length of the summer semester is two months.

3.1 Choice Set

Each period the agent chooses a vector of variables from the choice set Θ:

$$\Theta = \{(h_t, s_t^C, s_t^U, a_{t+1}) : h_t \in \{0, .5, 1\}, s_t^C \in \{0, .5, 1\}, s_t^U \in \{0, .5, 1\}, a_{t+1} \geq \underline{a}\} \tag{1}$$

The work decision of the agent, h_t, is discretized into three possible choices: full-time ($h_t = 1$), part-time ($h_t = .5$), and not at all ($h_t = 0$). s_t^C and s_t^U indicate enrollment in 2-year colleges (community colleges)

[4]Agents are allowed to delay entry to college in the KW model, but they do not examine this phenomenon or look at how policy changes could affect delayed entry.

[5]Because I include a number of state and choice variables that KW do not include in their model I must make sacrifices along other dimensions. I only model the behavior of students after they graduate from high school, whereas KW start their decision period at age 16 and model high school completion. I also choose to exclude marriage from my model. Less than 5% of people in my sample are married by the age of 20 so marriage will likely only have a small impact on schooling decisions, which are the main focus of my paper.

and 4-year colleges (universities). The agent may choose to enroll not at all, part-time, or full-time at either college type. Transfer between college types across periods is allowed, but the agent may attend at most one college type in any given period.

As will be discussed in more detail in Section 4, a large fraction of students enroll in 2-year colleges, work while enrolled, and attend school only part-time. These are important margins along which students may adjust when faced with borrowing constraints or changes in the price of college.

The agent also chooses a_{t+1}, the amount of savings for the following period. Assets may not fall below the (potentially negative) amount $\underline{a}$. The variable $\underline{a}$ captures the borrowing constraint faced by agents, which is discussed in detail in Section 3.8.

3.2 Initial Conditions

The agent begins the first period with seven initial conditions which capture heterogeneity across agents that existed before high school graduation. When the model begins the agent is potentially receiving parental transfers, which is denoted by the indicator variable P_0. The income of the agent's parents is denoted by Inc and the agent is endowed with an initial level of assets a_0. The agent's ability is denoted by $AFQT$ in light of the ability measure commonly used in studies involving NLSY data. Permanent unobserved heterogeneity in the population is captured by the agent's *type*. The final initial conditions are the *race* of the agent and the *state* in which the agent lives.

3.3 State Space

In addition to the initial conditions, the following variables are elements of the state space. S_t^C and S_t^U measure years of schooling completed at 2-year and 4-year colleges. BA_t is an indicator variable which takes on the value one if the agent has completed a bachelor's degree. Cumulative weeks of work experience is given by H_t. Lagged choices and the current level of assets also enter the state space. The vector of state variables Ω_t is given by:

$$\Omega_t = (a_t, Inc, AFQT, type, race, state, h_{t-1}, H_t, s_{t-1}^C, S_t^C, s_{t-1}^U, S_t^U, P_t, BA_t, age_t) \tag{2}$$

3.4 Preferences

The agent receives utility each period from consumption, school enrollment, and leisure. The utility function is given by:

$$u_t = \frac{c_t^{1-\rho}}{1-\rho} + g^u(s_t^C, s_t^U, h_t; \Omega_t, \epsilon_t) \tag{3}$$

Utility is constant relative risk aversion (CRRA) in consumption with risk aversion parameter ρ. CRRA utility plays an important role in the model because it captures the consumption smoothing and precautionary savings motives facing youths.

The g functions that appear in this section are in general linear functions of their arguments with some interaction terms (the exact functional forms appear in Appendix D). The function g^u allows for psychic costs of schooling and work which depend on the current state variables. In particular, the psychic costs of college attendance are allowed to depend on ability, which is an important mechanism through which heterogeneity in initial conditions leads to different educational outcomes among youths. The agent also receives a shock to preferences for 2-year college attendance, 4-year college attendance, and the desire to work each period which are contained in the vector $\epsilon_t = (\epsilon_t^C, \epsilon_t^U, \epsilon_t^h)$. The shocks are potentially correlated with each other but independent across time.

3.5 Budget Constraint

The expenses the agent incurs equal the income the agent receives every semester. The expenses are the agent's consumption c_t, the costs of schooling κ^j_{state} at school type j (given enrollment) in the state of residence of the agent, and the amount the agent saves which is given by a_{t+1}. An agent receives income from work $w_t h_t$, parental transfers tr_t, grants received for schooling costs from the government and from other sources, and interest income on assets carried over from the previous period. The model allows for the lending interest rate to differ from the borrowing interest rate (see Section C.2 for details).

The budget constraint binds each semester and is given by the following equation:

$$c_t + \kappa^C_{state} s^C_t + \kappa^U_{state} s^U_t + a_{t+1} = w_t h_t + tr_t P_t + grant_t + (1+r)a_t \tag{4}$$

3.6 Wages and Employment Opportunities

The agent's human capital function is of the form:

$$\Psi_t = g^{\Psi}(H_t, S^C_t, S^U_t, BA_t, AFQT, type) \tag{5}$$

This function captures the fact that the productivity of an agent is increasing in experience, education, and ability. Each period the agent receives a job offer with probability p^J_t:

$$p^J(J_t = 1) = g^J(\Psi_t, h_{t-1}, race) \tag{6}$$

If the agent receives a job offer he also receives a draw from the wage distribution with variance σ^2_w. The wages of an agent depend on the agent's human capital, race, and on the agent's school enrollment and work status. This dependence is meant to capture the fact that part-time jobs or jobs held while enrolled in school may pay different wages than those paid when an agent is fully attached to the labor market. The formula that determines the wage of the agent is:[6]

$$w_t = g^w(\Psi_t, h_t, race, s^C_t, s^U_t; \sigma^2_w) \tag{7}$$

If the agent does not receive a job offer and is not enrolled in school he receives w^{MIN} in social assistance programs. w^{MIN} is modeled as a function of the experience of the agent and includes money received from Unemployment Insurance, Food Stamps, and Supplemental Security Income.

3.7 Grants

The grant function is of the form:

$$grant_t = g^{grant}(Inc, s^C_t, s^U_t, AFQT, type) \tag{8}$$

The dependencies in this function are intended to capture three important facts about grants for postsecondary education. First, grants are decreasing in parental income since programs such as the Pell Grant are need-based scholarships. Second, grants are increasing in ability due to the prevalence of merit based scholarships. Third, only students that are enrolled in school are eligible to receive grants. As will be

[6] The model is silent about why wages and employment opportunities may differ by race. One potential explanation is labor market discrimination.

discussed in more detail in Section 4.5, grants are important in helping students finance their education and there is substantial variation in the amount of grants students receive.

3.8 Borrowing Constraints

The maximum the agent is allowed to borrow each period is given by $\underline{a}$:

$$\underline{a}_t = \underline{a}_t^s + \underline{a}_t^o \tag{9}$$

Here $\underline{a}_t^s$ is the maximum the agent is allowed to borrow for school-related expenses and $\underline{a}_t^o$ is the most the agent can borrow for other expenses. $\underline{a}_t^s$ is only available to students enrolled in school and is set using the rules of the GSL program (see Appendix C.2 for details). The function for $\underline{a}_t^o$ is:

$$\underline{a}_t^o = g^{\underline{a}^o}(age_t, \Psi_t) \tag{10}$$

This dependence reflects that the amount the agent is allowed to borrow for other expenses increases with the agent's credit history which is approximated by a function of age and human capital.

3.9 Degree Completion[7]

If the agent has not completed a bachelor's degree and is currently enrolled in a 4-year college, a degree is awarded with the following probability:

$$\Pr(BA_t = 1) = g^{BA}(S_t^C, S_t^U, age_t, \Psi_t) \tag{11}$$

This function is intended to capture the fact that there is substantial uncertainty from the point of view of the agent about the completion of a bachelor's degree. Over half of students who enroll in college never complete a BA. There is also a wide range of years of 2-year and 4-year college completed before a degree is received.[8]

3.10 Parental Transfers

Parental transfers are given to the agent with the following probability:

$$\Pr(P_t = 1) = g^p(age_t, Inc, P_{t-1}, s_t^C, s_t^U, race, J_t, \Psi_t) \tag{12}$$

The amount of parental transfers is given by:

$$tr_t = g^{tr}(age_t, Inc, s_t^C, s_t^U, race, J_t, \Psi_t) \tag{13}$$

The agent takes the parental transfers function as given but his school enrollment and human capital accumulation decisions affect the transfers. Parental transfers play a very important role in the financing of a youth's college education. In the data (discussed in Section 4.3) one can see that youths receiving parental transfers at age 18 are given approximately \$9,000 per year in terms of income and room and

[7] Completion of an associate's degree is not modeled for simplicity and because there is some debate in the literature about whether associate's degrees are valued in labor market. Kane and Rouse (1995) find no effects of associate's degrees on wages for the males in their sample while Jaeger and Page (1996) find positive effects.

[8] Students in the model are allowed to continue to attend 4-year colleges after they complete a bachelor's degree, but graduate degree completion is not modeled. Only 1% of the students in my sample have received a graduate degree at the time of the most recent survey.

board while living at home. The probability of receipt and the amount of money youths receive are higher if the youth is from a higher income household and if the youth is attending school. The probably of receipt and amount are also allowed to depend on whether or not the agent has received a job offer.[9]

4 Data and Summary Statistics

In this section I will provide information on how model equivalent constructs are created from the data set and present a series of facts and summary statistics that are important for the model to account for. The data I use come from the National Longitudinal Survey of Youth 1997-2007 (NLSY97). The NLSY97 surveys 8,984 youths aged 12-16 as of December 31, 1996. The NLSY97 is divided into two subsamples, a cross-sectionally representative sample of 6,748 youths and an oversample of 2,236 minorities. The first survey was conducted in 1997 and follow-up surveys were conducted annually.

My estimation sample uses non-hispanic white, black, and hispanic males from the representative NLSY97 sample. The data I use are unweighted. I exclude women from the analysis because I do not model marriage or fertility.[10] I include only youths that completed a high school degree between the ages of 16 and 19. I exclude GED recipients, youths who never complete a high school degree, and those who serve in the military.[11] I do not analyze these youths because they are not in the same position as the other youths in my sample when it comes to making decisions about entering college. It would be very complicated to add GED completion or military service to the model. After excluding youths for whom I have missing data on initial conditions and semesters for which I have missing data on all relevant state variables I am left with a sample of 1,492 youths and 28,435 person-semester observations.

4.1 School Attendance (s_t^C,s_t^U) and Degree Completion (BA_t)

At each survey the youths respond to questions about the beginning and end dates of all part-time and full-time enrollment spells at 2-year and 4-year colleges. These data are used to construct a monthly history of part-time and full-time college enrollment. A youth is defined to be attending either a 2-year or a 4-year college during the spring semester if he reports enrollment during the months of February, March, and April. Fall semester attendance is defined to be equivalent to enrollment during the months of October, November, and December.[12] Due to the data collection methods of the NLSY97, I am not able to determine if the youth is attending college during the summer semester and so exclude summer attendance as a choice in my model.[13] Given the short length of the summer semester and the small fraction of youths that likely attended college during the summer, this omission will not miss much completed schooling.

Table 1 shows the fraction of the sample attending each college type by age and semester. From the first row of the table we can see that 53% of youths in the sample are enrolled in college during the fall

[9]Parental transfers can provide youths with an important insurance mechanism against poor labor market outcomes. Kaplan (2009) shows that youths are more likely to move back in with their parents if they become unemployed.

[10]I plan to extend the model and estimate it separately for men and women in future work.

[11]28.3% of male youths fail to graduate from high school between ages 16 and 19. Only 12.2% of these youths attend college at any point during the sample and less than 1% have a completed a bachelor's degree by the last survey. 10.6% of the youths who graduate from high school between ages 16 and 19 serve in the military at some point during the survey.

[12]If the youth reports attending different types of colleges within the same semester, the April college type is assigned for the spring semester and the October college type is assigned for the fall semester.

[13]The NLSY97 only collects data on college *enrollment* and does not ask about *attendance*. Almost all students enrolled in consecutive spring and fall semesters report that they were enrolled in the intermediate summer semester. Actual attendance rates during summer are much lower, however. KW report using NLSY79 data that less than 5% of white males attend school during the summer that they are age 18, and that number falls to 2% or below for all ages 19 and higher.

semester when they are 18 years old.[14] This fraction decreases with age although the fraction attending 4-year colleges is relatively constant from ages 18-21, as is the fraction attending 2-year colleges from ages 18-19. Six percent of youths are still attending school during the spring semester at age 26.

Table 1: College Attendence by Age and Semester (Percent of Sample)[a]

			4-Year College		2-Year College		
Age	Semester	N	Full	Part	Full	Part	No School
18	Fall	1488	36.4	1.5	12.8	2.4	47.0
	Spring	1475	37.2	1.5	12.6	2.3	46.4
19	Fall	1469	36.9	1.0	13.1	2.0	47.0
	Spring	1454	35.9	1.3	12.0	3.0	47.8
20	Fall	1444	35.9	1.3	9.1	2.6	51.0
	Spring	1430	35.5	1.4	7.6	2.7	52.8
21	Fall	1419	36.5	1.0	5.3	1.9	55.3
	Spring	1396	34.6	2.4	4.9	3.0	55.1
22	Fall	1271	23.1	2.8	3.9	2.1	68.1
	Spring	1218	18.4	3.7	2.8	2.6	72.5
23	Fall	968	13.0	2.8	1.9	2.3	80.1
	Spring	864	8.8	3.2	2.0	2.3	83.7
24	Fall	653	6.9	2.5	2.0	1.7	87.0
	Spring	570	6.1	1.4	1.1	1.8	89.6
25	Fall	397	6.0	1.5	1.3	1.5	89.7
	Spring	317	5.4	1.6	1.6	0.9	90.5
26	Fall	170	4.7	1.2	1.2	1.8	91.2
	Spring	112	1.8	3.6	0.0	0.9	93.8

[a] The rows of this table add up to 100%. Sample size varies due to missing data for respondents in some semesters, attrition, and the age structure of the NLSY97.

Part-time enrollment in school is more common at older ages. Seven percent of youths enrolled in school at age 18 enroll part time, whereas 49% of students at age 26 are enrolled part time. Youths enrolled in college part-time may be more likely to be constrained in their borrowing decisions. They may be enrolling part-time so that they do not have to pay the higher cost of enrolling full-time or so that they have more time to spend working.

Table 2 displays various summary statistics categorized by type of college and whether or not students delay entry to college. Students who enroll in both 2-year and 4-year colleges appear similar to those who enroll in only 4-year colleges along some dimensions of educational attainment. The average highest grade completed is exactly the same between these two groups. One large difference between them is the fraction of students completing a bachelor's degree. This is suggestive evidence that while transferring from a 2-year college to a 4-year college may be a less expensive path for higher education, it comes at the cost of a lower probability of bachelor's degree completion. It is also interesting to note how much uncertainty there is surrounding degree completion. Only 53.7% of students who enroll solely in 4-year colleges complete a bachelor's degree.[15]

[14] For ease of exposition and simplification of the model estimation I set all agents age to 18 when they graduate from high school. For the remainder of this paper "age" will refer to this created age. For the majority of youths the created age will only differ by a few months. For the purposes of my model the time since graduation from high school is a more relevant statistic than the actual age.

[15] The youngest respondents are aged 22 at the time of the most recent NLSL97 survey. It is likely that educational attainment will increase somewhat for the youths in my sample in future rounds.

Table 2: Selected Statistics by Type of College Attended and Delayed Entry

	Only 4-Year	Both Types	Only 2-Year	Never	No Delay	Delay
N	592	184	271	445	788	259
Parental Income and Transfers						
Ave. Parental Income[a]	102	90	72	62	98	77
Percent with Par. Trans. at 18	96.2	95.5	93.8	89.3	96.4	92.7
Ave. Par. Trans. at 18 if >0	10440	8348	7355	6863	9922	7311
Percent with Par. Trans. at 20	90.7	86.9	85.2	69.8	89.5	86.3
Ave. Par. Trans. at 20 if >0	8995	6864	6551	4667	8505	6510
College Loans and Grants						
Percent with College Loans	57.9	62.0	29.5	.	54.2	42.5
Ave. College Loans if >0	9360	8516	5726	.	9128	6746
Ave. Loans/Year if >0	2630	2456	4637	.	2608	3994
Ave. Grants/Year	2800	1711	849	.	2360	1324
College Enrollment and Completion						
Percent of Sems at 2-year	0.0	48.3	100.0	.	26.6	57.9
Enrolled Part-Time[b]	7.6	15.6	31.7	.	10.6	29.1
Completed BA	53.7	23.9	0.0	0.0	42.8	9.7
Highest Grade Completed	15.7	15.7	13.6	12.0	15.6	14.0
Ability and Race						
Ave. AFQT Score[c]	189	181	165	155	185	170
Percent Black[d]	9.5	9.2	15.1	16.2	8.6	17.8
Percent Hispanic	6.4	7.1	11.4	8.8	6.7	11.2
Labor Market Outcomes						
Ave. Hourly Wage at 18	10.7	9.4	11.4	11.8	11.0	9.6
Ave. Hourly Wage at 20	12.0	11.5	12.0	12.5	11.9	11.9
Ave. Hourly Wage at 22	13.6	15.2	13.7	15.2	14.2	13.1
Ave. Hourly Wage at 25	18.2	18.0	16.9	16.1	18.3	16.9
Work PT While Enrolled[b]	30.6	34.3	27.1	.	32.0	25.2
Work FT While Enrolled[b]	27.8	34.9	51.3	.	31.1	47.3
Unemployed Before Enrolled	6.4	7.1	7.4	.	6.2	8.7

[a] Measured in thousands of dollars
[b] Average over all semesters enrolled
[c] See Section 4.9 for details on construction of this variable. The mean AFQT score in the sample is 173.4 and the standard deviation is 30.0
[d] The distribution of race in the sample is: 79.4% white, 12.5% black, and 8.1% hispanic.

4.2 Work Status (h_t) and Unemployment (J_t)

Youth work status is determined using the weekly history contained in the NLSY97 of number of hours worked. A youth is defined to be not working if he works less than 10 hours per week on average during the semester, working part-time if he works at least 10 hours per week but less than 30 hours per week, and working full-time if he works at least 30 hours per week.

Unemployment is treated as distinct from the choice of not working in the model. In addition to weekly hours data the NLSY97 also collects a weekly history of labor force participation. I exploit the fact that questions distinguish between being employed, unemployed, and out of the labor force. In terms of model equivalents, I define semesters of unemployment to be semesters during which the youth works less than 10 hours (so he is classified as not working) and the youth reports that he was unemployed during at least one of the weeks during the semester.

Table 3 displays descriptive statistics about labor force participation. A larger fraction of 2-year college students work while attending college than 4-year college students. Two-year college students are also more likely to work full-time while attending college. As students age they are more likely to work while enrolled. Between ages 18-21 a larger fraction of youths not attending school choose not to work or to work part-time in the summer semester than in fall or spring. This likely reflects students taking on part-time jobs or choosing not to work during the summer time. The lower unemployment rate during the summer semester for ages 18-21 also is most likely caused by students being out of the labor force during the summer. The unemployment rate decreases overall as the youths become older, as does the fraction of youths not working or working part-time.

Overall Table 3 shows that a large fraction of youths work while enrolled in college and that a much larger fraction of those enrolled part-time are working while in school. It is important to model both full and part-time work while in and out of school since this is a margin that students may adjust on when faced with borrowing constraints.

4.3 Parental Transfers (P_t, tr_t) and Parental Income (Inc)

Data on receipt of and the amount of parental transfers are only available at the date of interview. The amount of parental transfers is constructed from three sections of NLSY97 questions: the amount of money parents give to the youth, the amount of money the family gives for college related expenses[16], and whether or not the youth is living at home. It is necessary to assign a monetary benefit (in terms of rent, utilities, etc.) that the youth receives while living at home. I follow Kaplan (2009) and use the 2001 American Housing Survey to construct a monetary value of living at home. The American Housing Survey documents that the median rent for households with incomes between \$15,000 and \$30,000 is approximately \$600 per month. Adding \$50 for utilities brings the estimated monetary value of living at home to \$650 per month.

Table 4 displays descriptive statistics about the amount of parental transfers in each category, and for the total parental transfers variable. The fraction of youths receiving parental transfers and the amount of parental transfers conditional upon receipt both decline with age. At the age of 18, 93.6% of youths are receiving transfers from their parents. This percentage declines to 36.3% by the age of 26. The average amount received declines from \$9,154 at age 18 to \$5,290 at age 26. The co-residence category makes up the largest fraction of total parental transfer with youths receiving an estimated \$7,800 per year if they live with their parents. The college transfers category is the next largest with most youths receiving between \$4,000 and \$5,000 while they are enrolled in college between the ages of 18 and 22.

[16]Money received from other family members is counted as part of the parental transfers.

Table 3: Work Status and College Attendance by Age and Semester (Percent of Sample)[a]

			4-Year College			2-Year College			No School			
Age	Sem	N	Full	Part	No	Full	Part	No	Full	Part	No	Unemp
18	Sum	1462	.	.	.	.	.	.	38.0	32.6	29.3	6.7
	Fall	1470	2.8	8.8	26.3	4.1	6.8	4.2	23.2	13.5	10.3	9.7
	Spring	1464	5.0	13.3	20.4	5.7	5.9	3.3	25.8	11.1	9.5	11.5
19	Sum	1463	.	.	.	.	.	.	52.4	26.3	21.3	5.9
	Fall	1453	4.8	10.3	22.8	4.9	6.5	3.6	29.5	9.6	8.0	8.2
	Spring	1441	7.0	12.8	17.6	6.5	5.1	3.4	31.4	7.8	8.4	8.8
20	Sum	1440	.	.	.	.	.	.	55.8	22.0	22.2	5.3
	Fall	1432	5.6	12.1	19.6	5.3	3.8	2.7	33.4	9.6	7.9	6.9
	Spring	1424	7.1	13.4	16.5	4.8	3.5	2.0	36.1	7.3	9.2	8.4
21	Sum	1423	.	.	.	.	.	.	57.3	21.2	21.5	4.4
	Fall	1405	7.3	13.3	17.2	3.6	2.6	1.1	37.9	9.5	7.6	5.8
	Spring	1388	9.0	12.9	15.1	4.2	2.6	1.2	39.4	7.9	7.7	8.9
22	Sum	1387	.	.	.	.	.	.	62.0	18.5	19.5	5.6
	Fall	1232	5.9	9.0	10.9	3.7	1.7	0.7	48.9	10.8	8.4	5.2
	Spring	1208	7.0	7.4	7.8	3.3	1.2	0.7	54.6	9.5	8.4	6.1
23	Sum	1210	.	.	.	.	.	.	69.8	14.0	16.2	5.0
	Fall	902	6.4	4.9	4.0	2.9	0.7	0.6	60.8	10.5	9.3	5.3
	Spring	854	5.0	4.0	3.2	2.9	0.7	0.7	65.7	9.6	8.2	4.4
24	Sum	854	.	.	.	.	.	.	75.3	12.8	11.9	4.4
	Fall	590	3.9	3.2	1.5	2.4	1.0	0.2	68.5	11.7	7.6	3.6
	Spring	564	3.4	2.5	1.6	2.0	0.5	0.4	71.5	8.2	10.1	4.6
25	Sum	564	.	.	.	.	.	.	74.8	12.4	12.8	3.4
	Fall	348	3.7	2.6	1.4	1.4	0.9	0.0	71.3	10.1	8.6	3.4
	Spring	312	2.9	2.6	1.6	1.6	0.6	0.3	72.4	8.3	9.6	4.8
26	Sum	313	.	.	.	.	.	.	78.9	9.3	11.8	3.2
	Fall	127	0.8	3.1	0.8	1.6	0.0	0.0	78.0	7.9	7.9	3.9
	Spring	106	2.8	0.9	1.9	0.9	0.0	0.0	81.1	6.6	5.7	2.8

[a] The rows of this table (excluding the Unemployment column) add up to 100%. Sample size varies due to missing data for respondents in some semesters, attrition, and the age structure of the NLSY97. "Full", "Part", and "No" indicate the work status of agents in each schooling option.

The fraction of youths receiving college transfers is higher at age 19 than at age 18. This reflects the fact that a number of youths were interviewed at age 18 in the summer before they started college and would not yet be receiving college transfers from their parents. The money from parents category makes up the smallest fraction of parental transfers. The amount of the transfer is relatively stable between $900 and $1,600 though the fraction of youths receiving money from their parents declines with age.

Parental income is constructed in each year by summing the incomes of the father and mother of the youth. The parental income variable Inc used in the model is the average of all available parental income observations. Parental income is top coded at $300,000. As is displayed in Table 2, higher parental income is associated with more favorable educational outcomes. I show in Section 9.5 that higher transfers given by parents with higher income are responsible for a large part of this correlation.

Table 4: Parental Transfer Categories[a]

		Money from Parents		College Transfers		Co-residence[b]	Total Transfers	
Age	N	%	Mean if >0	%	Mean if >0	%	%	Mean if >0
18	1447	54.0	1183	28.5	4820	85.3	93.6	9154
19	1404	49.5	1513	39.0	4508	73.9	88.4	9145
20	1350	39.3	1406	36.4	4495	64.1	83.3	8490
21	1324	36.6	1490	32.6	4087	53.0	75.8	7850
22	1191	33.2	1327	27.4	3943	45.8	70.0	7217
23	905	28.6	1383	13.6	2963	36.0	58.9	6126
24	599	24.9	1111	5.5	1928	30.1	49.1	5555
25	364	20.9	983	3.0	1335	21.4	39.8	4812
26	157	20.4	1351	1.3	459	21.0	36.3	5290

[a] In each category "%" indicates the percent of the sample receiving positive amounts of the transfer type and "Mean if >0" is the average value of the transfer if a positive amount is reported. All categories are top coded at $25,000 and represent the annual amount of transfers received.

[b] Each youth that reports living with his parents is assumed to receive a monetary benefit of $650*12months=$7,800.

4.4 Assets (a_t)

The NLSY97 collects asset data when a youth reaches the age of 18, 20, and 25. The categories I use to construct the net asset variable used in the model consist of housing and property values, automobiles, checking and saving accounts, bonds, stocks, life insurance, pension value, business wealth, student loan debt, and categories for other assets and debts.[17] To prevent the skewness of the asset distributions having a large effect on the estimated means, asset values are top coded at $30,000 and bottom coded at -$28,000.

Cumulative distributions of the asset holdings are displayed in Figure 1 and descriptive statistics are displayed in Table 5.[18] At age 18 there is already a fair amount of dispersion in the asset distribution. Fifteen percent of youths have net worths of $10,000 or more (presumably these are savings from high school jobs or money given to them by their parents) while less than 7% are in debt. At age 20, 14.8% of youths have negative net worth. By Age 25 the asset distribution is very skewed with 7.1% of youths borrowing $28,000 or more and 20.7% saving $30,000 or more. The standard deviation also increases from $7,618 at age 18 to $17,282 at age 25.

[17] I do not include spousal assets in the net asset variable because marriage is not modeled. I also do not include the household furnishing variable in my calculations. I omit it because it is a categorical variable with large bins so including it would increase the measurement error in the net asset variable. Also data on household furnishing is not collected in most surveys with asset data and is rarely used in the literature.

[18] Due to the timing of the NLSY97 surveys and the convention of assigning all agents to be 18 years old upon high school graduation some of the asset data are collected a year before or after the ages 18, 20, and 25. This data are assigned to the age category closest to the actual collection time.

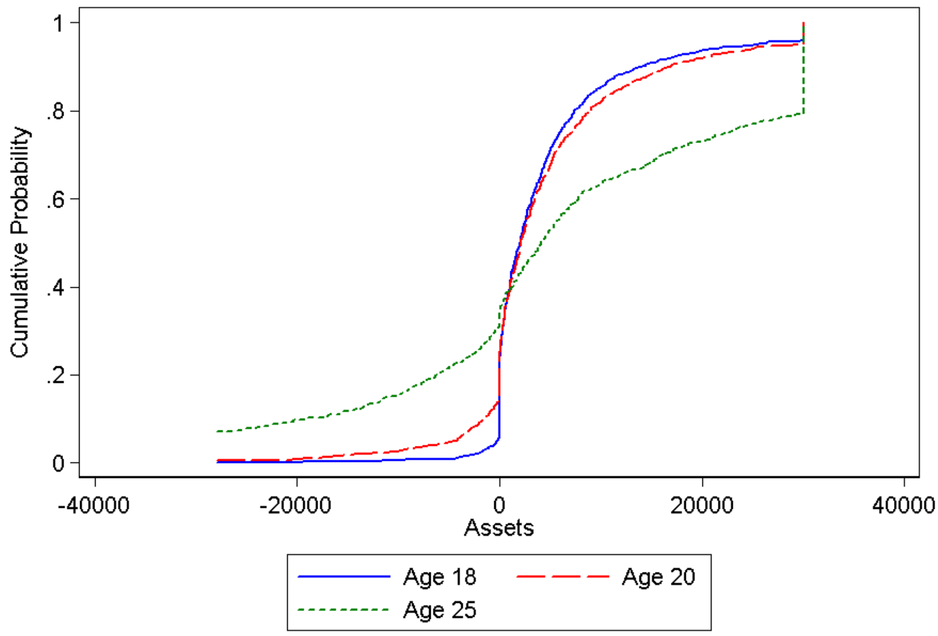

Figure 1: CDF of Net Asset Holdings by Age

Table 5: Asset Statistics by Age

Age	N	Median	Mean	Standard Deviation	Percent Negative
18	1492	2039	4658	7618	6.8
20	1422	2100	4623	9078	14.8
25	659	4145	6243	17282	32.0

4.5 College Loans and Grants ($grant_t$)

The NLSY97 collects data on grants and loans students receive to help finance their college education. The grant variable is constructed from the total grants and scholarship questions asked about each college and term attended. College loans are constructed from the questions about total government subsidized and other loans taken out during each college term.[19] While only net worth is included as a variable in the model, it is interesting to look at loans taken out specifically for college education. Summary statistics are displayed in Table 2.

Students who attend only 2 year colleges are less likely to take out loans to finance college and those who do take out fewer loans overall than students attending 4-year colleges. This is partly because students enrolled in only 2-year colleges spend less time in college and so have less time to accumulate loans. For those who take out loans, the average value of the loans per year of college is actually $2,000 higher for 2-year college students. This may indicate that borrowing constraints have more of an effect on some 2-year college students. Students who transfer between 2-year and 4-year colleges appear very similar along the loan dimension to students who attend only 4-year colleges. These students differ when it comes to grants, however. Students who attend only 4-year college are more likely to receive grants than transfer students and they receive larger grants on average. Two-year college students are least likely to receive grants and receive the smallest amounts conditional on receipt.

4.6 Wages (w_t)

Each semester wage data for the NLSY97 respondents are constructed from the hourly rate of pay variables for each job held. I use the stop and start dates for each job to generate the hourly wage for each semester during which the youth was working.[20]

Average wages by college type are displayed in Table 2. At age 18 the wages of those who never enroll in college are higher than those who enroll in the various college types. This reflects the fact that many students work at part-time jobs while enrolled in school while most youths who are not attending school are working full-time. This disparity in wage is still present at ages 20 and 22. By age 25 when most youths have completed their schooling the wages of those who attended 4-year colleges are higher than for those who attended 2-year colleges or never enrolled.

4.7 Delayed Entry

A student is designated as delaying entry to college if he at some point attends college but does not enroll during the first available semester after he graduates from high school.[21] Twenty-five percent of youths in my sample who eventually enroll in college delay by a semester or more, 16% delay by a year or more, and 8% delay by 2 or more years. Appendix B shows that, holding all else constant, delaying entry to college by one year costs a student more than $9,000 in lifetime income. It is therefore puzzling that such a large fraction of students delay entry to college.

Summary statistics for students who delay entry to college are displayed in Table 2. Students who delay come from lower income households, are more likely to be black or hispanic, are less likely to receive parental transfers, and receive less money from their parents conditional on receipt. Students

[19]The NLSY97 also collects data on total loans received from family members to help pay for college. These loans are not included in the summary statistics since it is not clear if or when they would need to be payed back and if interest is paid to the family members.

[20]If more than one job was held during a given semester, the wages are averaged across jobs. Wages are top coded at $200 per hour and bottom coded at $3 per hour.

[21]Almost all of the youths in my sample graduate from high school during the spring. The first available semester for these youths is the fall semester after the model begins.

that delay entry to college are less likely to receive grants and receive less money conditional on receipt. This is because a much higher fraction of those who delay enroll in 2-year colleges and also because they are of lower ability and therefore likely earn fewer merit based scholarships. Students that delay are less likely to receive loans for college, but take out more loans per year conditional upon receipt. Those who delay are also more likely to enroll part time and work while enrolled in school. These patterns are consistent with the conjecture that many students who delay entry to college are doing so because they are constrained in their borrowing decisions.

Another factor that could contribute to delayed entry to college are changes in the opportunity cost of enrollment. The last row of the Table 2 shows the unemployment rate of each group averaged over the semester of first enrollment and semester prior to first enrollment. The unemployment rate for all 18-20 year olds in the sample is 7.9%. The higher rate of unemployment for those who delay entry to college is suggestive evidence that some youths enroll in college when the opportunity cost of enrollment is low due to lack of a job offer.

4.8 Labor Market Opportunities in Adult Life

In order to solve the model presented in this paper I need to make assumptions about agents' expectations of future labor market outcomes. The approach commonly used in the literature is to use actual data on future labor market outcomes and assume rational expectations on the part of the agents. Since the respondents to the NLSY97 are only between ages 22 and 27 during the last interview, I have very little data on labor market outcomes after the age of 25. I therefore assume that to form expectations about future labor market outcomes the NLSY97 respondents look to the experiences of older people currently in the labor force with similar characteristics to their own.[22] A natural source for such data is the NLSY79. I use moments from the NLSY79 data for respondents aged 25 and older to help identify the parameters of the wage and unemployment probability equations. I use the same sample selection criteria for the NLSY79 data as is done for the NLSY97 data. I additionally exclude observations where a respondent is below the age of 25 or that take place before the year 1990. I exclude the 1980s to avoid potential bias in the parameter estimates induced by the increasing college wage premium.[23] See Appendix A for details about the use of the NLSY79 data.

4.9 Ability ($AFQT$)

Ability is measured by the AFQT score. This is an important measure in the model both for documenting the effects of observed ability on college attendance and for controlling for ability in the wage equation evaluated on NLSY79 data and used as future labor market expectations. This section provides details about the construction of the AFQT variable that is comparable across the NLSY79 and NLSY97 surveys.

The Armed Services Vocational Aptitude Battery (ASVAB) was administered to NSLY79 and NLSY97 respondents. The AFQT score used in this paper is the created from the scores on 4 sections of the ASVAB. The AFQT score is equal to the sum of scores on Arithmetic Reasoning, Word Knowledge, Paragraph Comprehension, and half of the score from Numerical Operations. The AFQT scores are not directly comparable across the NLSY79 and NLSY97 because the NLSY97 respondents took a different version of the ASVAB. The NLSY97 respondents took the ASVAB through a computer administered test (CAT) whereas the NLSY79 respondents took a pencil and paper (P&P) version of the test. In addition the respondents took the test at different ages in the two surveys. I follow the methods used in

[22] Dominitz and Manski (1996) show that college students are able to accurately estimate the median of the earnings distribution for college graduates.

[23] After 1990 the college wage premium leveled off; see Fortin (2006) for documentation of the trend in the wage premium.

Altonji et al. (2008) to make the AFQT scores comparable across the surveys. They use a mapping from the P&P version to the CAT version of the test created in Segall (1997) to make the raw AFQT scores equivalent. The scores are then age adjusted using an equipercintile procedure. First each respondent is assigned a percentile score within their age. Then the mapping between age 16 percentiles and age 16 scores are used to translate percentiles into scores for all other ages (age 16 is the age of greatest overlap of the number of tests taken in the NLSY79 and NLSY97).[24]

Average AFQT score by college type is displayed in Table 2. Students with higher AFQT scores tend to enroll in 4-year colleges more than 2-year colleges, suggesting that students with higher AFQT scores get a higher return from 4-year colleges or that the psychic costs of 4-year college attendance are lower for these students.

4.10 Race

Summary statistics about ability, parental transfers, and schooling by race are displayed in Table 6. Blacks and hispanics have lower AFQT scores than whites. Blacks and hispanics on average come from households with lower parental incomes, but are equally likely to be receiving parental transfers at age 18. They receive approximately $1,000 less per year in parental transfers, however. Blacks are less likely to enroll in college than whites and hispanics. Blacks and hispanics are more likely to spend time in 2-year colleges and enroll only part time. They complete fewer years of schooling on average and are much less likely to complete a bachelor's degree.

Table 6: Selected Statistics by Race

	White	Black	Hispanic
N	1185	186	121
Ave. AFQT Score	178	152	164
Ave. Parental Income[a]	90	51	68
Percent with Par. Trans. at 18	93.8	92.8	94.1
Ave. Par. Trans. at 18 if >0	8795	7731	7716
Percent Enrolling in College	71.8	61.3	67.8
Percent of Sems at 2-year	32.1	43.5	44.9
Enrolled Part-Time[b]	13.7	22.3	20.6
Completed BA	27.4	11.3	13.2
Highest Grade Completed	14.4	13.6	13.8

[a] Measured in thousands of dollars
[b] Average over all semesters enrolled

5 Solution Method

The model is solved numerically through backward recursion on a Bellman equation by assuming a terminal value function when the agent reaches age 40. It is computationally infeasible to allow for a continuous savings choice in the model, so I allow the agents to choose from a number of discrete grid points on the interval $[\underline{a}, \overline{a}]$. The agents therefore chooses a vector θ_t from the set given by Equation (1) each period to solve the following maximization problem:

$$V_t(\Omega_t) = \max_{\theta_t \in \Theta_t} u_t(\theta_t|\Omega_t) + \delta E(V_{t+1}(\Omega_{t+1})|\theta_t, \Omega_t) \tag{14}$$

[24]See http://www.econ.yale.edu/˜fl88/ for the data and methods used in Altonji et al. (2008)

The expectations operator E in Equation (14) is taken with respect to the distribution of preference shocks ϵ_t and the wage draw as well as the unemployment probability. This quantity is referred to in the literature as "Emax" and represents the future value that is expected to be attained given that the agent will make the optimal choice in each of the future periods.

The state space in my model is too large to evaluate the Emax functions at every possible point. I therefore follow the method used in KW and evaluate the Emax values at a subset of the points in the state space each period. I then approximate the Emax functions as polynomial functions of the state variables. The integrals needed to evaluate the Emax functions are approximated through Monte Carlo integration. See Appendix C.1 for further details on the Emax approximations and Monte Carlo integration.

6 Estimation

The likelihood function for this model is very complex due to the size of the model. In addition there are a number of missing state variables because of the timing of collection of data on parental transfers and assets. Estimation via maximum likelihood is therefore infeasible because it would require that I integrate out the distribution of the unobserved state variables. I use Indirect Inference to estimate the model (see Smith (1993) and Gouriéroux et al. (1993)).[25]

The idea behind Indirect Inference is to specify a set of easy to estimate auxiliary models that are to be evaluated at both the actual and simulated data. The estimation algorithm searches over structural parameters so that the estimated parameters of the auxiliary model evaluated on the actual and simulated data are as close as possible. This is achieved by minimizing the weighted sum of squared scores of the auxiliary models evaluated at the simulated data. More formally, let η be the vector of structural parameters and L be the likelihood functions of the auxiliary models with parameters β. The estimator $\hat{\eta}$ solves the equation:

$$\hat{\eta} = \arg\min_{\eta} \frac{\delta L}{\delta \beta}(y(\eta); \hat{\beta}) \Lambda \frac{\delta L}{\delta \beta}(y(\eta); \hat{\beta})' \tag{15}$$

$y(\eta)$ is the simulated data, $\hat{\beta}$ is the maximum likelihood estimate of β obtained using the actual data, and Λ is a weighting matrix. By construction $\frac{\delta L}{\delta \beta}$ evaluated at the actual data will be zero. Therefore the structural parameters η are chosen so that right-hand side of Equation (15) is as close to zero as possible. $\hat{\eta}$ is consistent and asymptotically normally distributed when the number of simulated and actual observations are proportional and the number of actual observations goes to infinity (see Gouriéroux and Monfort (1996) for a proof of this claim). See Appendix C.4 for details about the weighting matrix Λ.

The auxiliary models I use consist of a series of linear regressions and moments designed to provide a complete enough statistical description of the data to identify the structural parameters.[26] I present some of the auxiliary models below to give examples of the equations used and which parameters they help identify:

- A regression of log wage on years of schooling at each college type, BA degree completion, experience, experience squared, AFQT, race, part-time work, and school attendance helps to identify the parameters of the wage equation.

[25] There have been a number of recent studies which use Indirect Inference. For other implementations see Altonji et al. (2009), Guvenen and Smith (2009), van der Klaauw and Wolpin (2008), Nagypál (2007), and Tartari (2007).

[26] See Section 7 for a further discussion of identification.

- A regression of unemployment on experience, experience squared, AFQT, race, and not working in the previous semester helps identify the parameters of the job offer function.

- A regression of BA degree completion on years of 2-year college completed, years of 4-year college completed, and AFQT tercile helps identify the parameters of the degree completion function.

- Regressions of an indicator for enrollment in each college type on AFQT tercile help identify the parameters of the utility function pertaining to the psychic costs of schooling.

See Appendix C.4 for a full list of the auxiliary models.

7 Identification

It is not possible to provide a rigorous proof of identification for the parameters of the model. I am able to provide intuitive arguments regarding how the parameters are identified and also to run simple simulations to support the intuitive arguments and show identification for some of the parameters that are more difficult to visualize.

In general the g functions in Section 3 relate observable variables to observable outcomes. The NLSY97 provides data on all the outcomes to be estimated, so the identification comes from the functional form I assume for the g functions and the auxiliary models I specify for the Indirect Inference estimation method. The g functions are in general linear functions of their arguments, and the auxiliary models are linear regressions which closely approximate the g functions, so the g parameters are identified by the estimation algorithm which attempts to make the simulated data as close as possible to the actual data in terms of the parameters of the auxiliary models.

The utility function, however, is unobserved to the econometrician so it is impossible to supply auxiliary models which approximate the utility function itself. But the outcome of the utility function is a set of choices of asset accumulation, school enrollment, and work each period. Therefore specification of auxiliary models that relate the choices of agents to the arguments of the utility function identify the parameters of g^u.

The *type* distribution and coefficients on the *type* variables in the g functions are identified by examining the choices of agents each period.[27] The idea is to allow for agents to differ in permanent ways unobserved to the econometrician and estimate the distribution of types to fit the persistence of various choices and outcomes of the agents. When two agents that are equivalent in their observable characteristics persistently make different choices, this indicates that they are likely to differ in unobservable characteristics. Of course if the number of types were allowed to approach the number of observations and allowed to vary over time then the data could be fit perfectly. (This is similar to a linear regression with n observations and n parameters fitting the data perfectly). Discipline is imposed by fixing a small number of types and requiring the unobserved heterogeneity to be permanent.

The remaining parameter for which identification may be difficult to visualize is $\underline{a}_t^o$, the lower bound of assets for non-school related expenses. It is important to show identification for this parameter, since the main focus of this paper is determining the extent to which borrowing constraints bind. I provide some simulation evidence on the identification of $\underline{a}_t^o$ and then discuss what is driving identification.

To isolate the factors identifying $\underline{a}_t^o$ in the simulation, I simplify the model drastically by making the following assumptions: There is no schooling and no psychic costs of working so all agents enter the labor market at age 18 and work full-time. All agents start with 0 assets and the interest rate is

[27] See Heckman and Singer (1984) for a proof of identification of unobserved heterogeneity related to duration models.

set to 0%. I assume a constant probability of unemployment of 5% each semester. There is no wage wage growth; earnings are constant at $10,000 per semester except during semesters when the agent is unemployed when earnings drops to $1,000.[28] Agents in this model save for purely precautionary reasons, desiring to smooth consumption between employed and unemployed states. I examine how average asset accumulation at age 25 varies with $\underline{a}_t^o$. The results are displayed in Figure 2.

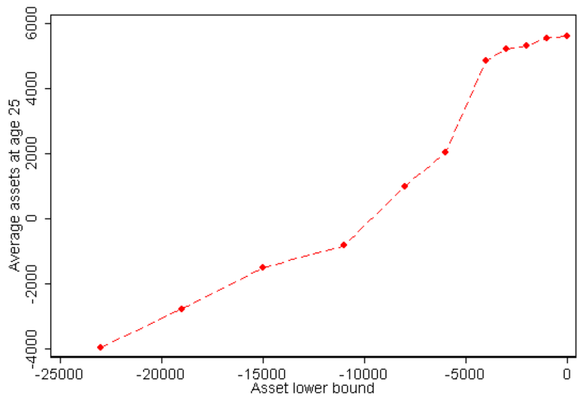

Figure 2: Average Asset Holdings by Borrowing Limit

As $\underline{a}_t^o$ increases from -$23,000 to 0 the average asset accumulation at age 25 in the simulated population increases from -$4,000 to $6,000. $\underline{a}_t^o$ is therefore identified by the assumption of CRRA utility with a precautionary savings motive (positive third derivative) and the asset accumulation patterns of youths in the data.

8 Parameter Estimates and Model Fit

The parameter estimates and standard errors are reported in Table 20 in Appendix E.2. Overall the parameter estimates are reasonable. The model allows for three types of agents which can be thought of as high ability (type 1), average ability (type 2), and low ability (type 3). The probability that an agent is of a more able type is increasing in $AFQT$ and parental income. The estimated distribution of types in the population is: 18% type 1, 35% type 2, and 47% type 3.

Psychic costs of schooling are lowest for high ability agents. The costs are higher for 4-year college attendees, older students, and those who work while enrolled. Psychic costs of schooling are lower for blacks and hispanics at 2-year colleges and higher for hispanics at 4-year colleges. Wages increase with each year of completed schooling and the highest returns come from completion of a bachelor's degree. A student who completes four years of school at a 4-year college and earns a bachelor's degree has wages that are 29% higher at younger ages than an otherwise equivalent high school graduate. Wages are lower for blacks than for whites and hispanics.

The probability of receiving a job offer is increasing in the human capital of the agent but is much lower if the agent is not working in the previous semester. Blacks and hispanics are on average less likely to receive a job offer than whites.

Grants are increasing in ability and decreasing in family income at 4-year colleges. The lower bound on assets for other expenses, $\underline{a}_t^o$, is larger (more negative) as human capital and age increase.[29] Parental

[28]Here and in the remainder of the paper the dollar amount of income does not decrease during the summer semester. The shorter length of the summer is accounted for by adjusting the discount factor in the utility function.

[29]See Table 18 in Section C.2 for estimates of $\underline{a}_t^o$ categorized by age and ability.

transfers increase with family income and are higher for youths attending college. There is substantial persistence in the receipt of parental transfers although the probability of receipt declines with age.

For each person in my sample the simulated data consist of 5 agents that have initial conditions that are exactly the same as those of the actual person. Simulated data are generated for these agents from age 18 to age 40. Overall the model fits the patterns of educational attainment very well. The simulated data and actual data on 4-year college enrollment, 2-year college enrollment, and degree completion are contrasted in Figures 3, 4, and 5. The model fits 4-year college enrollment better than 2-year college enrollment, mainly because a smaller fraction of the population is enrolled in 2-year colleges and there is less persistence in 2-year college enrollment. The pattern of decreasing enrollment with age is matched for both college types. The simulated data matches the fraction of the population completing a bachelor's degree quite closely. Full-time and part-time enrollment at 4-year and 2-year colleges are displayed in Figures 6 and 7. The model fits the broad patterns of part-time and full-time enrollment well.

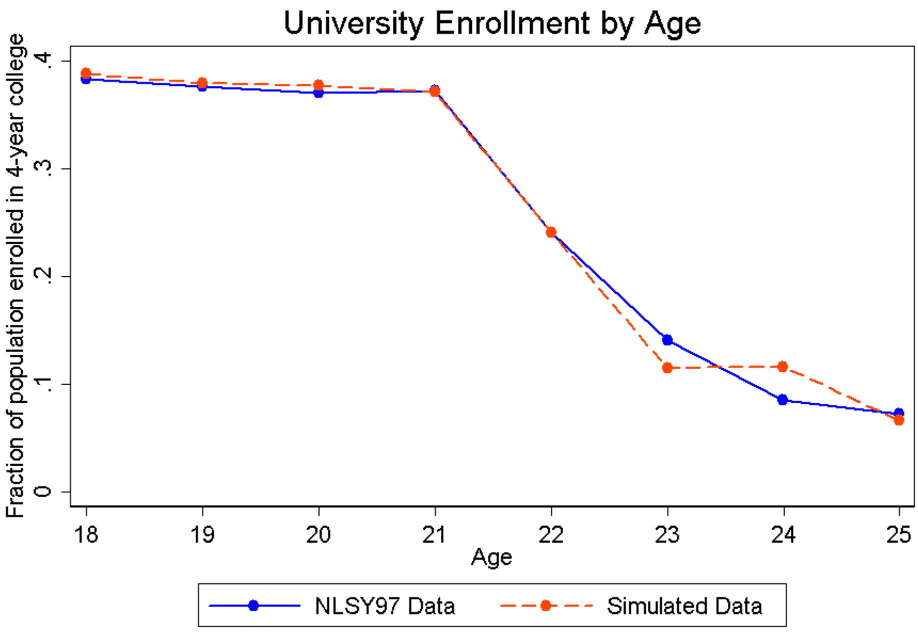

Figure 3: University Enrollment by Age

Table 7 shows the percent of students delaying entry to college by number of years of delay along with the percent of students never enrolling in college. The model slightly over predicts the fraction of students delaying entry to college by a semester or more. The fraction of students delaying declines at a similar rate with years of delay in the simulated data as in the actual data.

Table 7: Percentage of students delaying entry to college

Years after HS graduation	0	.5+	1+	2+	3+	Never
Data	75.3%	24.7%	16.3%	7.9%	5.0%	29.8%
Simulation	70.4%	29.6%	14.7%	11.4%	5.7%	30.6%

The model matches the labor market outcomes of the sample youths. Graphs of the wage and unemployment rates of the youths by age are displayed in Figures 8 and 9. The model slightly under predicts the wages of youths between ages 18 and 25. This is due to the fact that the model needs to fit wage data from both the NLSY97 and the NLSY79; the model slightly over predicts wages at ages higher

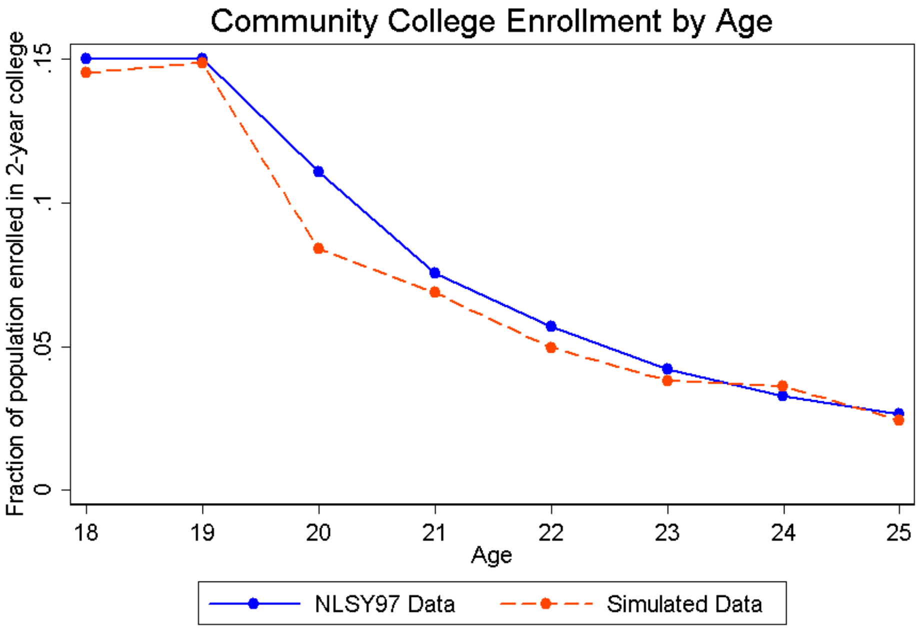

Figure 4: Community College Enrollment by Age

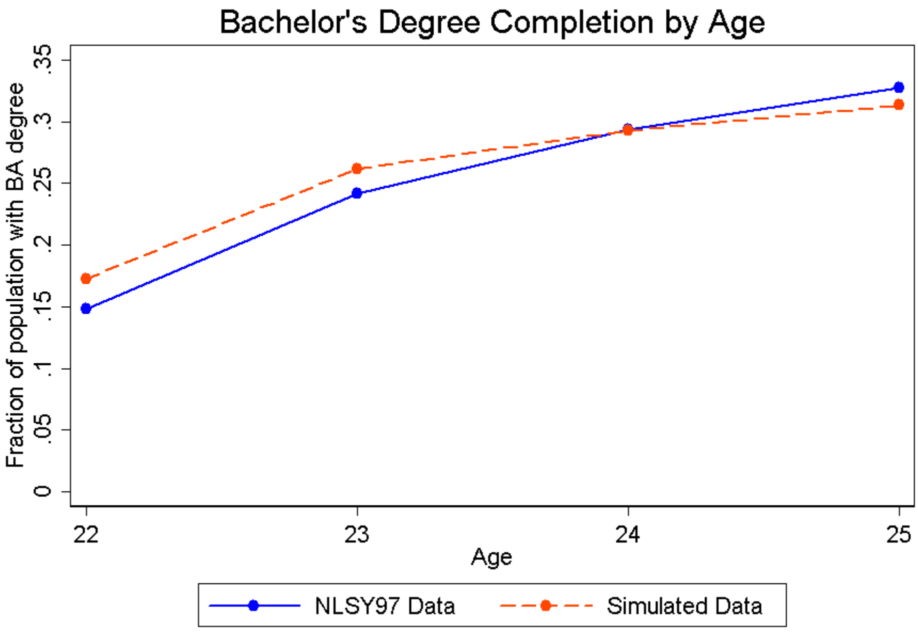

Figure 5: Bachelor's Degree Completion by Age

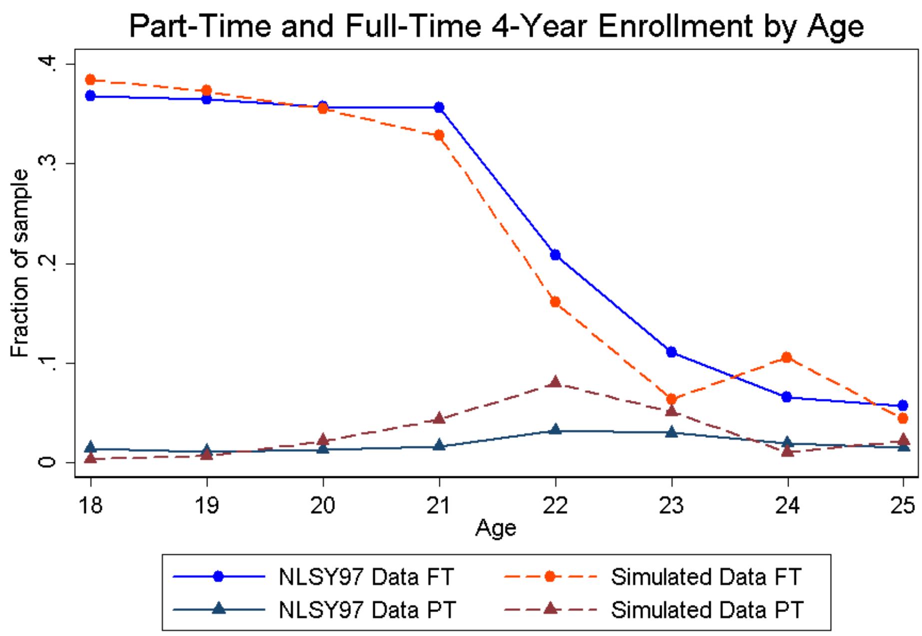

Figure 6: Part-Time and Full-Time 4-Year Enrollment by Age

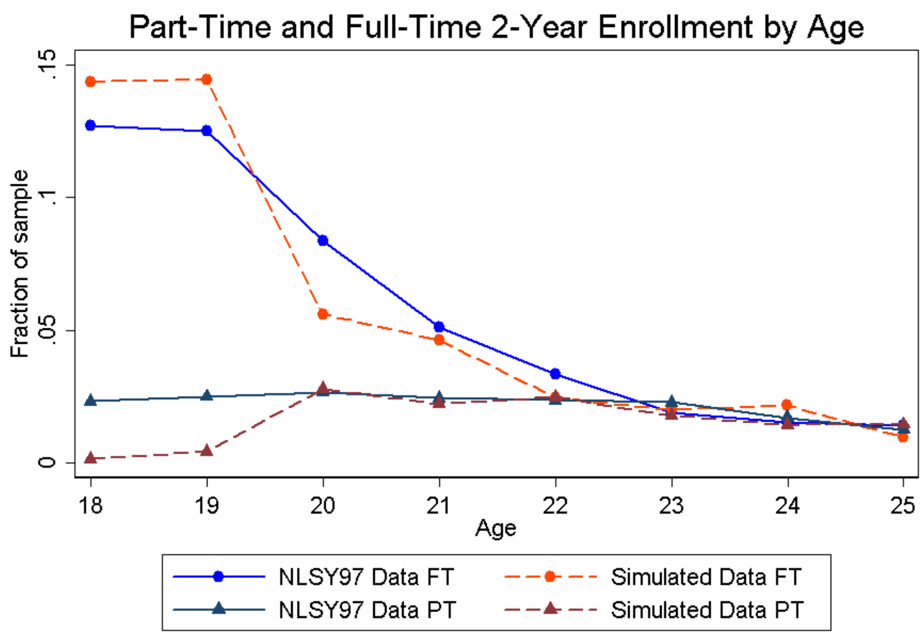

Figure 7: Part-Time and Full-Time 2-Year Enrollment by Age

than 25 as compared to the data from the NLSY79. The unemployment rate declines with age but not as quickly at younger ages in the simulated data. The fraction of the population working full-time and part-time by age is displayed in Figure 10. The model fits these patterns, although it over-estimates full-time work at ages 18 and 19.

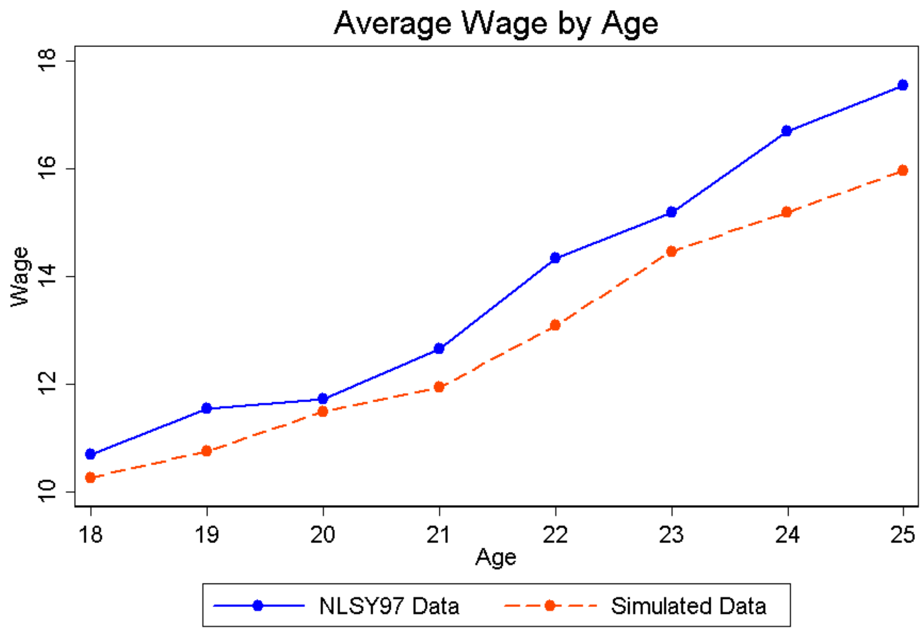

Figure 8: Average Wage by Age

The fraction of the population receiving parental transfers is displayed in Figure 11 and the average amount received is displayed in Figure 12. The parental transfers received by the simulated agents are quite close to those received by the actual agents. Actual and simulated asset cumulative distribution functions at ages 20 and 25 are displayed in Figures 13 and 14.[30] Additional statistics from the actual and simulated asset distribution are displayed in Table 8. The simulated data matches the mean and median asset holdings and the fraction of the population with negative net worth well. The model has difficulty matching the skewness of the asset distribution, however, particularly at age 25.

Table 8: Asset Statistics by Age

Age	Data	Median	Mean	Standard Deviation	Percent Negative
20	Actual	2100	4623	9078	14.8
20	Simulated	3000	5895	7773	19.7
25	Actual	4145	6243	17282	32.0
25	Simulated	3000	5706	9846	31.4

The previous dimensions of model fit discussed are all moments that are explicitly targeted by the auxiliary models. The model also fits well along other dimensions. Table 9 shows how well the model fits the various statistics reported in Table 2 broken down by type of college attended and delay status. The model fits the patterns of the data: parental income and transfers, college grants, college enrollment and completion, ability, and labor market outcomes tend to decrease as college quality decreases and with delayed entry to college.

[30]The cdf of the simulated assets jumps discretely at each asset grid point.

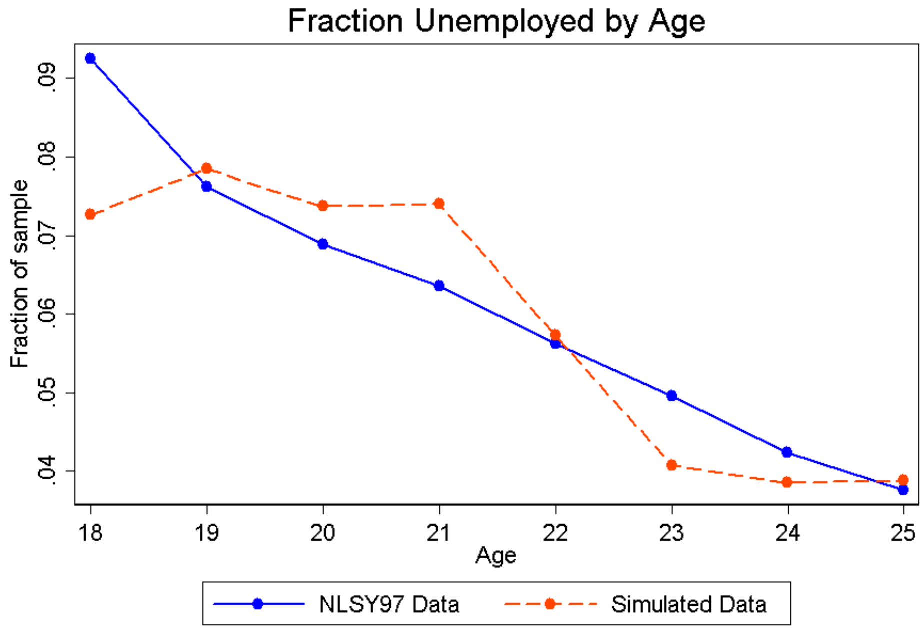

Figure 9: Fraction Unemployed by Age

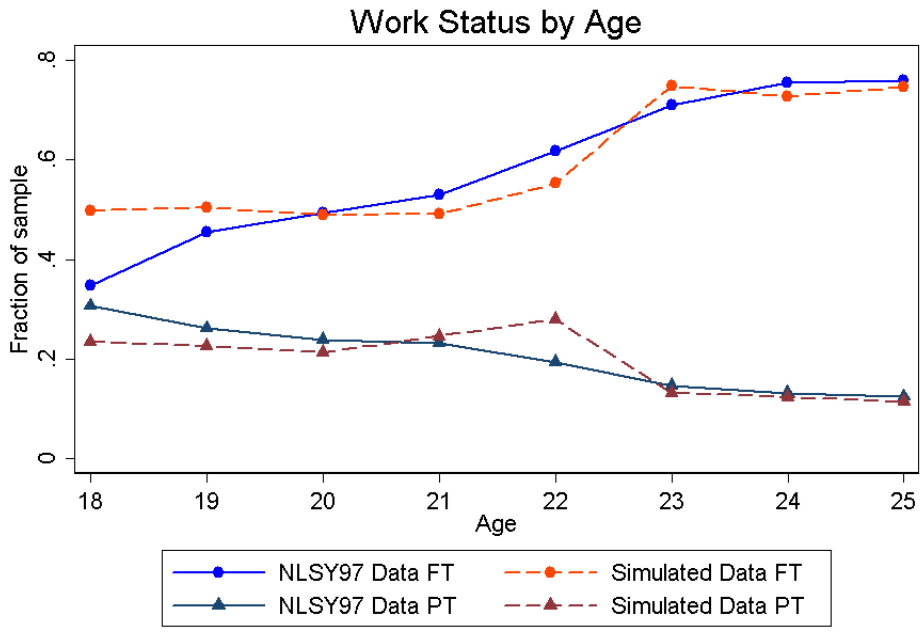

Figure 10: Work Status by Age

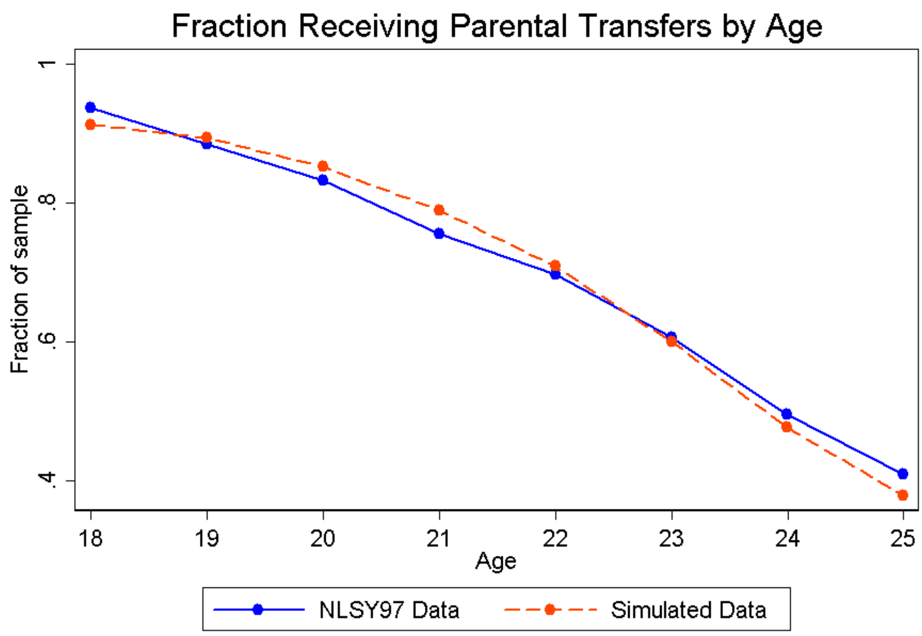

Figure 11: Fraction Receiving Parental Transfers by Age

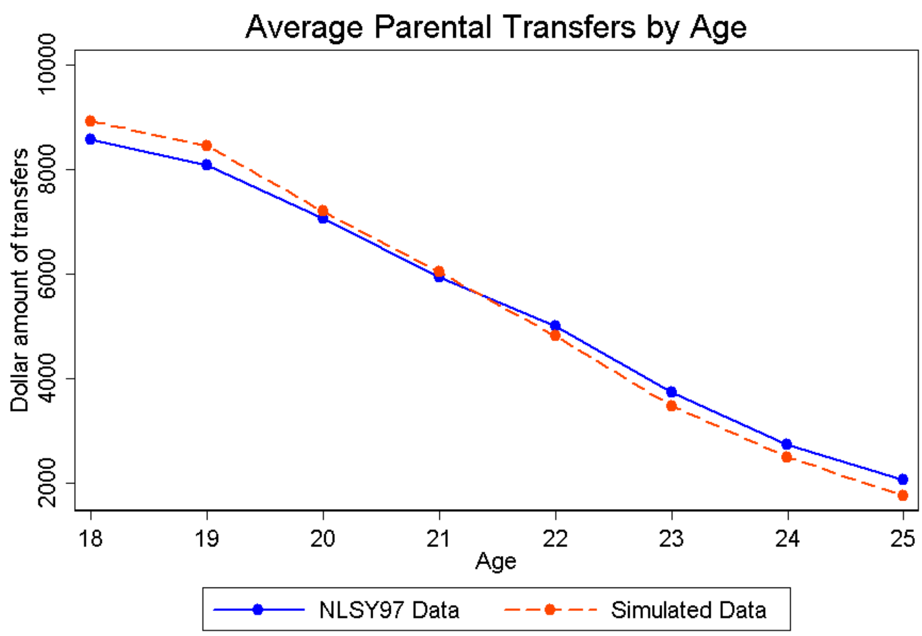

Figure 12: Average Parental Transfers by Age

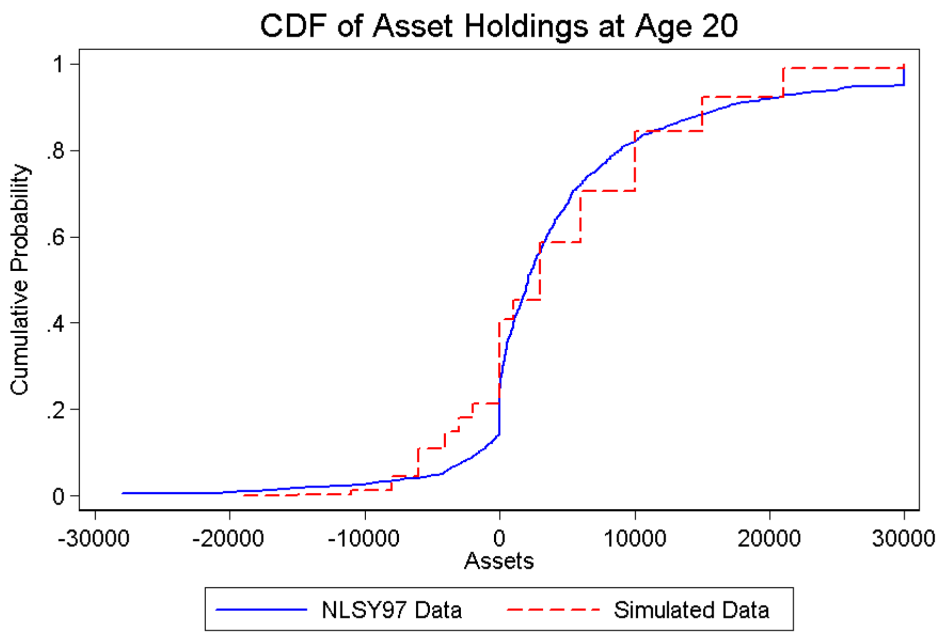

Figure 13: CDF of Asset Holdings at Age 20[30]

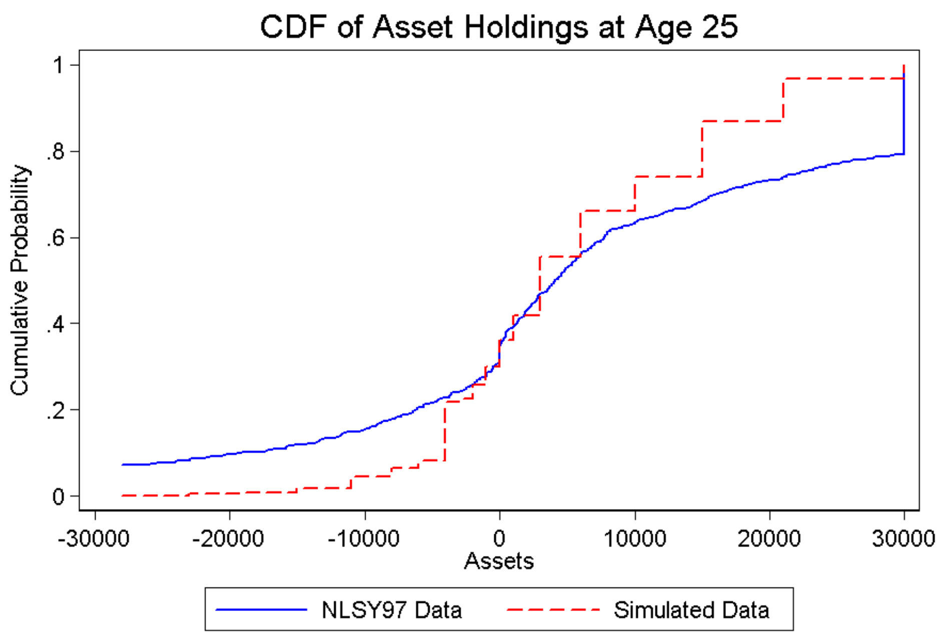

Figure 14: CDF of Asset Holdings at Age 25

Table 9: Selected Statistics by Type of College Attended and Delayed Entry[a]

		4-Year	Both	2-Year	Nvr	No Del	Del
N	D	592	184	271	445	788	259
	S	2891	840	1448	2281	3645	1534
Parental Income and Transfers							
Ave. Parental Income[b]	D	102	90	72	62	98	77
	S	105	85	72	61	99	79
Percent with Par. Trans. at 18	D	96.2	95.5	93.8	89.3	96.4	92.7
	S	95.5	93.3	90.4	87.3	95.2	90.2
Ave. Par. Trans. at 18 if >0	D	10440	8348	7355	6863	9922	7311
	S	8516	6993	5498	5020	8176	5641
Percent with Par. Trans. at 20	D	90.7	86.9	85.2	69.8	89.5	86.3
	S	92.6	90.8	86.0	73.3	92.0	86.7
Ave. Par. Trans. at 20 if >0	D	8995	6864	6551	4667	8505	6510
	S	9937	7714	5641	4505	9236	6332
College Grants							
Ave. Grants/Year	D	2800	1711	849	.	2360	1324
	S	2350	1566	756	.	1958	1360
College Enrollment and Completion							
Percent of Sems at 2-year	D	0.0	48.3	100.0	.	26.6	57.9
	S	0.0	42.9	100.0	.	23.0	63.2
Enrolled Part-Time[c]	D	7.6	15.6	31.7	.	10.6	29.1
	S	9.3	19.1	12.1	.	12.2	10.6
Completed BA	D	53.7	23.9	0.0	0.0	42.8	9.7
	S	73.0	28.7	0.0	0.0	61.0	8.1
Highest Grade Completed	D	15.7	15.7	13.6	12.0	15.6	14.0
	S	16.3	15.9	13.7	12.0	16.3	13.6
Ability and Race							
Ave. AFQT Score	D	189	181	165	155	185	170
	S	190	177	160	159	184	168
Percent Black	D	9.5	9.2	15.1	16.2	8.6	17.8
	S	7.8	11.5	16.1	16.4	9.9	12.7
Percent Hispanic	D	6.4	7.1	11.4	8.8	6.7	11.2
	S	1.7	6.7	21.3	8.5	6.1	12.4
Labor Market Outcomes							
Ave. Hourly Wage at 18	D	10.7	9.4	11.4	11.8	11.0	9.6
	S	9.3	9.6	9.6	10.2	9.1	10.4
Ave. Hourly Wage at 20	D	12.0	11.5	12.0	12.5	11.9	11.9
	S	10.3	11.0	11.3	11.2	10.6	11.0
Ave. Hourly Wage at 22	D	13.6	15.2	13.7	15.2	14.2	13.1
	S	13.3	12.9	12.6	12.0	13.3	12.4
Ave. Hourly Wage at 25	D	18.2	18.0	16.9	16.1	18.3	16.9
	S	18.1	16.2	14.2	13.1	17.7	14.3
Work PT While Enrolled[b]	D	30.6	34.3	27.1	.	32.0	25.2
	S	24.6	21.0	19.6	.	25.1	16.6
Work FT While Enrolled[b]	D	27.8	34.9	51.3	.	31.1	47.3
	S	39.5	44.9	38.1	.	42.2	34.7
Unemployed Before Enrolled	D	6.4	7.1	7.4	.	6.2	8.7
	S	7.0	5.8	5.1	.	6.8	5.0

[a] "D" represents the statistics from the actual data and "S" denotes the simulated data.
[b] Measured in thousands of dollars
[c] Average over all semesters enrolled

9 Results of Policy Experiments

I first evaluate the effects of borrowing constraints by simulating increases in the loan limits of the GSL program. I compare the changes in educational outcomes to those produced by increasing tuition subsidies. I then determine which policy is most cost effective at promoting higher education by simulating tuition subsidies targeted toward different groups of students. I also examine the effect of relaxing borrowing constraints and increasing tuition subsidies on the fraction of students delaying entry to college. I then evaluate the different determinants of the change in degree completion patterns between the NLSY79 and NLSY97 cohorts. Finally, I discuss the relationship between parental income and educational outcomes and show that a large portion of the correlation is due to the transfers parents give their children.

9.1 Borrowing Constraints and Tuition Subsidies

How much do borrowing constraints matter? How effective is relaxing borrowing constraints at increasing educational attainment relative to tuition subsidies? I explore these questions by considering a \$1,500 decrease in the cost of tuition at 2-year and 4-year colleges and a \$1,500 increase in the maximum students are allowed to borrow each year from the GSL program. I also increase the cumulative maximum students are allowed to borrow through the GSL program from \$23,000 to \$28,000. The results are displayed in Figures 15, 16, and 17. The relaxation of borrowing constraints causes a very small increase in 4-year college enrollment which is mainly due to a small substitution between 2-year and 4-year colleges. The increase in loan limits causes an increase in bachelor's degree completion by age 25 of 0.7 percentage points.

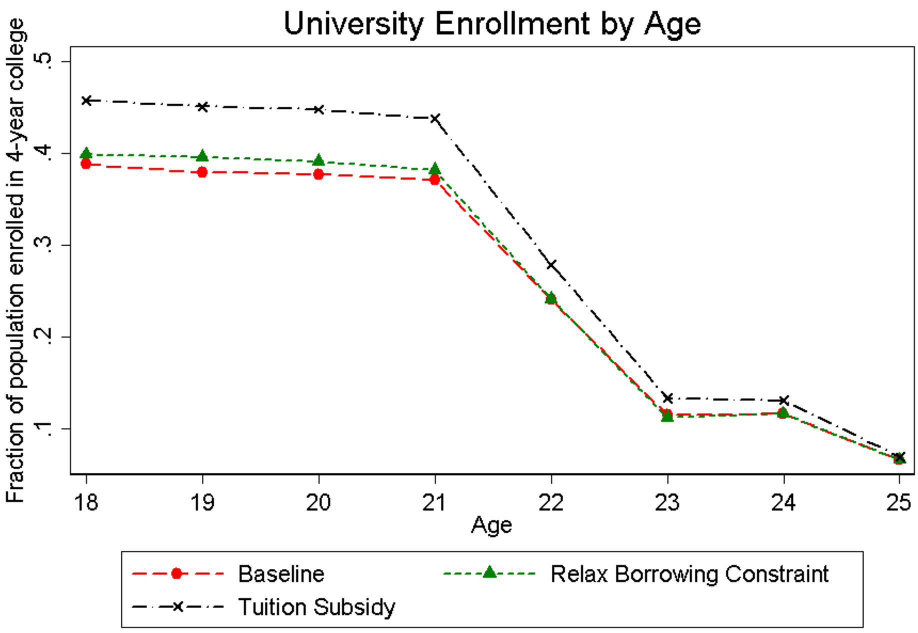

Figure 15: University Enrollment by Age

A tuition subsidy equal in dollar terms to the loan limit increase is much more effective at increasing enrollment and degree completion. The tuition subsidy causes a large increase in enrollment at 4-year colleges and a small decrease in enrollment at 2-year colleges. Overall college enrollment increases on

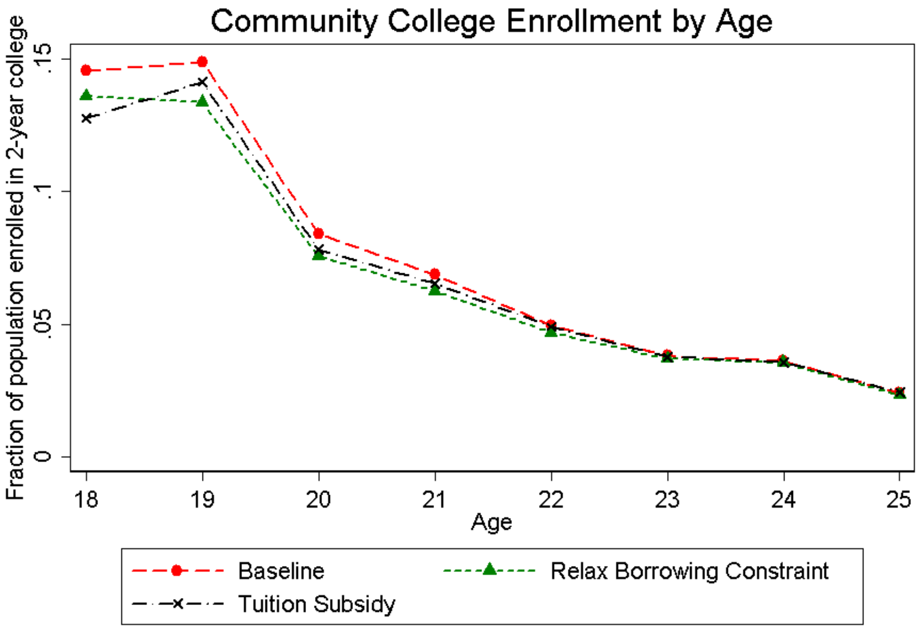

Figure 16: Community College Enrollment by Age

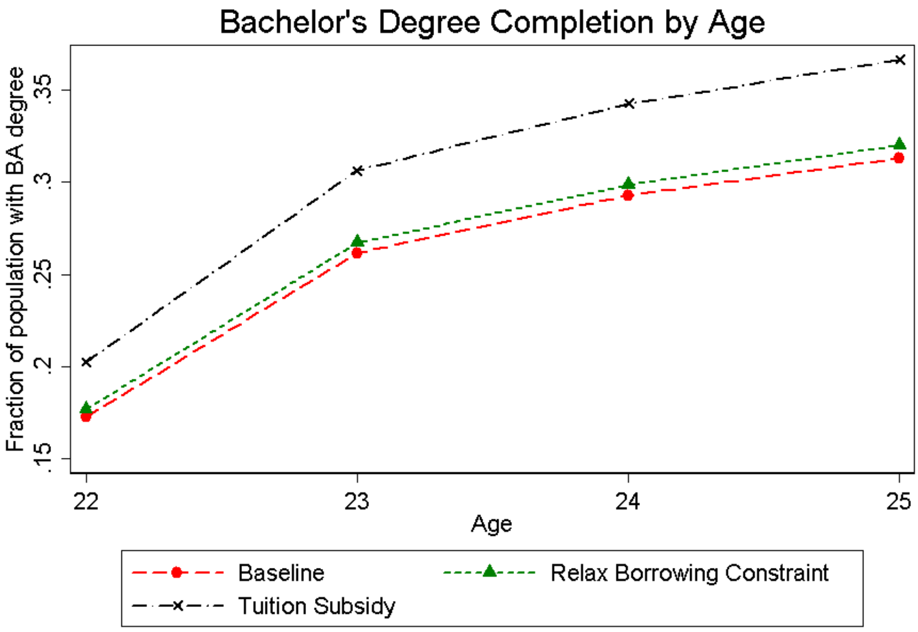

Figure 17: Bachelor's Degree Completion by Age

average 6.1 percentage points for ages 18-21 in response to a $1,500 decrease in tuition at both college types. This estimate is in line with estimates in other papers of the effect of changes in the cost of college on enrollment. Kane (2006) surveys the literature on the effects of tuition changes on enrollment and shows that on average studies find that a change of $1,000 in 1990 dollars (this is equivalent to $1,445 in 2004 dollars) is associated with a change in enrollment of 5 percentage points. Under the tuition subsidy bachelor's degree completion increases by 5.6 percentage points.

Why is a dollar of tuition subsidies more effective at increasing enrollment and degree completion than a dollar of increased loan limits? In part this is because students do not have to repay tuition subsidies. If a youth is currently choosing not to attend school but is close to the margin when he weighs the return to education against the opportunity cost and psychic costs of schooling, then allowing him to borrow more money is unlikely to change his decision and cause him to attend school. Giving him $1,500 each year he attends school is much more likely to influence his decision. The only cases in which relaxing borrowing constraints would change a youth's decision is when he is unable to smooth consumption because he can not borrow enough during school and therefore chooses to work instead. Even though borrowing constraints are tight,[31] the uncertainty surrounding future labor market outcomes causes youths to borrow much less than if they were simply smoothing consumption. Few youths, therefore, are affected by the increase in loan limits.

It is important to note that increases in loan limits in the GSL program are much less expensive for the government to implement than tuition subsidies. Ignoring administrative costs to the government the costs of the student loan program are the amount of interest the government pays on subsidized loans while students are enrolled in school and the amount that the government must pay to lenders if students default on the loans. In contrast, the government must pay each dollar of tuition subsidy to all students enrolling in college (unless the subsidies are targeted; targeted subsidies are considered in section 9.2). The added cost to the government of completely removing education related borrowing constraints is $382 per youth in my sample. This number is calculated by simulating a version of the model in which students are allowed to borrow up to the full cost of schooling (tuition, room, and board) each period from the GSL program. The added cost to the government from implementing these changes is the increase in loans taken out by students multiplied by the default rate on student loans multiplied by the fraction of the loan the government must repay to the lender.[32] To this total I add the subsidized interest the government pays while students are enrolled in school. The default rate in these calculations is assumed to be 5%, which is the average cohort default rate during the years 2001-2005.[33] The government repays 97% of the value of a loan to lenders if a student defaults. When a tuition subsidy with the same cost to the government is considered the effects on enrollment and degree completion are much smaller than those of relaxing educational borrowing constraints. This indicates that the optimal policy for the government is to increase loan limits if the objective is to increase enrollment and degree completion by a small amount. Tuition subsidies are needed to implement larger increases in enrollment and degree completion. Given that tuition subsidies are effective at implementing larger increases in educational attainment, it is important that the government implement the most cost-effective subsidies.

[31]The average youth attending school can only borrow $3,080 at age 18; he can borrow $455 from other sources and $2,625 from the GSL program (see Table 18 and Appendix C.2). The cost of tuition, room, and board at an average 4-year college is $15,049. (See Table 19).

[32]The actual payment the government makes to lenders is more complicated. The government guarantees that the lenders will earn an interest rate equal to the three-month commercial paper rate plus a fixed premium. See Delisle (2008) for details. The government also pays small amounts of money to loan guaranty agencies. For simplicity these factors are ignored in the calculations of the cost to the government of increasing loan limits.

[33]Note that default on student loans is abstracted from in the model. The default rate is only used in this exercise to calculate the cost to the government of the policy changes. Cohort default rates are obtained from the US Department of Education Office of Student Financial Assistance Programs.

Various designs of tuition subsidies are considered in the next section.

9.2 Tuition Subsidy Design

The tuition subsidy considered in the previous section subsidized tuition at 2-year and 4-year colleges for all students. Given the high labor market returns to bachelor's degree completion and that 4-year colleges are much more expensive than 2-year colleges, it is likely to be more cost-effective to increase tuition subsidies at 4-year colleges only. Tuition subsidies targeted at certain groups of students may also be more cost effective than a subsidy that reduces tuition for all students.

Many government aid programs are currently targeted towards low income households. For example, only students who have parents with low incomes are eligible to receive Pell grants and subsidized Stafford loans. If the policy goal of the government is to reduce inequality, then programs targeted toward low income households are the most effective. The government may, however, desire to pursue other policy objectives such as increasing the average productivity of the workforce or increasing college completion rates.[34] In these cases it is unclear what the most cost-effective tuition subsidy would be; it depends on how many people in each section of the family income distribution are close to the margin of college attendance and completion. Holding the cost of a subsidy constant, the government can offer higher subsidy levels to lower income household since fewer youths from low income households attend college. However, these youths may be farther from the margin of attendance. The optimal tuition subsidy design is therefore very difficult to determine analytically. My model, however, is well suited to answer this question by simulating various levels of tuition subsidies targeted towards youths who come from different sections of the parental income distribution.[35]

I simulate increases in tuition subsidies at 4-year colleges for all students simultaneously and for students in each parental income tercile. All of the subsidy schemes cost the government approximately $1000 per capita for my sample.[36] The un-targeted subsidy decreases tuition at 4-year colleges by $460, the low income subsidy by $1,600, the subsidy targeted toward the second income tercile by $1,590, and the high income subsidy by $820. The results of the experiments are displayed in Table 10 where the effects are broken down by ability tercile. The tuition subsidies are also compared to the effects of completely removing education related borrowing constraints.

Tuition subsidies targeted toward households in the middle third of the parental income distribution are more effective at increasing educational attainment in the sample.[37] The effects of the tuition subsidies on higher education outcomes are concentrated in the top two AFQT terciles. This indicates that students in the second and third AFQT terciles are most likely to be close to the margin of attendance and degree completion.

To evaluate the return the government receives (in terms of increased productivity of the work force) from the increased tuition subsidies I examine the changes in the present discounted value of lifetime

[34]It is possible that increasing college tuition subsidies may increase the high school graduation rates since the costs of pursuing further education would be lower. The effect would probably be very small, however. Students that fail to graduate from high school are likely to be very far from the college attendance margin. Since they are not completing high school when it is provided for free it is unlikely that an increase in college tuition subsidies would induce them to complete high school and then pay for further schooling.

[35]Subsidies targeted toward youths with differing levels of ability could also be considered. Here I restrict my attention to targeting different levels of parental income. Parental income is easier for the government to observe than ability (all students who fill out the Free Application for Federal Student Aid are required to report the income of their parents).

[36]It is difficult to design subsidies that represent the exact same cost to the government because *ex ante* I do not know how responsive students will be to the various subsidies. The current approximate cost to the government is calculated by iterating between changing the amount of the subsidies, running the simulation, and evaluating how much the subsidies cost the government *ex post*.

[37]The increase in bachelor's degree completion resulting from the middle income subsidy is significantly different from the increase resulting from the high income subsidy at the 1% level and from the untartegeted and low income subsidies at the 10% level.

Table 10: Changes in Youth Outcomes Under Various Policies[a]

	$AFQT_1$	$AFQT_2$	$AFQT_3$	All
Highest grade completed				
Baseline	13.08	14.47	15.70	14.41
Relax Borrowing Constraint	0.01	0.03	0.05	0.03
Untargeted Tuition Subsidy	0.04	0.07	0.14	0.08
Low Income Subsidy	0.08	0.13	0.11	0.11
Middle Income Subsidy	0.02	0.10	0.20	0.10
High Income Subsidy	0.04	0.05	0.10	0.06
Percent Completing Bachelor's Degree				
Baseline	7.54	30.87	55.38	31.02
Relax Borrowing Constraint	0.73	1.74	0.87	1.12
Untargeted Tuition Subsidy	0.64	3.27	2.35	2.08
Low Income Subsidy	1.55	3.45	1.24	2.09
Middle Income Subsidy	0.74	3.34	4.96	2.99
High Income Subsidy	0.45	2.57	1.20	1.41
Wages at 30				
Baseline	15.23	18.49	20.03	17.91
Relax Borrowing Constraint	0.03	0.10	0.03	0.05
Untargeted Tuition Subsidy	0.03	0.13	0.08	0.08
Low Income Subsidy	0.08	0.16	0.07	0.10
Middle Income Subsidy	0.05	0.19	0.17	0.14
High Income Subsidy	0.02	0.11	0.04	0.06
Present Discounted Value of Income[b]				
Baseline	514.31	603.19	649.81	588.47
Relax Borrowing Constraint	0.57	2.38	0.99	1.32
Untargeted Tuition Subsidy	0.65	2.97	1.94	1.85
Low Income Subsidy	1.73	3.71	1.32	2.26
Middle Income Subsidy	1.29	4.46	4.54	3.42
High Income Subsidy	0.38	2.58	0.77	1.25

[a] Changes in outcome relative to the baseline are displayed in each category.
[b] Measured in thousands of dollars

income youths experience under the various policies. The returns in terms of income outweigh the costs for all the tuition subsidy programs. The total cost per person for each subsidy is approximately $1,000 whereas the average increase in lifetime income in each case is more than $1,000. The tuition subsidy targeted toward middle income households has the largest payoff, increasing average lifetime income by $3,420.[38]

9.3 Delayed Entry

Table 11 shows the effect of the policies considered in the previous section on the fraction of students delaying entry to college. All of the policies slightly decrease the fraction of students delaying entry to college by a semester or more. The small magnitude of these effects, however, indicate that borrowing constraints and the price of college are not the main reasons behind the large number of students delaying entry to college. Other candidate explanations within the model for delayed entry to college are shocks to preferences for schooling and changes in the opportunity cost of schooling caused by unemployment or negative wage shocks. My results indicate that shocks to preferences are the largest contributor to delayed entry to college. When shocks to 2-year and 4-year college enrollment are set to zero, the fraction of students delaying entry to college by a year or more drops to 0 (results not shown), indicating that the shocks to preference explain almost all the delayed entry to college. The shocks to preferences are a black box, however. Future research needs to be done to determine exactly what drives such large shocks to preferences. A model that incorporates learning about ability and preferences for high school level jobs may be able to explain the changes in tastes that agents experience.

Table 11: Percentage of students delaying entry to college

Years after HS graduation	0	.5+	1+	2+	3+	Never
Baseline	70.4%	29.6%	14.7%	11.4%	5.7%	30.6%
Relax Borrowing Constraint	71.0%	29.0%	14.5%	11.1%	5.6%	30.7%
Tuition Subsidy	70.8%	29.2%	14.9%	11.3%	5.5%	29.6%
Low Income Subsidy	70.9%	29.1%	15.1%	11.7%	6.0%	28.9%
Middle Income Subsidy	71.4%	28.6%	14.4%	11.2%	5.5%	29.3%
High Income Subsidy	71.0%	29.0%	14.6%	11.3%	5.6%	29.9%

9.4 Changes in Degree Completion Since the 1980s

How much of the change in college completion rates over the past two decades can be explained by increases in the college wage premium and the change in the costs of college in terms of tuition and grants?[39] I take a first pass at answering this question by using the estimated parameters of my model and performing simulations that alter the returns to education and the costs of college. I perform three simulations to evaluate the effect of the change in returns to education and the change in the costs of college since the early 1980s. First, I approximate the change in the college wage premium by changing the wage equation so that the returns to years of schooling at each college type and to bachelor's degree completion are decreased by 43%.[40] Second, I change the costs of college such that annual tuition at a 2-year college is reduced by 42% and tuition at 4-year colleges is reduced by 46%.[41] I also increase the

[38] These calculations do not incorporate the dead-weight loss that could arise through an increase in taxes to pay for the tuition subsidy programs.

[39] Castex (2009) addresses a similar question.

[40] This approximates the change in the overall college wage premium from 1983 to 2003 documented in Fortin (2006).

[41] These numbers reflect enrollment weighted average tuition at each college type for the years 1979-1983 as reported by IPEDS.

limits on student loans to the levels that prevailed during the early 1980s and decrease the amount of grants students receive by 45%.[42] For both experiments I reduce the amount of parental transfers youths receive by 33%.[43] Finally, I look at the combined effects and evaluate how well my model captures the change in degree completion from the early 1980s to the early 2000s. This exercise can also be thought of as an evaluation of the out of sample fit of my model.

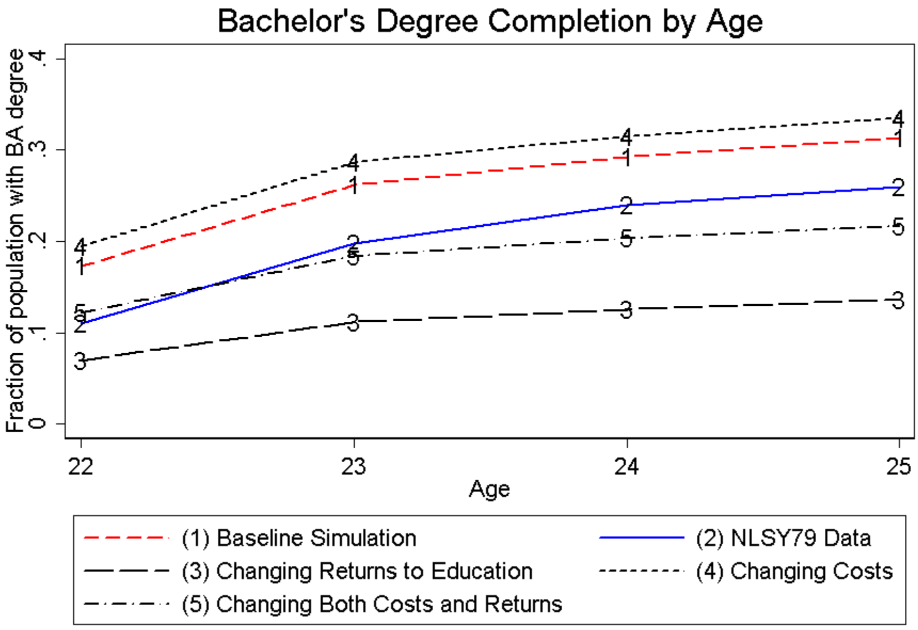

Figure 18: University Enrollment by Age

The results are displayed in Figure 18. The first two lines in the graph represent degree completion in the baseline simulation (which closely approximates the NLSY97 data) and in the NLSY79 data. One can see that bachelor's degree completion at age 25 increased by 5 percentage points across the two cohorts. This change across cohorts reflects both the increase in the college wage premium and the fact that cost of college has increased. The third line isolates the effect of the change in the college wage premium. The model predicts that if the returns to education were as low as they were in the 1980s while college costs were still as high as the current level, then bachelor's degree completion would decrease by approximately 20 percentage points. On the other hand, if the returns to education are held constant at the current level and college costs decreased to their 1980 level, degree completion would increase by approximately 2 percentage points (this is reflected in the fourth line of the figure). The final line of the figure adjusts both the college wage premium and the costs of college to their levels in the early 1980s. In this case the model slightly under predicts the level of bachelor's degree completion, as compared to the outcomes of the NLSY79 respondents.

These results should be interpreted with caution for a number of reasons. First, the factor used to decrease the college wage premium to 1980s is taken from raw CPS data on the difference between college and high school graduate wages. The actual change in the college wage premium after controlling for

[42]This decrease in grants reflects the change in average grants received across the NLSY79 and NSLY97 cohorts. Alternatively, I could use NLSY79 data to re-estimate the parameters of the grant function in the model. These calculations have not yet been performed.

[43]Unfortunately data on parental transfer amounts does not exist in the NLSY79. To approximate how much lower parental transfers were in the 1980s I use the estimates of parental transfer amounts from KW and compare them to actual amounts from the NLSY97 data.

ability may not have been as great. Second, some of the younger respondents in the NLSY79 cohort (who made college completion decisions after 1983) may have already seen some of the increases in the college wage premium and therefore should be excluded from the calculations. Finally, the adjustment made to the amount of parental transfers in each experiment is based on estimates from the KW model rather than actual data.

9.5 Link Between Parental Income and Educational Outcomes

Parental resources affect the educational attainment of their children through investments made when the children are young and through financial support provided during college years. Early childhood investment by parents enter in this model through the AFQT score and through unobserved heterogeneity. Investments made by parents during college years enter directly through parental transfers. Tables 12 and 13 replicate and extend the results in Belley and Lochner (2007) to assess the effect of parental income on educational attainment.

Table 12: Regression of Indicator for College Attendance by Age 21[a]

	Data	Simulation	Simulation
AFQT Q2	0.222**	0.191**	-0.023
	(0.031)	(0.014)	(0.012)
AFQT Q3	0.330**	0.281**	0.019
	(0.033)	(0.015)	(0.012)
AFQT Q4	0.435**	0.330**	0.131**
	(0.034)	(0.015)	(0.012)
Parental Income Q2	0.144**	0.039**	0.004
	(0.032)	(0.014)	(0.011)
Parental Income Q3	0.184**	0.146**	0.069**
	(0.033)	(0.015)	(0.012)
Parental Income Q4	0.288**	0.290**	0.219**
	(0.034)	(0.015)	(0.012)
Black	0.089*	0.055**	0.066**
	(0.036)	(0.016)	(0.013)
Hispanic	0.082*	0.049**	0.073**
	(0.041)	(0.018)	(0.015)
Type 2			-0.002
			(0.012)
Type 3			-0.565**
			(0.011)
Constant	0.276**	0.359**	0.833**
	(0.031)	(0.014)	(0.015)
R-squared	0.200	0.159	0.465
N	1396	7460	7460

[a] Standard errors appear in parentheses below coefficients. ** p<0.01, * p<0.05

Belley and Lochner (2007) regress various indicators for educational attainment on AFQT, parental income, and other controls for family background. Table 12 uses this methodology to asses the effect of parental income and ability on whether a youth has entered college by the age of 21. The first two columns display the results of the regression run on actual and simulated data. The results in the first

Table 13: Regression of Indicator for 4+ Years of College by Age 23[a]

	Data	Simulation	Simulation
AFQT Q2	0.120**	0.101**	-0.048**
	(0.043)	(0.013)	(0.012)
AFQT Q3	0.282**	0.236**	0.040**
	(0.045)	(0.014)	(0.012)
AFQT Q4	0.467**	0.441**	0.253**
	(0.045)	(0.014)	(0.012)
Parental Income Q2	0.021	-0.039**	-0.067**
	(0.042)	(0.014)	(0.011)
Parental Income Q3	0.094*	-0.004	-0.062**
	(0.043)	(0.014)	(0.012)
Parental Income Q4	0.192**	0.291**	0.219**
	(0.045)	(0.014)	(0.012)
Black	0.029	0.065**	0.075**
	(0.047)	(0.015)	(0.013)
Hispanic	-0.098	-0.064**	-0.040**
	(0.059)	(0.018)	(0.015)
Type 2			-0.252**
			(0.012)
Type 3			-0.644**
			(0.011)
Constant	0.056	0.078**	0.636**
	(0.041)	(0.013)	(0.015)
R-squared	0.189	0.238	0.490
N	864	7460	7460

[a] Standard errors appear in parentheses below coefficients. ** $p<0.01$, * $p<0.05$

column match the patterns found in Belley and Lochner (2007).[44] The coefficients from the regression run on the simulated data match the AFQT coefficients and the broad pattern of the effects of parental income very well. The model slightly under predicts the effect of the second and third parental income quartiles on college attendance by age 21. Table 13 displays a similar set of results where the outcome of interest is if a youth completed four or more years of college by age 23. The third column of both tables adds controls for the unobserved heterogeneity types. When these controls are added, the effect of parental income on educational attainment is diminished, indicating that some of the correlation between parental income and educational outcome is due to the correlation between parental income and unobserved ability of youths. However, parental income still has a substantial direct effect on the educational attainment of youths after controlling for observed and unobserved ability. Youths from households in the highest income quartile are 22% more likely to attend college by age 21 and to have completed four or more years by age 23.

According to Belley and Lochner (2007) if parental income helps predict college outcomes after controlling for ability and family background then this may indicate that borrowing constraints are binding. The results in this paper show that this is not the case and that educational borrowing constraints have almost no impact on college attainment. These results are consistent with an observation made by Kane (2006) that direct transfers from parents during college years can explain a large fraction of the gap in educational attainment between youths from low and high income households. The direct effect of parental income on educational outcomes is explored further in Table 14.

Table 14: Counterfactual Changes in Youth Outcomes[a]

	$AFQT_1$	$AFQT_2$	$AFQT_3$	Inc_1	Inc_2	Inc_3	All
Percent Enrolling in College by Age 21							
Baseline	44.81	77.84	83.32	52.17	65.25	88.97	67.74
Grants Independent of Income	-0.40	-0.44	-0.66	-4.42	0.04	3.09	0.26
Equalize Parental Transfers	-0.83	-0.44	-4.22	10.61	1.62	-18.35	-1.05
Percent Completing 4+ Years by Age 23							
Baseline	11.85	29.86	58.73	21.76	20.77	57.98	32.37
Grants Independent of Income	-1.27	-1.36	-0.33	-6.54	-0.48	4.32	-0.13
Equalize Parental Transfers	1.99	-8.18	-5.49	10.53	0.73	-23.70	-3.02

[a] Changes in outcome relative to the baseline are displayed in each category.

The design of government programs to sponsor higher education favors lower income households. Youths from high income households are not eligible to receive Pell grants or subsidized loans. The first counterfactual experiment in Table 14 makes grant receipt independent of income by treating each youth as if he had the average family income in the sample for the purposes of Equation (8). This counterfactual also changes the Stafford loan eligibility rules so that all students are eligible for subsidized loans. Students from the highest income tercile benefit from these changes with a 3.09 percentage point increase in the fraction attending college by age 21 and a 4.32 percentage point increase in the fraction completing four or more years by age 23. Students from the lowest income tercile are hurt the most with a 6.54 percentage point decrease in fraction completing four or more years by age 23.

The direct effect of parental transfers is explored by inserting the average parental income in the sample for all youths into Equations (12) and (13). These changes have large effects on educational attainment across income terciles. Educational attainment increases for youths from the lowest family income terciles and decreases dramatically for youths from the highest family income tercile. The effects

[44]The magnitude of the coefficients found in Belley and Lochner (2007) are smaller since they add additional controls for family background.

across AFQT terciles are strongest in the top two thirds of the ability distribution. This counterfactual exercise provides evidence that a substantial fraction of the correlation between parental income and educational attainment is due to the direct effect of parental transfers youths receive while in college.

10 Conclusion

In this paper I have solved and estimated a dynamic structural model of the education, work, and asset accumulation decisions of students after they graduate from high school. The model allows for heterogeneity in both observed and unobserved ability, family income, and parental transfers. I explicitly modeled the uncertainty students face about degree completion and about future labor market outcomes. I estimated the model using Indirect Inference and used the estimates to perform various policy and counter-factual experiments.

I showed that borrowing constraints have a very small impact on overall educational attainment. Simulated increases in the availability of student loans raise bachelor's degree completion by at most 1.1 percentage points. Increases in tuition subsidies have larger impacts on educational attainment. Tuition subsidies targeted towards middle income households are shown to be the most cost-effective method for the government to increase the average level of degree completion and earnings in the population.

Recent papers have proposed borrowing constraints as a possible explanation for why parental income matters for educational outcomes after conditioning on ability. I have shown that borrowing constraints are not behind the effect of parental income and that the transfers youths receive from their parents while in college can explain a large portion of the correlation between parental income and education.

References

Akyol, A. and K. Athreya (2005). Risky higher education and subsidies. *Journal of Economic Dynamics and Control 29*, 979–1023.

Altonji, J. G., P. Bharadwaj, and F. Lange (2008). Changes in the characteristics of american youth: Implications for adult outcomes. *NBER Working Paper w13883.*

Altonji, J. G., A. A. Smith, and I. Vidangos (2009). Modeling earnings dynamics. *NBER Working Paper w14743.*

Belley, P. and L. Lochner (2007). The changing role of family income and ability in determining educational achievement. *Journal of Human Capital 1*(1), 37–89.

Cameron, S. V. and C. Taber (2004). Estimation of educational borrowing constraints using returns to schooling. *Journal of Political Economy 12*(1), 132–182.

Carneiro, P. and J. J. Heckman (2002). The evidence on credit constraints in post-secondary schooling. *The Economic Journal 112*(482), 705–734.

Carroll, C. D. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *The Quarterly Journal of Economics 112*(1), 1–55.

Carroll, C. D., K. E. Dynan, and S. D. Krane (2003). Unemployment risk and precautionary wealth: Evidence from households' balance sheets. *The Review of Economics and Statistics 85*(3), 586–604.

Castex, G. (2009). Accounting for the college attendance profile. Mimeo.

Delisle, J. (2008, October). Cost estimates for federal student loans. New America Foundation.

Dominitz, J. and C. F. Manski (1996). Eliciting student expectations of the returns to schooling. *The Journal of Human Resources 31*(1), 1–26.

Fortin, N. M. (2006). Higher-education policies and the college wage premium: Cross-state evidence from the 1990s. *The American Economic Review 96*(4), 959–987.

Gallipoli, G., C. Meghir, and G. L. Violante (2007). Equilibrium effects of education policies: a quantative evaluation. Mimeo.

Garriga, C. and M. P. Keightley (2007). A general equilibrium theory of college with education subsidies, in-school labor supply, and borrowing constraints. *Federal Reserve Bank of St. Louis Working Paper Series 2007-051A*.

Gouriéroux, C. and A. Monfort (1996). *Simulation-Based Econometric Methods*. Oxford University Press.

Gouriéroux, C., A. Monfort, and E. Renault (1993). Indirect inference. *Journal of Applied Econometrics 8*, S85–S118.

Guvenen, F. and A. A. Smith (2009). Inferring labor income risk from economic choices: an indirect inference approach. Mimeo.

Heckman, J. J. and B. Singer (1984). A method for minimizing the impact of distributional assumptions in econometric models for duration data. *Econometrica 52*(2), 271–320.

Ionescu, F. (2008). Risky college investment under alternative bankruptcy regimes for student loans. Mimeo.

Ionescu, F. (2009). The federal student loan program: Quantative implications for college enrollment and default rates. *Review of Economic Dynamics 12*, 205–231.

Jaeger, D. A. and M. E. Page (1996). Degrees matter: New evidence on sheepskin effects in the returns to education. *The Review of Economics and Statistics 78*(4), 733–740.

Kane, T. J. (1996). College cost, borrowing constraints and the timing of college entry. *Eastern Economic Journal 22*(2), 181–194.

Kane, T. J. (2006). Public intervention in post-secondary education. In E. A. Hanushek and F. Welch (Eds.), *Handbook of the Economics of Education, Volume 2*, pp. 1370–1401. Washington, DC: Elsevier B.V.

Kane, T. J. and C. E. Rouse (1995). Labor-market returns to two- and four-year college. *The American Economic Review 85*(3), 600–614.

Kaplan, G. (2009). Moving back home: Insurance against labor market risk. Mimeo.

Keane, M. P. and K. I. Wolpin (2001). The effect of parental transfers and borrowing constraints on educational attainment. *International Economic Review 42*(4), 1051–1103.

Lee, D. and M. Wiswall (2007). A parallel implementation of the simplex function minimization routine. *Computational Economics 30*, 171–187.

Light, A. (1995). The effects of interrupted schooling on wages. *The Journal of Human Resources 30*(3), 472–502.

Lochner, L. J. and A. Monge-Naranjo (2008). The nature of credit constraints and human capital. *NBER Working Paper w13912*.

Nagypál, É. (2007). Learning by doing vs. learning about match quality: Can we tell them apart? *Review of Economic Studies 74*, 537–566.

Rothstein, J. and C. E. Rouse (2008). Constrained after college: Student loans and early career occupational choices. Mimeo.

Rube, K. (2003). Private loans: Who's borrowing and why? Washington, DC: The State PIRG's Higher Education Project.

Segall, D. O. (1997). Equating the cat-asvab. In W. A. Sands, B. K. Waters, and J. R. McBride (Eds.), *Computerized Adaptive Testing: From Inquiry to Operation*, pp. 10–119. Washington, DC: American Psychological Association.

Smith, A. A. (1993). Estimating nonlinear time-series models using simulated vector autoregressions. *Journal of Applied Econometrics 8*, S63–S84.

Stinebrickner, R. and T. Stinebrickner (2008). The effect of credit constraints on the college drop-out decision: A direct approach using a new panel study. *American Economic Review 98*(5), 2163–2184.

Stoops, N. (2004). Educational attainment in the united states: 2003. Washington, DC: U.S. Census Bureau.

Taniguchi, H. (2005). The influence of age at degree completion on college wage premiums. *Research in Higher Education 46*(8), 861–881.

Tartari, M. (2007). Divorce and the cognitive achievement of children. Mimeo.

van der Klaauw, W. and K. I. Wolpin (2008). Social security and the retirement savings behavior of low-income households. *Journal of Econometrics 145*, 21–42.

Wei, C. C. and L. Berkner (1997). Trends in undergraduate borrowing ii: Federal student loans in 1996-96, 1999-2000, and 2003-2004. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Winter, C. (2009). Accounting for the changing role of family income in determining college entry. *Institute for Empirical Research in Economics University of Zurich Working Paper Series 402*.

A NLSY79 Data and Sample Selection

I use data from the NLSY 1979-2004. Then NLSY79 surveys 12,686 youths aged 14-22 in 1979. I use the same sample selection criteria as I do for the NLSY97, namely I use only white, black, and hispanic males from the cross-sectionally representative sample. I include only youths that complete a high school degree between the ages 16 and 19 and exclude GED recipients and youths that ever serve in the military. I additionally exclude youths who received a high school degree before the first survey in 1979 because the NLSY79 did not collect detailed retrospective college attendance histories before the first survey date. I need this data to construct the years of schooling variables at 2-year and 4-year colleges to be consistent with the NLSY97 data. After imposing the additional restriction that youths need to be aged 25 or older and surveyed in year 1990 or later I am left with a sample size of 936 youths and 35,450 person-semester cells of valid data. The data are transformed into model equivalents the same way as the NLSY97 data. College attendance history is constructed using the monthly enrollment history variables in the NLSY79. Work status and unemployment are constructed using the weekly employment history variables.

The wage and unemployment probability equations estimated on NLSY79 data are used as auxiliary models to identify the structural parameters of the wage and unemployment functions by providing data at ages higher than 25. The parameters of the wage equation are reported in Table 15. The coefficients are consistent with what one would expect to find in a standard Mincer earnings equation. One cannot reject the null hypothesis that the returns to years of schooling at 2-year and 4-year colleges are the same. This is consistent with the findings of Kane and Rouse (1995) about the similar return to credits at 2-year and 4-year colleges. The largest returns to schooling, however, come from completion of a bachelor's degree.

Table 15: NLSY79 Log Wage Regression[a]

VARIABLES	Log Wage
Years at University	0.0440**
	[0.0124]
Years at Community College	0.0292*
	[0.0145]
Bachelor's Degree	0.147**
	[0.0529]
Years of Experience	0.0695**
	[0.00583]
Experience Squared	-0.00148**
	[0.000182]
AFQT	0.00479**
	[0.000552]
Black	-0.0828
	[0.0448]
Hispanic	0.0109
	[0.0679]
Part Time Work	-0.0540
	[0.0560]
Enrolled in School	-0.276**
	[0.0431]
Constant	1.316**
	[0.103]
Observations	30248
R-squared	0.243

[a] Standard errors appear in brackets below coefficients and are clustered at the person level. ** p<0.01, * p<0.05

The parameters of the unemployment probability equation are reported in Table 16. The probability of unemployment is higher for blacks and lower for those with a bachelor's degree. The probability of unemployment in a given semester is much larger for someone who did not work in the previous semester.

Table 16: NLSY79 Unemployment Probit[a]

VARIABLES	Unemployment
Years at University	0.000261
	[0.000578]
Years at Community College	-0.00158
	[0.000910]
Bachelor's Degree	-0.00565**
	[0.00204]
Years of Experience	-0.000783
	[0.000610]
Experience Squared	3.66e-06
	[1.93e-05]
AFQT	-4.39e-06
	[3.52e-05]
Black	0.0108*
	[0.00455]
Hispanic	0.00266
	[0.00388]
Not Working Previous Semester	0.123**
	[0.0144]
Observations	35422

[a] Marginal effects coefficients reported. Standard errors appear in brackets below coefficients and are clustered at the person level. ** p<0.01, * p<0.05

B Delayed Entry

Table 17 illustrates the life cycle income profile of the same agent under two possible scenarios. In the first scenario the agent enters college directly after high school and in the second the agent delays entry by one year and works during that year. A number of simplifying assumptions are made to make the comparison easy to interpret. I assume that the agent does not work while enrolled in college, that he completes college in 4 years, and that he retires at age 60. The earnings at the high school level job, W^H, are assumed to be \$17,000. The earnings at the college level job, W^C, initially start at \$23,000 and grow at rate $g = 2\%$ per year. Future income is discounted at an annual rate of $r = 5\%$.

Table 17: Life Cycle Income Profile by Timing of College Entry

Age	19	20	21	22	23	24	25	26
No Delay	0	0	0	0	$\frac{W^C}{(1+r)^4}$	$\frac{(1+g)W^C}{(1+r)^5}$	$\frac{(1+g)^2 W^C}{(1+r)^6}$	...
Delay By 1 Year	W^H	0	0	0	0	$\frac{W^C}{(1+r)^5}$	$\frac{(1+g)W^C}{(1+r)^6}$	...

Under these assumptions the agent loses \$9,037 in present discounted value of lifetime income by delaying entry to college by one year. Some papers indicate that delaying entry to college itself might cause earnings to decrease. This could arise if older students do not benefit as much from college education or if employers statistically discriminate against students who delay entry to college because they believe that delayed entry is correlated with unobservable traits that decrease productivity. Taniguchi (2005) finds that students who earn bachelor's degrees at ages 25 and older earn lower premiums than students who earn the degrees at traditional ages. Light (1995) also shows that students who interrupt their schooling between high school and college earn lower wage premiums. Under the assumption that post school earnings for those who delay entry to college are reduced by 10% each year for 4 years after graduation (near the middle of the range found by Light (1995)) the present discounted value of the loss in lifetime income in the previous example becomes \$15,775.

The exercise performed in this section provides a useful benchmark for thinking about the costs of delayed entry to college. It is important to note, however, that the assumptions made in this section do not hold for many students. As shown in Table 2 students who delay entry to college are more likely to enroll in 2-year colleges and less likely to complete a bachelor's degree.

C Additional Model Details

C.1 Model Solution

The model is solved through backward recursion starting from the terminal value function V^{TERM} at age 40. V^{TERM} consists of $v_1 a_t$, the value of assets at age 40, and PDV which denotes the present discounted consumption value of wages between ages 41 and 65. The $v_1 a_t$ term is designed to partially capture retirement savings incentives and is also in place to prevent agents from wanting to borrow the maximum amount in the terminal period. v_1 is identified by adding the average asset holdings of respondents in my NLSY79 sample between ages 38-40 as an auxiliary model. PDV is calculated by assuming that the state variables of the agent remain constant after age 40 and that the agent always works full-time (unemployment is abstracted from after age 40).

In the model youths are allowed to enroll in school until they reach age 30 after which enrollment is prohibited for computational simplicity. Each youth starts the model with 0 years of completed schooling at 2-year and 4-year colleges when he graduates from high school.[45] When a student attends college for a semester his years of schooling variable at the corresponding college type increases by .5 if he attends full-time and .25 if he attends part-time.

During each period prior to the last the Emax functions are approximated using linear regressions. Each period variables in the state space are used as independent variables in the regression approximations. In the approximations there are indicator variables for each asset grid point and indicator variables for each type. Each of the following variables also enters the regression, along with interactions between it and the level of assets: years completed at each college type, Bachelor's degree completion, experience, AFQT, indicator for not working in the previous period, parental income, and lagged receipt of parental transfers. There are also interactions between the type indicators and the level of assets, experience, years completed at each college type, bachelor's degree completion, lagged enrollment at each college type, and lagged work status. The remaining variables are the square of AFQT, the square of parental income, lagged school enrollment, lagged school enrollment interacted with the years completed at each college type, lagged school enrollment interacted with AFQT, AFQT tercile indicators interacted with years of school at each college type, parental income interacted with lagged parental transfers, race indicators interacted with assets and parental income, and state of residence indicators interacted with assets and parental income.

In total there are 83 independent variables used each period in the Emax approximation regressions. The Emax values are evaluated at 250 randomly drawn state vectors each period and these points are used as data for the approximation regressions. Each period three separate regressions are used for agents in each third of the parental income distribution. The R-squared value of the approximation regressions is 0.99 or higher for each period. The multivariate integrals necessary to take expectations with respect

[45] A small fraction of youths report having attended some college before they graduate from high school. This schooling is ignored for the purposes of the model to simplify the initial conditions.

to the vector of shocks each period are approximated using Monte Carlo integration. Thirty draws from the joint distribution of shocks are taken for each integral approximation. I use a simplex method similar to the one implemented in Lee and Wiswall (2007) to minimize the function in Equation (15).

C.2 Borrowing Constraint and Interest Rate Details

Recall from Equation (9) that the lower bound on assets is the sum of the lower bound on schooling related assets $\underline{a}_t^s$ and the lower bound on other assets $\underline{a}_t^o$. $\underline{a}_t^o$ evolves according to Equation (22). $\underline{a}_t^s$ is set according to the rules of the GSL program.[46] From 1993-2007 the loan limits for the Stafford loan program students were constant in nominal terms and set according to the following rules: Dependent undergraduates were allowed to borrow \$2,625 during the first year of enrollment, \$3,500 during the second year of enrollment, and \$5,500 during subsequent years up to a cumulative maximum of \$23,000. Independent undergraduates were allowed to borrow \$6,625 during the first year of enrollment, \$7,500 during the second year of enrollment, and \$10,500 during subsequent years up to a cumulative maximum of \$46,600.[47] Under the Stafford loan program students are allowed to borrow up to the full cost of schooling related expenses (tuition, room, and board) until the yearly maximum is reached. Students that have a cost of schooling greater then their expected family contribution (EFC) are eligible for subsidized loans. When a loan is subsidized the government pays interest on the loan while the student is enrolled in school. The EFC is a calculated from the parental income and assets, student income and assets, and the number of other children from the family attending college. Since parental assets and number of siblings attending college are outside my model I am unable to calculate the EFC for each student. For simplicity I assume that students from households with incomes below the median income in my sample are eligible for subsidized loans since Wei and Berkner (1997) show that subsidized loans make up the majority of loans for students from households with below median income.

The borrowing constraint is enforced in model in the following way: Each youth is able to borrow up to his $\underline{a}_t$ each period (subject to the discretization of assets).[48] If the agent is in debt and $\underline{a}_{t+1}$ is closer to zero than his current debt level he is not forced to repay the debt during that period and $\underline{a}_{t+1}$ remains at the level it was during the previous period. This is designed to capture the fact that students are not forced to repay their debts immediately. If the agent leaves school and is not borrowing then the asset lower bound returns to the level of $\underline{a}_t^o$. Table 18 displays the estimates of $\underline{a}_t^o$ categorized by age and ability. The asset lower bound increases with ability and age and increases more quickly as age increases.

The interest rate in the model is intended to capture the real interest rate[49] earned on savings and paid on debts. The interest paid on debt while in school (if the loan is not subsidized) is set to 2.2%, which is the average real interest rate paid on Stafford loans between 2001 and 2005. If the agent is borrowing and is no longer enrolled in school the interest rate is set to 5.9% which is the average prime rate between 2001-2007 minus inflation plus a two percent risk premium. If the agent is saving the interest rate is set to 0.9% which is the average real interest rate on one year US government bonds from

[46]The GSL program is also known as the Federal Family Education Loan Program. The Parent Loan for Undergraduate Students program is not modeled since loans parents take out are assumed to be part of parental transfers. The Perkins loan program is also not modeled for simplicity since it only makes up about 3% of total loan aid (Rube (2003)). Private education loans are assumed to be part of the other borrowing limit Only 3.6% of students took out loans from private lenders for education in 2000 (Rube (2003)).

[47]See Wei and Berkner (1997) for a details on Stafford loan limits.

[48]There are 19 asset grid points located at -\$28,000, -\$23,000, -\$19,000, -\$15,000,-\$11,000, -\$8,000,-\$6,000,-\$4,000,-\$3,000, -\$2,000, -\$1,000, \$0, \$1,000, \$3,000, \$6,000, \$10,000, \$15,000, \$21,000, and \$30,000. The grid points are clustered near \$0 on the negative side to better capture the effects of the borrowing constraint. The actual lower bound is rounded down to the nearest grid point each period.

[49]Recall that all dollar amounts in the paper are in constant 2004 dollars.

Table 18: Estimates of $\underline{a}_t^o$ by Ability and Type

Age	$AFQT_1$	$AFQT_2$	$AFQT_3$	Type 1	Type 2	Type 3	All
18	-431	-469	-466	-509	-477	-418	-455
19	-575	-628	-625	-685	-638	-557	-609
20	-765	-840	-838	-923	-856	-741	-814
21	-1015	-1121	-1122	-1243	-1143	-982	-1085
22	-1357	-1539	-1596	-1813	-1588	-1304	-1496
23	-2746	-3185	-3379	-3883	-3326	-2627	-3101
24	-3651	-4281	-4591	-5290	-4504	-3486	-4170
25	-4831	-5720	-6158	-7119	-6039	-4604	-5564

2001-2007.

C.3 Tuition Cost Details

In the model tuition varies by state of residence of the agent. For simplicity in the estimation the tuitions are collapsed into four categories based on the level of the tuition at 2-year and 4-year colleges in each state. To construct the categories I use data from IPEDS on average public and private tuition by state between 2001 and 2005. I sort the states based on average tuition weighted by on enrollment in each college type. With this sorted list I divide the states in to four categories such that each category has approximately the same total population. I then generate the average tuition at 2-year and 4-year colleges within these categories, weighting by state population. The amounts of tuition in each category are displayed in Table 19. I use geocode data from the NLSY97 on state of residence at age 16.[50] I abstract from migration across states and assume that the agent goes to school in a state in the same tuition category as the state of residence at age 16.[51]

C.4 Auxiliary Models

The auxiliary models consist of regressions and moments evaluated on the actual and simulated data and are designed to give a rich enough statistical description of the data to identify the structural parameters. In total there are 256 auxiliary parameters (there are 128 structural parameters being estimated).[52] Recall from Equation (15) that the estimated structural parameters $\hat{\eta}$ are chosen to minimize the weighted sum of squared scores of the auxiliary models evaluated at the simulated data. The β parameters in this equation are the coefficients of the linear regressions. The weighting matrix Λ for each regression is the inverse of the Hessian matrix. Λ gives higher weight to the more precisely estimated β coefficients in each regression. The likelihood contributions of each regression model are summed to generate the likelihood function in Equation (15). The likelihood contributions of the auxiliary models are weighted in the final sum to generate the likelihood function. I give greater weight to the models that describe the more important features of the data such as school enrollment and degree completion.[53] The auxiliary models used are listed below (with the weight given to each model in the likelihood function listed in parentheses).

1. Regressions

[50] Age 15 or 14 state or residence is used if the data is missing at age 16.
[51] 83% of students in my sample go to school in the same state they were residing in at age 16. 89% of students go to college in a state in the same tuition category as their age 16 state of residence.
[52] Estimates of the auxiliary model parameters are available upon request.
[53] Weighting the auxiliary models is a more parsimonious, but approximately equivalent, way of adding auxiliary models that describe similar important correlations in the data.

- Log wage on years of schooling at each college type, BA degree completion, experience, experience squared, AFQT, race, part-time work, and school attendance. Separate equations estimated for ages 25 and below (NLSY97 data) and 26 and higher (NLSY79 data) (1)
- Enrolled in college by age 21 on AFQT quartile, family income quartile, and race (2)
- Enrolled in college by age 21 on AFQT on family income quartile (1)
- Completed 4 or more years of college by age 23 on AFQT quartile, family income quartile, and race (2)
- Completed 4 or more years of college by age 23 on family income quartile (1)
- Assets at 25 on assets at 20, and assets at 20 on assets at 18 (1)
- Unemployed on years of schooling at each college type, BA degree completion, experience, experience squared, AFQT, race, and indicator for not working in previous period. Separate equations estimated for ages 25 and below (NLSY97 data) and 26 and higher (NLSY79 data) (1)
- Receipt of parental transfers on family income, family income squared, age, race, previous semester school attendance, previous school attendance interacted with family income, indicator for receipt of parental transfers during previous year, and indicator for being unemployed in the previous year[54] (.01)
- Amount of parental transfers received if positive on family income, family income squared, years of school completed, age, race, enrollment in 4-year college, enrollment in 4-year college interacted with family income, and indicator for being unemployed in the previous year (.01)
- Average 2-year grant amount on family income and family income squared (5)
- Average 4-year grant amount on AFQT, AFQT squared, family income, and family income squared (5)
- Three equations of enrollment in 4-year college, enrollment in 2-year college, and not enrolling in college on AFQT tercile for ages 18-21 (1)
- Two equations of enrollment in 4-year college and 2-year college on previous period enrollment in each college type and age (1)
- BA degree completion on years of 2-year college completed, years of 4-year college completed, AFQT tercile, and race (1)
- Log wage on previous period log wage (1)
- Indicator for not working and not in school on race indicators (3)
- Average monthly unemployment benefits on experience (1)

2. Moments

   - Fraction of sample completing a bachelor's degree at each age for ages 22-25 (25)
   - Fraction of sample enrolled in each college type at each age[55] (20)
   - Fraction unemployed at each age and average wage if working at each age (15)
   - Fraction working part-time and full-time at each age (10)

[54] Since there is no error term in the equation for the receipt of parental transfers a low weight is given to prevent this equation contributing too much to the likelihood function.

[55] "Each age" hereafter refers to the ages for which I have enough NLSY97 data for inference, namely 18-25.

- Fraction receiving parental transfers at each age, average amount of transfers received if positive at each age (2)
- Fraction of population in debt at ages 20 and 25 (10)
- Average asset holdings at ages 20 and 25 (5)
- Average asset holdings if borrowing at ages 20 and 25 (1)
- Fraction of population in debt, average asset holdings, and average asset holdings if borrowing at ages 20 and 25 for those who have not enrolled in school (1)
- Fraction of population never enrolling in college, enrolling directly from high school, delaying by a semester or more, by a year or more, by two years or more, and by 3 or more years (1)
- Fraction of sample enrolled part-time in each college type at each age (1)
- Average highest grade completed at age 25 (1)
- Fraction of sample working full-time, part-time, and not working while enrolled in 2-year and 4-year colleges full-time and part-time (1)
- Fraction of sample working full-time, part-time, and not working while not enrolled in school (1)
- Person specific variance of wages at each age (1)
- Average asset holdings between ages 38 and 40 in the NLSY79 (1)

D Exact Functional Forms

D.1 Utility Function (g^u)[56]

$$u_t = \frac{c_t^{1-\rho}}{1-\rho} + [\gamma_1 AFQT_3 + \gamma_2 AFQT_2 + \gamma_3 AFQT_1 \tag{16}$$

$$+\gamma_4 black + \gamma_5 hispanic + \epsilon_t^U][I(s_t^U = .5) + \gamma_6 I(s_t^U = 1)]$$

$$+[\gamma_7 AFQT_3 + \gamma_8 AFQT_2 + \gamma_9 AFQT_1 + \gamma_{10} black + \gamma_{11} hispanic + \epsilon_t^C][I(s_t^C = .5) + \gamma_{12} I(s_t^C = 1)]$$

$$+\gamma_{13} age_t s_t^U I(age_t \geq 22) + \gamma_{14} age_t s_t^C I(age_t \geq 20) + \gamma_{15} I(s_t^U > 0) I(s_{t-1}^U > 0)$$

$$+\gamma_{16} I(s_t^C > 0) I(s_{t-1}^C > 0) + \gamma_{17} I(s_t^U > 0) I(s_{t-1}^U > 0) I(sem = 1) + \gamma_{18} I(s_t^C > 0) I(s_{t-1}^C > 0) I(sem = 1)$$

$$+\gamma_{19} I(s_t^U + s_t^C > 0) I(BA_t = 1) + [\gamma_{20} + \sum_{k=2}^{K} \gamma_{21,k} I(type = k) + \gamma_{22} black + \gamma_{23} hispanic + \epsilon_t^w][I(h_t = .5) + \gamma_{24} I(h_t = 1)]$$

$$+\gamma_{25} I(h_t = 1) age_t + \gamma_{26} I(h_t = 1) age_t + \gamma_{27} I(h_t = 1) I(age \geq 23)$$

$$+\gamma_{28} I(h_t = 1) I(s_t^U = 1) + \gamma_{29} I(h_t = .5) I(s_t^U = 1)$$

$$+\gamma_{30} I(h_t = 1) I(s_t^C = 1) + \gamma_{31} I(h_t = .5) I(s_t^C = 1) + \gamma_{32} I(h_t = 1) I(s_t^U = .5) + \gamma_{33} I(h_t = .5) I(s_t^U = .5)$$

$$+\gamma_{34} I(h_t = 1) I(s_t^C = .5) + \gamma_{35} I(h_t = .5) I(s_t^C = .5) + [\gamma_{36} I(s_t^U > 0) AFQT_3$$

$$+\gamma_{37} I(s_t^U > 0) AFQT_2 + \gamma_{38} I(s_t^U > 0) AFQT_1 + \gamma_{39} I(s_t^C > 0) AFQT_3 + \gamma_{40} I(s_t^C > 0) AFQT_2$$

[56] $AFQT_i$ and Inc_i indicate that the youth's ability and parental income fall in tercile i. sem indicates the semester; 1=Summer, 2=Fall, and 3=Spring. The first term in the utility function is multiplied by 10^6 to avoid dealing with very small coefficients in the remainder of the utility function

$$+\gamma_{41}I(s_t^C > 0)AFQT_1]I(age_t = 18)I(semester = 2) + \gamma_{42}I(s_t^U > 0)I(S_t^U > 2.5)$$

$$+\gamma_{43}I(s_t^U > 0)I(age \geq 24) + \sum_{k=2}^{K}\gamma_{44,k}I(type = k)I(s_t^C + s_t^U > 0)$$

D.2 Human Capital Function (g^{Ψ})[57]

$$\Psi_t = \exp\{\phi_0 + \phi_1 S_t^U + \phi_2 S_t^C + \phi_3 BA_t + \phi_4 H_t + \phi_5 H_t^2 + \tag{17}$$

$$\phi_6 AFQT + \sum_{k=2}^{K}\phi_{7,k}I(type = k)\}$$

D.3 Wage Function (g^w)

$$w_t = \Psi_t \exp\{\alpha_1 I(h_t = .5) + \alpha_2 I(s_t^C + s_t^U > 0) + \alpha_3 black + \alpha_4 hispanic + \epsilon_t^w\} \tag{18}$$

D.4 Unemployment Probability (J_t)[58]

$$\Pr(J_t = 1) = \Phi[\xi_0 + \xi_1\Psi_t + \xi_2 I(h_{t-1} = 0) + \xi_3 black + \xi_4 hispanic] \tag{19}$$

D.5 Grant Functions (g^{grant})

D.5.1 Grants at 4-year college

$$grant_t = \zeta_0^U + \zeta_1^U AFQT + \zeta_2^U \frac{AFQT^2}{1000} + \zeta_3^U Inc \tag{20}$$

$$+\zeta_4^U \frac{Inc^2}{1000} + \sum_{k=2}^{K}\zeta_{5,k}I(type = k)$$

D.5.2 Grants at 2-year college[59]

$$grant_t = \zeta_0^C + \zeta_1^C Inc + \zeta_2^C \frac{Inc^2}{1000} \tag{21}$$

D.6 Asset Lower Bound ($g^{\underline{a}^o}$)

$$\underline{a}^o = -exp\{\mu_0 + \mu_1\Psi_t + \mu_2\Psi_t^2 + \mu_3 age_t + \mu_4 I(age_t \geq 23)\} \tag{22}$$

D.7 Degree Completion (BA_t)

$$\Pr(BA_t = 1|Eligible) = \Phi[\nu_0 + \nu_1 S_t^U I(S_t^U > 4.5) + \nu_2 S_t^U I(S_t^U > 5.5) \tag{23}$$

$$+\nu_3\Psi_t + \nu_4\Psi_t^2]$$

[57] Here H_t denotes years of work experience.

[58] Φ indicates the normal cumulative distribution function.

[59] In the data grants at 2-year colleges do not appear to depend on AFQT. This indicates that most merit based scholarships are awarded at 4-year colleges and that the Pell grant program is responsible for most of the grants at 2-year colleges.

D.8 Parental Transfers Probability (P_t)

$$\Pr(P_t = 1) = \Phi[\lambda_0 + \lambda_1 Inc + \lambda_2 \frac{Inc^2}{1000} + \lambda_3 I(s^C_{t-1} + s^U_{t-1} > 0) \tag{24}$$
$$+\lambda_4 I(s^C_{t-1} + s^U_{t-1} > 0)Inc + \lambda_5 I(P_{t-1} = 1) + \lambda_6 age_t$$
$$+\lambda_7 \Psi_t + \lambda_8 I(age_t > 23) + \lambda_9 black + \lambda_{10} hispanic + \lambda_{11} I(J_t = 0)]$$

D.9 Amount of Parental Transfers (tr_t)

$$tr_t = \exp\{\chi_0 + \chi_1 I(s^U_t > 0) + \chi_2 I(s^U_t > 0)Inc + \chi_3(S^U_t + S^C_t + 12) \tag{25}$$
$$+\chi_4 age_t + \chi_5 Inc + \chi_6 \frac{Inc^2}{1000} + \chi_7 \Psi_t + \chi_8 black + \chi_9 hispanic + \chi_{10} I(J_t = 0)\}$$

D.10 Type Probability Distribution[60]

$$\Pr(type = k) = \frac{\exp\{\pi_{0,k} + \pi_{1,k} AFQT_1 + \pi_{2,k} AFQT_2 + \pi_{3,k} Inc_1 + \pi_{4,k} Inc_2 + \pi_{5,k} black + \pi_{6,k} hispanic\}}{1 + \sum_{m=2}^{K} \exp\{\pi_{0,m} + \pi_{1,m} AFQT_1 + \pi_{2,m} AFQT_2 + \pi_{3,m} Inc_1 + \pi_{4,m} Inc_2 + \pi_{5,m} black + \pi_{6,m} hispanic\}} \tag{26}$$

D.11 Minimum Earnings[61]

$$w^{MIN} = \omega_0 + \omega_1 H_t \tag{27}$$

D.12 Terminal Value Function (V^{TERM})[62]

$$V^{TERM} = PDV + \upsilon_1 a_t \tag{28}$$

D.13 Distribution of Shocks[63]

$$\begin{pmatrix} \epsilon^C_t \\ \epsilon^U_t \\ \epsilon^h_t \\ \epsilon^w_t \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_C & & & \\ \sigma^2_{CU} & \sigma^2_U & & \\ \sigma^2_{Ch} & \sigma^2_{Uh} & \sigma^2_h & \\ \sigma^2_{Cw} & \sigma^2_{Uw} & \sigma^2_{hw} & \sigma^2_w \end{pmatrix} \right]$$

E Parameter Values

E.1 Calibrated Parameter Values

[60] Coefficients for type 1 are all normalized to 0.
[61] Amount of monthly welfare benefits received if unemployed and not enrolled in school.
[62] See Appendix C.1 for details about PDV, the present discounted value of future wages.
[63] Currently all covariances between shocks are set to zero.

Table 19: Calibrated Parameter Values

Description	Symbol	Value	Source
Annual college tuition by state category[a]			IPEDS data on statewide enrollment weighted average tuition from 2001-2005
	κ_1^U	\$5,214	
	κ_2^U	\$7,499	
	κ_3^U	\$8,607	
	κ_4^U	\$12,748	
	κ_1^C	\$1,507	
	κ_2^C	\$989	
	κ_3^C	\$2,192	
	κ_4^C	\$2,520	
Cost of room and board at 2-year college[b]	.	\$4,539	IPEDS data on room and board at 2-year colleges from 2001-2005
Cost of room and board at 4-year college	.	\$6,532	IPEDS data on room and board at 4-year colleges from 2001-2005
Risk aversion parameter	ρ	2	Standard value from the literature
Annual discount rate	δ	.97	Standard value from the literature

[a] The average tuition in the second group for 2-year colleges is lower in the first group due to the fact that some states have relatively low average tuition at 2-year colleges and relatively high average tuition at 4-year colleges. See Section C.3 for details on the construction of the tuition categories.

[b] In principle average costs of room and board could be broken down into the different categories above. The variation in room and board prices across states is relatively small, however, so I use national averages for simplicity.

E.2 Estimated Parameter Values[64]

Table 20: Estimated Parameters

Description	Symbol	Estimate (S.E.)
Utility Function		
Psychic costs of 4-year college attendance		
$AFQT_3$	γ_1	-20.26 (4.09)
$AFQT_2$	γ_2	-59.99 (9.6)
$AFQT_1$	γ_3	-44.14 (6.76)
Black	γ_4	9.893 (5.89)
Hispanic	γ_5	-77.56 (31.9)
Psychic costs for 4-year college full time shifter	γ_6	1.121 (.07)
Psychic costs of 2-year college attendance		
$AFQT_3$	γ_7	-39.68 (6.97)
$AFQT_2$	γ_8	-48.45 (6.82)
$AFQT_1$	γ_9	-28.55 (4.25)
Black	γ_{10}	18.06 (5.78)

Continued on next page...

[64] Standard errors are calculated using the formula on page S92 of Gouriéroux et al. (1993).

Description	Symbol	Estimate (S.E.)
Hispanic	γ_{11}	25.33 (6.7)
Psychic costs for 2-year college full time shifter	γ_{12}	1.286 (.068)
Attending 4-year college after age 22	γ_{13}	-3.118 (.261)
Attending 2-year college after age 20	γ_{14}	-2.568 (.314)
Persistence in college attendance		
4-year college	γ_{15}	138.6 (6.82)
2-year college	γ_{16}	116 (7.39)
Fall to spring in 4-year college	γ_{17}	49.67 (11.5)
Fall to spring in 2-year college	γ_{18}	61.2 (22.1)
Attending school after completing BA	γ_{19}	-119.3 (11.6)
Work preferences		
Preference for working part-time	γ_{20}	-16.32 (2.45)
Type 2	$\gamma_{21,2}$	-2.645 (.786)
Type 3	$\gamma_{21,3}$	-1.103 (.711)
Black	γ_{22}	-46.37 (4.09)
Hispanic	γ_{23}	-43.95 (4.86)
Preference for working full time shifter	γ_{24}	4.927 (.34)
Work full-time interacted with age	γ_{25}	2.164 (.279)
Work part-time interacted with age	γ_{26}	-.6864 (.125)
Work full-time after age 23	γ_{27}	47.66 (5.07)
Working while attending college		
Work full-time 4-year college full-time	γ_{28}	-75.27 (6.29)
Work part-time 4-year college full-time	γ_{29}	-3.08 (2.21)
Work full-time 2-year college full-time	γ_{30}	-9.78 (4.62)
Work part-time 2-year college full-time	γ_{31}	-.1433 (1.2)
Work full-time 4-year college part-time	γ_{32}	-55.87 (7.46)
Work part-time 4-year college part-time	γ_{33}	-24.27 (18.4)
Work full-time 2-year college part-time	γ_{34}	-10.33 (5.68)
Work part-time 2-year college part-time	γ_{35}	-5.784 (8.58)
Starting 4-year college semester after high school		
$AFQT_3$	γ_{36}	77.72 (23.6)
$AFQT_2$	γ_{37}	65.87 (28.5)
$AFQT_1$	γ_{38}	14.71 (82.9)

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Description	Symbol	Estimate (S.E.)
Starting 2-year college semester after high school		
$AFQT_3$	γ_{39}	3.807 (17.1)
$AFQT_2$	γ_{40}	2.231 (27)
$AFQT_1$	γ_{41}	2.313 (38.2)
Continuing in 4-year college after completing 3 years	γ_{42}	64.77 (6.6)
Attending 4-year college after age 24	γ_{43}	57.69 (5.22)
Unobserved heterogeneity in psycic schooling costs		
Type 2	$\gamma_{44,2}$	-36.85 (5.2)
Type 3	$\gamma_{44,3}$	-150.6 (12.2)
Human Capital Function		
Constant	ϕ_0	2.485 (.013)
Years at 4-year college	ϕ_1	.0168 ($2.4e-03$)
Years at 2-year college	ϕ_2	.0145 ($1.9e-03$)
BA degree completion	ϕ_3	.1905 (.02)
Years of experience	ϕ_4	.0685 ($1.3e-03$)
Years of experience squared	ϕ_5	-.0032 ($1.0e-04$)
$AFQT$	ϕ_6	2.5e-04 ($7.0e-05$)
Type 2	$\phi_{7,2}$	-.0709 (.011)
Type 3	$\phi_{7,3}$	-.2264 (.016)
Wage Equation Parameters		
Part-time work	α_1	-.0107 ($7.8e-03$)
Enrolled in school	α_2	-.4677 (.024)
Black	α_3	-.1015 (.013)
Hispanic	α_4	-.0284 (.022)
Job Offer Probability Parameters		
Constant	ξ_0	1.446 (.071)
Human capital	ξ_1	.0492 ($4.2e-03$)
Not working in previous semester	ξ_2	-1.111 (.017)
Black	ξ_3	-.4199 (.023)
Hispanic	ξ_4	-.1333 (.027)

Continued on next page...

Description	Symbol	Estimate (S.E.)
Grant Function		
Grants at 4-year college		
Constant	ζ_0^U	8479 ($1.8e+03$)
$AFQT$	ζ_1^U	-67.22 (3.82)
$AFQT^2/1000$	ζ_2^U	260.7 (54.1)
Family income	ζ_3^U	-36.53 (5.82)
$Inc^2/1000$	ζ_4^U	80.47 (24.4)
Type 2	$\zeta_{5,2}^U$	-150.3 (157)
Type 3	$\zeta_{5,3}^U$	-309 (104)
Grants at 2-year college		
Constant	ζ_0^C	2011 (448)
Family income	ζ_1^C	-22.19 (4.16)
$Inc^2/1000$	ζ_2^C	57.91 (18.8)
Asset Lower Bound		
Constant	μ_0	.5523 (.171)
Human capital	μ_1	.0984 (.012)
Human capital squared	μ_2	-.0011 ($2.3e-04$)
Age	μ_3	.2507 ($5.2e-03$)
Age 23 or older	μ_4	.4159 (.141)
Degree Completion Probabililty		
Constant	ν_0	-3.334 (.091)
Years at 4-year college if > 4.5	ν_1	-5.4e-04 ($4.9e-04$)
Years at 4-year college if > 5.5	ν_2	.0856 (.017)
Human capital	ν_3	.1666 ($8.6e-03$)
Human capital squared	ν_4	6.4e-05 ($5.3e-05$)
Parental Transfers Probabililty		
Constant	λ_0	1.681 (.145)
Family income	λ_1	9.5e-04 ($1.4e-04$)

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Description	Symbol	Estimate (S.E.)
$Inc^2/1000$	λ_2	-.0017 ($5.7e-04$)
Attending college previous semester	λ_3	.0551 (.016)
Attending previously interacted with family income	λ_4	.0035 ($4.6e-04$)
Parental transfers previous semester	λ_5	2.695 (.094)
Age	λ_6	-.1949 ($1.7e-03$)
Human capital	λ_7	.0841 ($7.4e-03$)
Age>21	λ_8	-.0522 (.021)
Black	λ_9	.071 (.019)
Hispanic	λ_{10}	.2904 (.069)
Unemployed	λ_{11}	2.414 (.429)
Amount of Parental Transfers		
Constant	χ_0	10.8 (.022)
4-year college attendance	χ_1	.1581 (.05)
4-year attendance interacted with family income	χ_2	.0021 ($2.2e-04$)
Years of schooling	χ_3	.0033 ($1.7e-03$)
Age	χ_4	-.1373 ($3.3e-03$)
Family income	χ_5	.0036 ($3.1e-04$)
$Inc^2/1000$	χ_6	-.0054 ($8.9e-04$)
Human capital	χ_7	.0366 ($6.5e-03$)
Black	χ_8	.0467 (.028)
Hispanic	χ_9	-.0347 (.037)
Unemployed	χ_{10}	.4932 (.065)
Type Probability Distribution		
Type 2		
Constant	$\pi_{0,2}$	-.5899 (.27)
$AFQT_1$	$\pi_{1,2}$	.3418 (.659)
$AFQT_2$	$\pi_{2,2}$	2.015 (.535)
Inc_1	$\pi_{3,2}$	.1918 (.85)
Inc_2	$\pi_{4,2}$	.611 (.293)
Black	$\pi_{5,2}$	-.1486 (.289)
Hispanic	$\pi_{6,2}$	.1027 (.737)

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Description	Symbol	Estimate (S.E.)
Type 3		
Constant	$\pi_{0,3}$	-.1928 (.132)
$AFQT_1$	$\pi_{1,3}$	1.749 (.218)
$AFQT_2$	$\pi_{2,3}$	.2873 (.33)
Inc_1	$\pi_{3,3}$	.7125 (.339)
Inc_2	$\pi_{4,3}$	.359 (.172)
Black	$\pi_{5,3}$	.0789 (.125)
Hispanic	$\pi_{6,3}$	.2091 (.151)
Minimum Earnings		
Constant	ω_0	325.2 (137)
Experience	ω_1	51.53 (13.6)
Terminal Value Function		
Assets	υ_1	.0805 (.02)
Shock Distribution		
Preference for 2-year college	σ_C^2	3482 (471)
Preference for 4-year college	σ_U^2	2599 (526)
Preference for work	σ_h^2	201.3 (37.3)
Wage	σ_w^2	.0473 ($1.8e-03$)