Borrowing Constraints, College Enrollment, and Delayed Entry

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Abstract

The costs of college attendance in real terms in the US have approximately doubled over the past two decades while the amount students are able to borrow from government sponsored loan programs has shrunk by half. I examine the effects of relaxing borrowing constraints on educational attainment by simulating increases in the amount students are able to borrow from government sponsored loan programs. When evaluating higher education policies it is important to take into account the substantial heterogeneity that exists in the population of students in family characteristics, observed and unobserved ability, choice of college type, and the timing of college entry. The previous literature has not fully accounted for these sources of heterogeneity. In this paper I solve and estimate a dynamic structural model of education, borrowing, and work decisions of youths who graduate from high school. My results indicate that borrowing constraints have a small impact on college enrollment and degree completion. The removal of education related borrowing constraints increases degree completion by up to 2.7 percentage points. Tuition subsidies have a much larger effect on educational attainment. Subsidies targeted toward high income households are shown to be most cost-effective policy the government can implement to increase degree completion in the population. Borrowing constraints and tuition prices are shown to have small impacts on the fraction of students delaying entry to college.

1 Introduction

The large increase in the college wage premium in the 1980s has been accompanied by a relatively modest increase in college completion.[1] One possible explanation for this disparity is that the price of college has increased while the availability of student loans has declined. 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). Over this time period the amount first year undergraduates can borrow through the Stafford loan program has shrunk from $4,700 to $2,700. Another potential reason for the modest increase in educational attainment is that there is substantial heterogeneity in the population in terms of ability and resources and that few students are close to the margin of college graduation. This paper will incorporate heterogeneity in observed and unobserved ability, parental income, and parental transfers into a model of college entry and degree completion. The model will then be used to evaluate the effects of relaxing borrowing constraints and increasing tuition subsidies.

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

How might borrowing constraints affect educational decisions? Outside of loans the main avenues available to students to finance college are parental transfers, 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 saves up money. 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.

The government subsidizes higher education through both the Guaranteed Student Loan (GSL) program and through tuition subsidies in the form of Pell grants. It is useful to explore from a policy perspective whether increases in loan limits or tuition subsidies are the most cost effective method for the government to promote higher education. I explore this question by holding constant the cost of a policy change and looking at the effects of relaxing borrowing constraints and increasing various tuition subsidies.

When evaluating policy changes that the government may implement it is important to take into account the substantial heterogeneity that exists between students in family characteristics, observed and unobserved ability, choice of college type, and the timing of college entry. The previous literature has not fully accounted for these sources of heterogeneity when evaluating higher education policy. In this paper I solve and estimate a dynamic structural model of education, borrowing, and work decisions of youths who graduate from high school. My model expands and improves on those in the existing literature in many ways. I model the choice between two and four year colleges and the probability of completing a bachelor's degree. I explicitly take into account the uncertainty students face by modeling the probability that they will become unemployed after graduating from school. I use the rules of the GSL program to identify the borrowing constraints students face. I estimate the model through Indirect Inference, a moment based estimation method, using data from the NLSY97 on student college entry decisions and labor market outcomes.

I find that borrowing constraints have a small impact on college enrollment and degree completion. The removal of education related borrowing constraints increases degree completion by up to 2.7 percentage points. It is interesting to note that despite borrowing constraints being tight removing them has only a small impact on educational attainment. I argue that the precautionary savings motive (Carroll (1997)) can explain the reluctance of youths to borrow against high future incomes because they are concerned about building a buffer stock of savings to insure against unemployment and low wage shocks in the future. I show that borrowing constraints and tuition subsidies have very small impacts on the fraction of students delaying entry to college. 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 find that tuition subsidies targeted toward high income households are the most cost-effective method of increasing degree completion and raising the average wage in the population.

2 Related Literature

There is a large literature related to borrowing constraints and educational attainment. The main papers in the literature that use older (NLSY79) data are Keane and Wolpin (2001), Carneiro and Heckman (2002), and Cameron and Taber (2004). None of these papers finds evidence that borrowing constraints affect educational attainment. Keane and Wolpin (2001) estimate a structural model similar to the one used this paper and show that relaxation of borrowing constraints has no effect on the average highest grade completed in their sample. Carneiro and Heckman (2002) examine whether 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 and that significant differences in educational attainment across parental income quartiles would be suggestive evidence of credit constraints. They find that after controlling for ability there is little or no difference in educational attainment 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 credit constrained is compared to an instrument that should affect all students equally. They also estimate a structural model and test whether the interest rate faced by lower income students is higher than that faced by the rest of the population. Neither of these methods provides any evidence that borrowing constrains affect educational attainment.

In recent years there has been renewed interest in the literature about whether borrowing constraints have an impact on educational attainment. Rothstein and Rouse (2008) suggest that graduates from elite universities may be credit constrained early in the life cycle. Belley and Lochner (2007) use the methods in Carneiro and Heckman (2002) and compare differences 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 simple 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. 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 micro data to evaluate the decisions and outcomes of agents. It is therefore difficult to accurately assess the effects of borrowing constraints on student decisions.

There are 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). It is important to use these types of models to take into account changing relative prices when considering 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.

Stinebrickner and Stinebrickner (2008) directly ask a group of low income students at Berea college if they are constrained in their borrowing decisions. They ask if the students would take up a loan offered to them at the market interest rate. Stinebrickner and Stinebrickner (2008) find that the vast majority of students would not take up the loan if it were available and that borrowing constraints do not explain most of the drop-out decisions at Berea college. 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 by students. Students choose to borrow as little as possible 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.

Very few papers in the literature address delayed entry to college. 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.

The model in this paper is based on Keane and Wolpin (2001) (hereafter KW). There are a number of important differences between my model and theirs. I explicitly model the choice between 2-year and 4-year colleges and degree completion. Only years of completed schooling enters the KW model and there is no notion of degree completion. I have a better model of grants and loans and I explicitly use the rules of the Guaranteed Student Loan (GSL) program when I model the borrowing constraint. It is important to model the borrowing constraint and the rules of the GSL program accurately because when the government implements policies to relax borrowing constraints, this is the program that is most often altered. I also explicitly look at delayed entry to college as an outcome for agents in my model. Agents are allowed to choose to delay entry to college in the KW model, but they do not examine this phenomena or look at how policy changes could affect delayed entry. As mentioned previously, delayed entry decreases the lifetime earnings of students and is therefore worthy of study. I also better capture the uncertainty that agents face in the labor market by including a probability of unemployment in my model. In the KW model agents receive a random wage draw each period but always have the option to work. It is important to model unemployment because when an agent is unemployed the opportunity cost of schooling will be 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.

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 choose to exclude marriage from my model, whereas KW include it in theirs. 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. I also only model the behavior of students after they graduate from highschool, whereas KW start their decision period at age 16 and model high school completion. Since students who fail to graduate from high school are not prepared for college entry, omitting them from the sample is unlikely to affect inference about attainment in postsecondary education.

3 Model

The model describes the decision of an individual from the semester he 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:

$$\Theta = \{(h_t, s_t^C, s_t^U, a_{t+1}) : \tag{1}$$

$$h_t \in \{0, .5, 1\}, s_t^C \in \{0, .5, 1\}, s_t^U \in \{0, .5, 1\}, a_{t+1} \in [\underline{a}, \overline{a}]\}$$

The work decision of the agent, h_t, is discretized in to 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 and 4-year colleges, respectively. 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.

The agent also chooses a_{t+1}, the amount of savings for the following period. Assets may not fall below the (potentially negative) amount $\underline{a}$. For computational simplicity the maximum the agent is allowed to save is restricted to be less than or equal to $\overline{a}$.

3.2 Initial Conditions

The agent begins the first period with five initial conditions which are elements of the state space and capture heterogeneity across agents that existed before high school graduation. During the first period the agent is potentially receiving parental transfers, which is denoted by the indicator variable P_0. The income of the parents of the agent is denoted Inc and the agent is endowed with an initial level of assets a_0. The agents observed ability is measured by the variable $AFQT$. The final initial condition is the agent's *type*. The *type* is known to the agent (but not to the econometrician) and captures permanent unobserved heterogeneity in the population.

3.3 State Space

In addition to the initial conditions, the following variables evolve over time and appear in the state space. S_t^C and S_t^U measure years of schooling completed at 2-year colleges (community colleges) and 4-year colleges (universities). 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 measured by the variable H_t. Lagged choice variables and the current level of assets also enter the state space. The vector of state variables Ω_t is given by:

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

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. Throughout the remainder of this section the exact form of the g functions is left to Appendix D. In general the g functions are linear functions of their arguments, sometimes including higher order polynomials. The function g^u captures the psychic costs of schooling and work which depend on the current state variables. The agent also receives a shock to preferences for 2-year college attendance, 4-year college attendance, and desire to work each period given by 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 budget constraint binds each semester and is given by the following equation:

$$c_t + \kappa^C s_t^C + \kappa^U s_t^U + a_{t+1} = w_t h_t + tr_t P_t + grant_t + (1+r)a_t \tag{4}$$

The costs the agent incurs must be equal to the income the agent receives every semester. The costs are the agent's consumption c_t, the costs of schooling κ^j at school type j multiplied by the enrollment status at that school, and the amount the agent saves which is given by a_{t+1}. The income an agent receives is from work $w_t h_t$, money received from parental transfers tr_t, grants received for schooling costs from the government and from other sources $grant_t$, and assets carried over from the previous period plus interest earned at rate r.

3.6 Wages and Unemployment

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

$$\Psi_t = g^{\Psi}(H_t, S_t^C, S_t^U, BA_t, AFQT, type) \tag{5}$$

Each period the agent receives a job offer J with probability p_t^J:

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

If the agent receives a job offer he receives a draw from the wage distribution with variance σ_w^2. The wages of an agent depend both on the agent's human capital and on the agent's school enrollment and work status. This is designed 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:

$$w_t = g^w(\Psi_t, h_t, s_t^C, s_t^U; \sigma_w^2) \tag{7}$$

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} includes money received from Unemployment Insurance, Food Stamps, and Supplemental Security Income.

3.7 Grants and Loans

The grant function is of the form:

$$grant_t = g^{grant}(Inc, AFQT, s_t^C, s_t^U, type) \tag{8}$$

The grant function is designed to capture the fact that grants for post-secondary education are decreasing in parental income since programs such as the Pell Grant are need based scholarships. Grants are increasing in ability due to the prevalence of merit based scholarships. Only students that are enrolled in school are eligible to receive grants.

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

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

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 consumption smoothing purposes. $\underline{a}_t^s$ 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 of the form:

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

This functional form captures that the amount people are allowed to borrow for other expenses (say through a credit card or a loan to purchase a car) increases as the with the agent's credit history, which can be approximated as a function of age and human capital.

3.8 Degree Completion

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:

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

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.

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.

3.9 Parental Transfers

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

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

The amount of parental transfers is given by:

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

The agents take the parental transfers as given. The decisions of the agent affect parental transfers through school enrollment and human capital accumulation.

4 Solution Method

The model is solved numerically through backward recursion on a Bellman equation by assuming a terminal value function V^{TERM} when the agent reaches age 40. It is computationally infeasible to allow for a continuous savings choice in the model, so I allow the agent to choose between a number of discrete grid points on the interval $[\underline{a}, \overline{a}]$. The agent therefore chooses a vector $\theta_t = (h_t, s_t^C, s_t^U, a_{t+1})$ each period to solve the following maximization problem:

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

The expectations operator E in (14) is taken with respect to the preference shocks ϵ_t, the wage draw, and 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 each period. 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 high dimensional 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.

5 Estimation

The likelihood function for this model is very complex due to the size of the model and the fact that the number of choices each period is greater than the number of error terms. In addition there are a number of missing state variables due to the timing of collection of data on parental transfers and assets. Estimation via maximum likelihood is infeasible because it would require that I integrate out the distribution of the unobserved state variables for an already intractably complex likelihood function. I therefore use Indirect Inference to estimate the model (see Smith (1993) and Gouriéroux and Monfort (1996) for an overview of the method).[2]

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 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 (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). The auxiliary models I use consist of a series of linear regressions. See Appendix C.3 for the variables included in the regressions and details about the weighting matrix Λ.

6 Data and Descriptive Statistics

The data I use are 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,

[2]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 (2006), Nagypál (2007), and Tartari (2007).

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 males from the representative NLSY97 sample.[3] I exclude women from the analysis because I do not model marriage or fertility. I plan to extend this model and estimate it separately for men and women in future work. The focus of my model is about college entry decisions, so I include only youths that completed a high school degree between the ages of 16 and 19. I exclude GED recipients, those who never complete a high school degree, and youths who serve in the military.[4] 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 makeing decisions about entering college. It would be very complicated to add GED completion or military service to the model. After exculiding youths for which 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 1,329 youths and 25,579 person-semester observations.

6.1 NLSY79 Data

In order to solve the model presented in this paper I need make assumptions about agents' expectations of future labor market outcomes. The approach commonly used in the literature when estimating this type of model 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 23 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. A natural source to acquire 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.[5] See Appendix A for details about the use of the NLSY79 data.

6.2 School Attendance (s_t^C,s_t^U)

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. The NLSY97 uses this data 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 fall semester if he reports enrollment during the months of February, March, and April. Spring semester attendance is defined to be equivalent to enrollment during the months of October, November, and December.[6] 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

[3] The data are unweighted. Currently only white males are used in the estimation. The next version of this paper will use the data on minorities and will allow for differences between whites and minorities in various functions.

[4] 24.6% of white male youths fail to graduate from high school between ages 16 and 19. Only 12% 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. 10.3% of the youths who graduate from high school between ages 16 and 19 serve in the military at some point during the survey.

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

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

in my model.[7] Given the short length of the summer semester and the small fraction of youth 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 one can see that 55.9% of youths in the sample are enrolled in college during the fall semester when they are 18 years old.[8] 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. 7% of youths are still attending school during the spring semester of age 26. In the model youths are allowed to enroll in school until they reach age 30 after which enrollmented is prohibited for computational simplicity.

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	1325	39.2	1.4	12.9	2.4	44.1
	Spring	1315	40.1	1.6	12.6	2.4	43.3
19	Fall	1309	39.3	1.0	13.2	2.2	44.3
	Spring	1295	38.1	1.2	12.3	3.0	45.4
20	Fall	1283	38.5	1.3	9.4	2.6	48.2
	Spring	1273	38.3	1.4	7.9	2.6	49.7
21	Fall	1265	39.3	1.1	5.3	1.9	52.4
	Spring	1247	37.5	2.6	5.0	2.9	52.0
22	Fall	1136	24.4	3.1	3.5	1.9	67.1
	Spring	1095	19.5	3.6	2.5	2.6	71.9
23	Fall	885	13.2	2.8	2.0	2.1	79.8
	Spring	801	9.1	3.2	1.7	2.2	83.6
24	Fall	611	7.0	2.1	2.0	1.6	87.2
	Spring	543	6.1	1.1	1.3	1.8	89.7
25	Fall	377	5.8	1.3	1.1	1.6	90.2
	Spring	303	5.0	1.7	1.3	1.0	91.1
26	Fall	159	5.0	1.3	1.3	1.9	90.6
	Spring	99	2.0	3.0	1.0	1.0	92.9

[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.

Each youth starts the model with 0 years of completed schooling at 2-year and 4-year colleges when he graduates from high school.[9] 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.

[7]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.

[8]For ease of exposition and simplification of the model estimation I set all agents age to 18 and zero semesters 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.

[9]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

6.3 Work Status (h_t) and Unemployment (J_t)

A large fraction of youths work while enrolled in college. 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.

Youth work status is determined using the weekly history 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, part time if he works at least 10 hours per week but less than 30 hours per week, and 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. The 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 2 displays descriptive statistics about labor force participation. A larger fraction of 2-year college students work while attending college than 4-year college students. 2-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.[10] 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 tends to be higher during the spring semester at younger ages, and decreases overall as the youths become older. The fraction of youths working part time or not at all also decreases with age.

6.4 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 youth, the amount of money the family gives for college related expenses[11], 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 3 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. 93.7% of youths receive transfers from their parents when they are 18 years old. This percentage declines to 31.7% by the age of 26. The average amount received declines from $9,942 at age 18 to $4,660 at age 26.[12] The coresidence 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

[10] Recall that the NLSY97 does not gather data on summer college attendance. Summer attendance is therefore excluded as an option in the descriptive statistics and in the model.

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

[12] All dollar amounts in this paper are expressed in 2004 dollars.

Table 2: 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	1303	.	.	.	.	.	.	39.1	33.6	27.2	4.9
	Fall	1312	2.7	9.6	28.4	4.0	7.1	4.3	23.6	12.8	7.5	7.9
	Spring	1306	5.5	14.2	21.8	5.4	6.0	3.6	26.5	9.8	7.1	10.2
19	Sum	1305	.	.	.	.	.	.	54.0	26.4	19.6	4.8
	Fall	1295	5.0	11.7	23.6	5.3	6.7	3.4	28.8	8.4	7.1	7.1
	Spring	1282	6.9	14.0	18.4	6.9	5.1	3.3	30.7	7.3	7.3	7.7
20	Sum	1281	.	.	.	.	.	.	56.6	23.0	20.4	4.2
	Fall	1275	5.6	12.8	21.6	5.3	4.1	2.6	33.4	8.1	6.7	6.5
	Spring	1268	7.4	15.0	17.5	5.0	3.5	2.1	35.4	6.3	7.8	7.4
21	Sum	1268	.	.	.	.	.	.	57.5	21.6	20.9	3.7
	Fall	1255	7.4	14.6	18.6	3.5	2.4	1.3	37.6	8.3	6.4	5.0
	Spring	1242	9.8	14.0	16.3	4.2	2.2	1.5	38.6	6.8	6.6	8.8
22	Sum	1241	.	.	.	.	.	.	62.9	18.2	18.9	5.0
	Fall	1107	6.1	9.7	11.5	3.2	1.8	0.6	49.1	10.3	7.7	4.5
	Spring	1088	7.3	7.6	8.3	3.2	0.9	0.8	55.1	9.3	7.4	5.1
23	Sum	1089	.	.	.	.	.	.	70.7	13.4	15.9	4.8
	Fall	828	6.4	5.0	4.0	2.7	0.8	0.6	62.3	9.8	8.5	4.5
	Spring	792	5.4	4.3	2.8	2.7	0.6	0.8	66.8	8.7	8.0	3.9
24	Sum	792	.	.	.	.	.	.	76.3	12.5	11.2	3.5
	Fall	559	3.2	3.2	2.1	2.5	0.9	0.2	69.4	12.0	6.4	3.0
	Spring	539	3.0	2.4	1.7	2.0	0.6	0.6	72.7	8.7	8.3	3.9
25	Sum	539	.	.	.	.	.	.	76.1	12.6	11.3	3.2
	Fall	332	3.6	2.1	1.8	1.2	0.9	0.0	73.2	9.6	7.5	3.0
	Spring	301	2.7	2.3	1.7	1.3	0.7	0.3	75.7	7.3	8.0	3.0
26	Sum	301	.	.	.	.	.	.	82.1	8.3	9.6	2.0
	Fall	114	2.6	1.8	0.9	2.6	0.0	0.0	77.2	7.9	7.0	1.8
	Spring	93	3.2	0.0	2.2	2.2	0.0	0.0	77.4	7.5	7.5	3.2

[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.

$4,000 and $5,000 while they are enrolled in college between the ages of 18 and 22. 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 $1,100 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. Table 5 displays some statistics about parental income and parental transfers broken down by college type and delayed entry.

Table 3: Parental Transfer Categories[a]

		Money from Parents		College Transfers		Coresidence[b]	Total Transfers	
Age	N	%	Mean if >0	%	Mean if >0	%	%	Mean if >0
18	1284	53.2	1129	30.9	5013	86.0	93.7	9942
19	1254	48.3	1537	41.1	4749	74.7	89.1	9719
20	1201	40.0	1422	38.6	4738	64.6	84.3	8893
21	1181	37.7	1633	35.5	4255	54.4	77.4	8169
22	1063	34.2	1489	29.3	4399	46.1	71.1	7400
23	824	28.6	1603	15.0	3404	37.6	59.8	6354
24	558	24.9	1152	5.2	1851	29.6	48.4	5343
25	351	21.9	1204	3.7	2620	21.9	41.3	4773
26	142	18.3	1467	2.1	1562	16.2	31.7	4660

[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 topcoded 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.

6.5 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.[13] To prevent the skewness of the asset distributions having a large effect on the estimated mean of assets 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 4.[14] At age 18 there is already a fair amount of dispersion in the asset distribution. 20% of youths have net worths of $10,000 or more (presumably these are savings from high school jobs or money

[13] 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.

[14] 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.

given to them by their parents) while less than 6% are in debt. At age 20, 18.5% of youths have negative net worth. By Age 25 the asset distribution is very skewed with 8.3% of youths borrowing $28,000 or more and 23.1% saving $30,000 or more. The standard deviation also increases from 7,932 at age 18 to 16,841 at age 25.

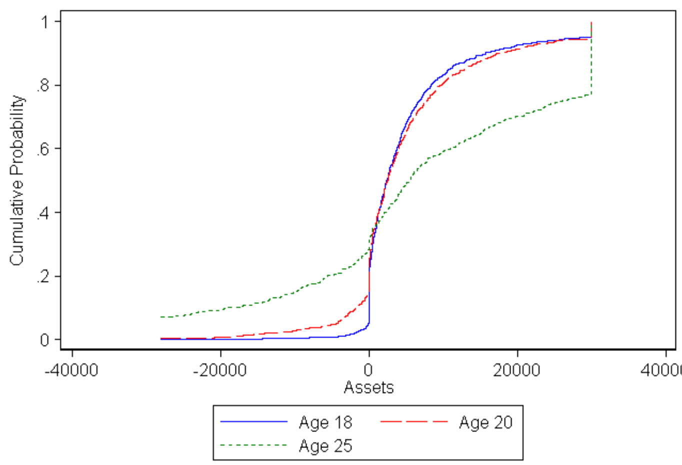

Figure 1: CDF of Net Asset Holdings by Age

Table 4: Asset Statistics by Age

Age	N	Median	Mean	Standard Deviation	Percent Negative
18	1329	2411	5259	7946	5.8
20	1270	2518	5008	9260	14.6
25	622	5388	7450	17575	29.1

6.6 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.[15] 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.[16]

Statistics about college grants and loans by type of college are displayed in Table 5. Students who attend only 2 year colleges are less likely to take out loans to finance college and those who do take out less than

[15]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.

[16]It would be too computationally burdensome to allow agents to choose over different types of assets with varying levels of liquidity and interest rates.

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 median value of loans per year of college is actually $2,000 higher for 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. 2-year college students are least likely to receive grants and receive the smallest amounts conditional on receipt.

Students who enroll in both 2-year and 4-year colleges appear similar to those who enroll in only 2-year colleges along many dimensions. 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 that only 62% of students that attend both college types start out at 2-year colleges. This means that over a third of these students begin at 4-year colleges and find them to be too difficult or too expensive to continue on and chose to transfer to a 2-year college.

6.7 Ability ($AFQT$)

Ability is measured by the AFQT score. This is an important measure in the model both for documenting the affects 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 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 map 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).[17]

Average AFQT score by college type is displayed in Table 5. 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 students with higher AFQT scores.

6.8 Wages (w_t)

Each semester wage data for the NLSY97 respondents is 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

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

Table 5: Selected Statistics by Type of College Attended and Delayed Entry

	Only 4-Year	Both Types	Only 2-Year	Never	No Delay	Delay
N	552	173	232	372	741	216
Parental Income and Transfers						
Average Parental Income[a]	110	98	80	70	104	88
Percent with Par. Trans. at 18	97.1	95.2	93.3	88.2	96.7	92.7
Ave Par. Trans. at 18 if >0	11233	8950	8073	7335	10649	8014
Percent with Par. Trans. at 20	91.1	88.1	85.5	70.7	90.0	86.4
Ave Par. Trans. at 20 if >0	9521	7206	6723	4859	8933	6765
College Loans and Grants						
Percent with College Loans	56.3	59.5	28.4	.	53.2	39.8
Ave College Loans if >0	9663	9116	5934	.	9500	6893
Ave Loans/Year if >0	2769	2452	4510	.	2676	4151
Percent Receiving Grants	69.4	60.1	35.3	.	65.3	39.4
Ave Grants if >0	14171	9245	3304	.	12808	5421
Ave Grants/Year if >0	3796	2419	2049	.	3453	2375
College Enrollment and Completion						
Fraction of Sems at 2-year	0.0	47.0	100.0	.	24.8	59.9
Enrolled Part-Time[b]	7.0	13.7	30.5	.	10.0	27.5
Completed BA	57.6	28.3	0.0	0.0	46.3	11.1
Highest Grade Completed	15.8	15.8	13.6	12.0	15.6	14.0
Ability and Labor Market Outcomes						
Ave AFQT Score	192	183	167	157	187	174
Average Hourly Wage at 18	10.8	9.7	10.4	11.7	10.8	9.5
Average Hourly Wage at 20	11.9	11.5	13.7	13.0	12.2	12.7
Average Hourly Wage at 22	14.0	15.8	14.1	15.9	14.6	13.5
Average Hourly Wage at 25	19.0	19.1	17.1	16.3	18.9	17.6
Work PT While Enrolled[b]	31.2	35.1	27.5	.	32.0	27.7
Work FT While Enrolled[b]	27.4	33.8	51.9	.	30.7	47.5
Unemployed Before Enrolled	6.0	6.1	6.5	.	5.7	7.4

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

during which the youth was working.[18]

Average wages by college type are displayed in Table 5. 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.

6.9 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.[19] 23% of youths in my sample who eventually enroll in college delay by a semester or more, 15% 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 are displayed in Table 5. Students who delay entry to college come from lower income households, are less likely to receive parental transfers, and receive less money from their parents conditional on receipt. Students who delay are less likely to borrow for college expenses, but those who do take out more loans per year on average than those who don't delay.

Students 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. Those who delay are also more likely to work while enrolled in school. The last row of the Table 5 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 6.7%. 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.

7 Identification

It is unfortunately 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 the model 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

[18]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

[19]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.

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 will 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. See Heckman and Singer (1984) for a proof of identification of unobserved heterogeneity related to duration models. 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. 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 my fixing a small number of types and requiring that 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. 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 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 $\$1,000$. Agents in this model save for purely precautionary reasons, desiring to smooth consumption between employed and unemployed states. I examine how average asset accumulation varies with $\underline{a}_t^o$. The results are displayed in Figure 2.

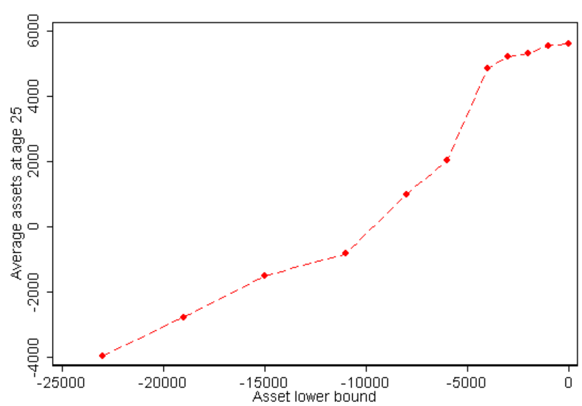

Figure 2: Average Asset Holdings by Borrowing Limit

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 Model Fit

The parameter estimates are reported in Table 18 in Appendix E.2.[20] 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 broad patterns of observed educational attainment in the data 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 broad pattern of decreasing enrollment with age is matched for both college types. The model fits the fraction of the population completing a bachelor's degree almost exactly. 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.

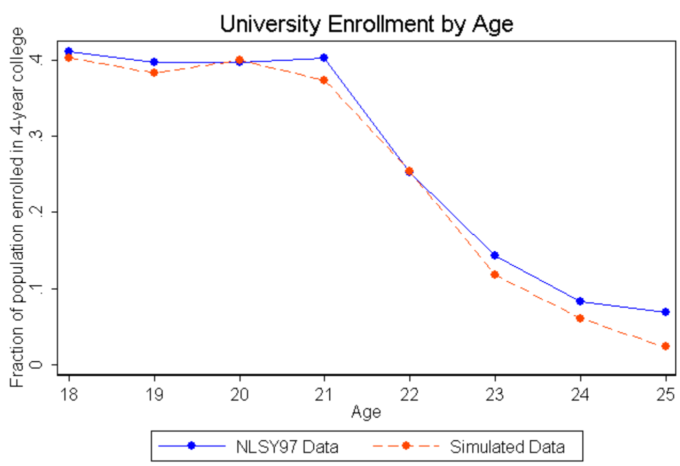

Figure 3: University Enrollment by Age

Table 6 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 under predicts the fraction of students delaying entry to college and the fraction of students ever attending college. The fraction of students delaying as the number of years of delay increases does not decline as sharply in the model as in the data. The main element of the model that generates delayed entry to college is the shock to preferences for college attendance. The structure of the shock (iid each period) is fairly simple, however. It appears that a more complicated model that perhaps incorporates learning about ability and preferences for high-school level jobs may be necessary to fully capture delayed entry.

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 age pattern of wages is fit very well,

[20]Standard errors will be estimated by bootstrapping. These calculations have not yet been performed.

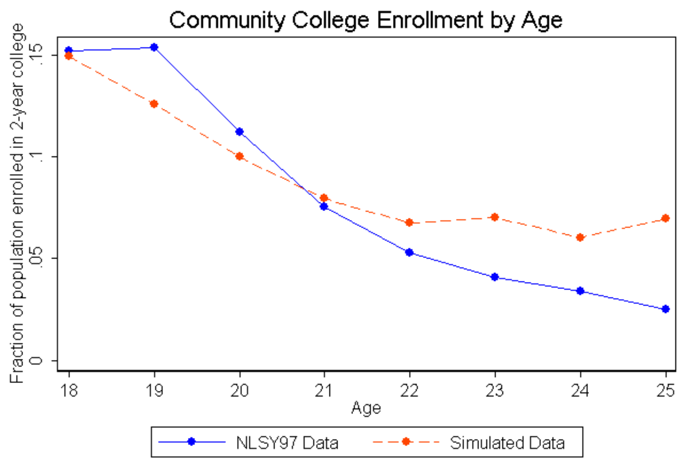

Figure 4: Community College Enrollment by Age

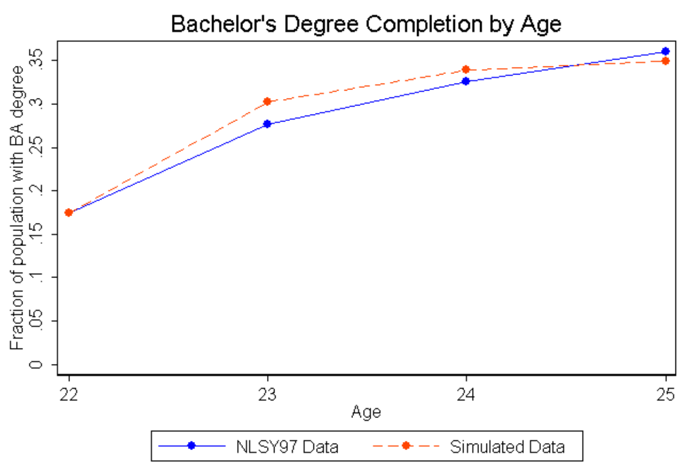

Figure 5: Bachelor's Degree Completion by Age

Table 6: Percentage of students delaying entry to college

Years after HS graduation	0	.5+	1+	2+	3+	Never
Data	75.7%	24.3%	17.2%	8.6%	4.9%	27.3%
Simulation	85.1%	14.9%	12.5%	11.0%	8.8%	34.5%

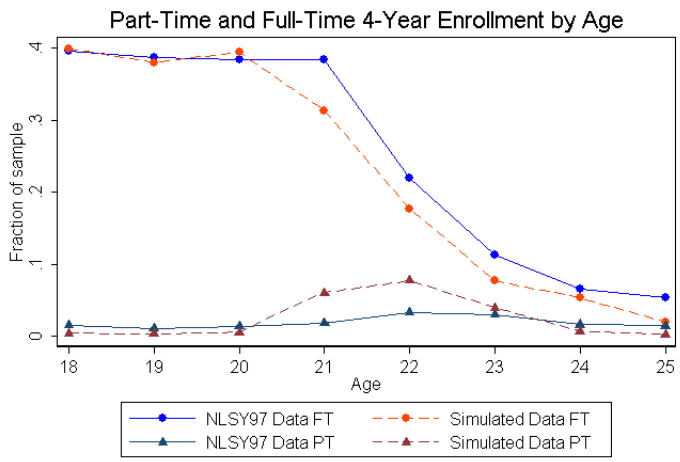

Figure 6: Part-Time and Full-Time 4-Year Enrollment by Age

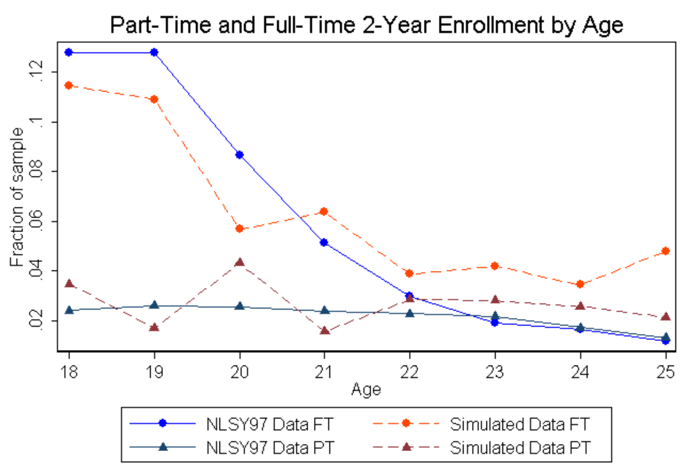

Figure 7: Part-Time and Full-Time 2-Year Enrollment by Age

while unemployment is slightly under-predicted at younger ages. 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 younger ages.

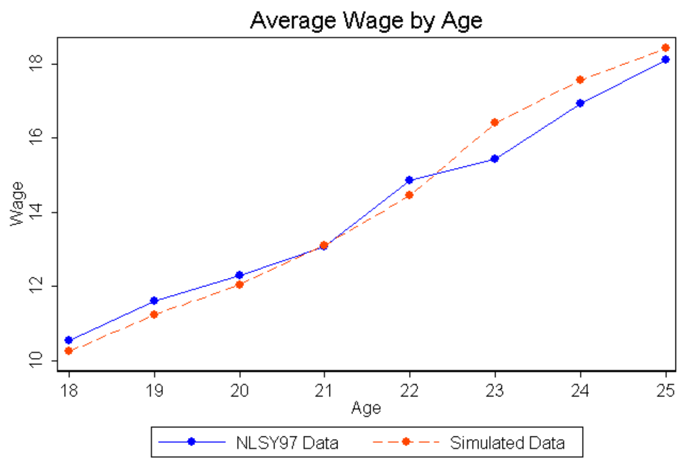

Figure 8: Average Wage by Age

The fraction of the population receiving parental transfers is displayed in Figure 11 and the average amount received is displayed in Figure 12. Overall the parental transfers received by the simulated agents are quite close to those received by the actual agents. Asset holdings are much more difficult to match due to the skewness of the asset distribution. Actual and simulated asset cumulative distribution functions at ages 20 and 25 are displayed in Figures 13 and 14.[21] The fact that the actual and simulated CDFs meet near zero at both ages indicates that the model is matching the fraction of youths with negative net worth well. At both ages, particularly at age 25, the simulated asset distribution does not match the skewness of the actual distribution. See Table 16 in Appendix C.2 for the estimates of $\underline{a}_t^o$. $\underline{a}_t^o$ is larger (more negative) for agents of higher ability and for older agents.

The previous dimensions of model fit discussed are all moments that are explicitly targeted by the auxiliary models (see Appendix C.3 for a list of auxiliary models). The model also fits well along other dimensions. Table 7 shows how well the model fits the various statistics reported in Table 5 broken down by type of college attended and delay status. The model fits the broad patterns of the data in that 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.

9 Results

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

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

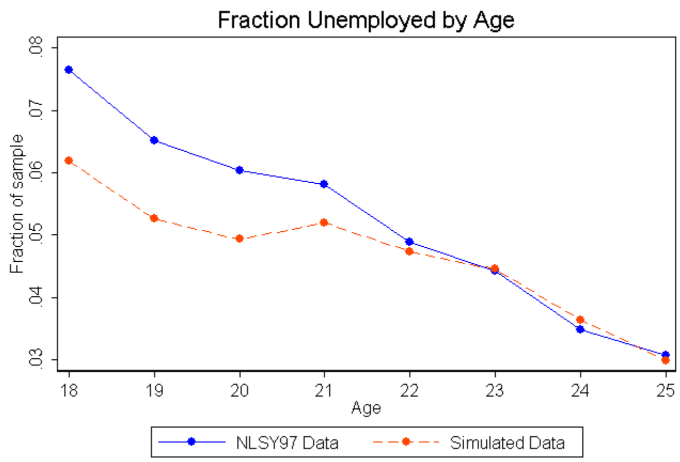

Figure 9: Fraction Unemployed by Age

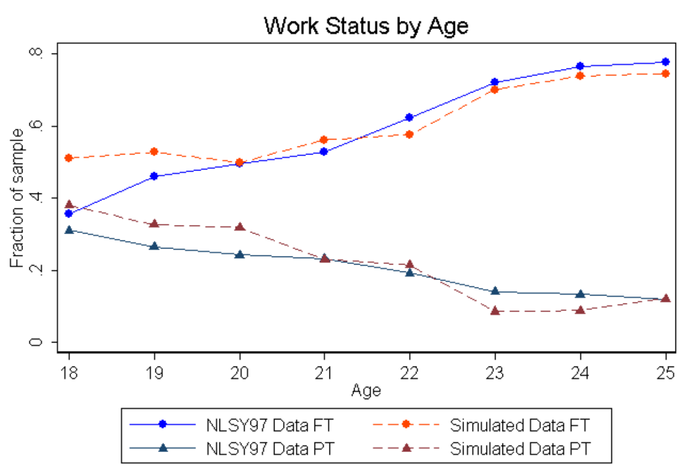

Figure 10: Work Status by Age

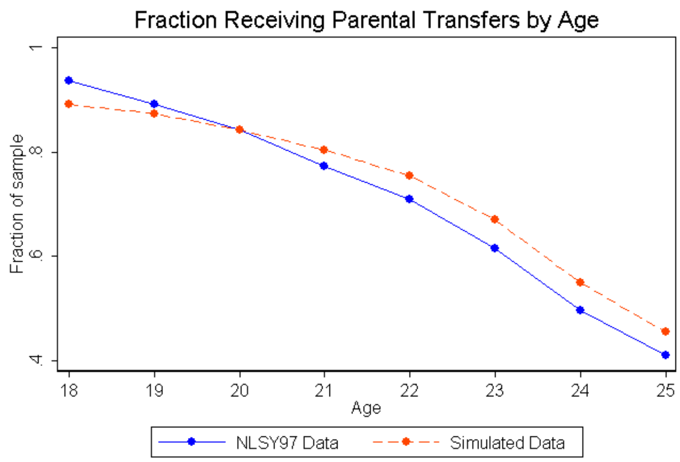

Figure 11: Fraction Receiving Parental Transfers by Age

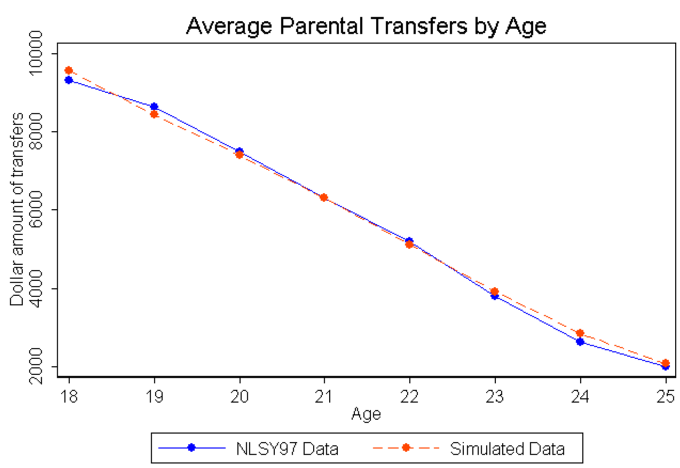

Figure 12: Average Parental Transfers by Age

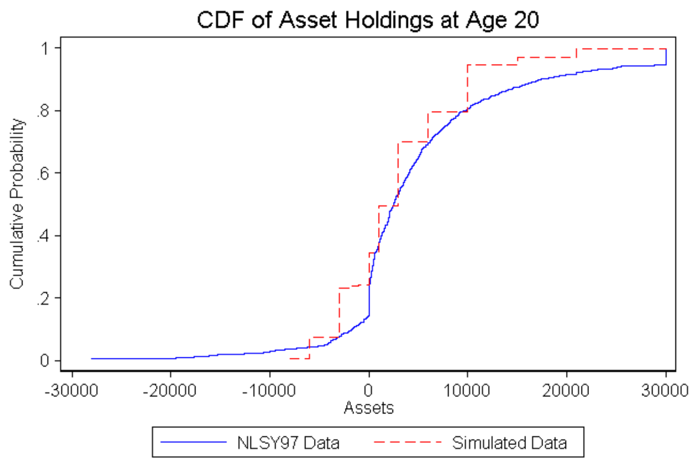

Figure 13: CDF of Asset Holdings at Age 20[21]

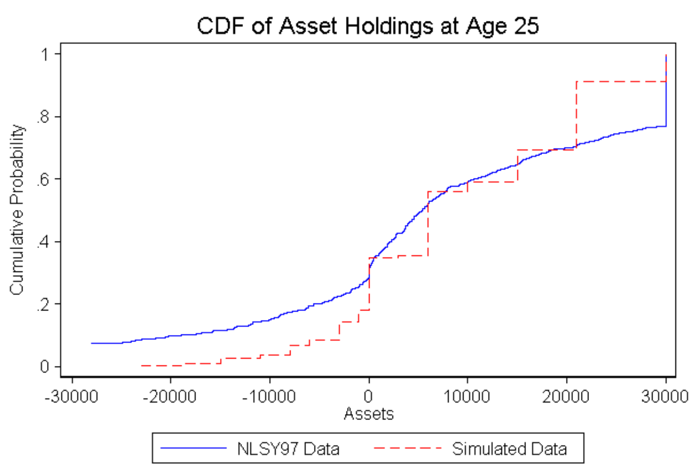

Figure 14: CDF of Asset Holdings at Age 25

Table 7: Selected Statistics by Type of College Attended and Delayed Entry*

		4-Year	Both	2-Year	Nvr	No Del	Del
N	D	552	173	232	372	741	216
	S	2825	338	1201	2281	3705	659
Parental Income and Transfers							
Average Parental Income[a]	D	110	98	80	70	104	88
	S	112	97	85	70	107	83
Percent with Par. Trans. at 18	D	97.1	95.2	93.3	88.2	96.7	92.7
	S	94.8	90.5	88.0	85.6	94.3	82.9
Ave Par. Trans. at 18 if >0	D	11233	8950	8073	7335	10649	8014
	S	9325	6999	5758	5281	8630	5540
Percent with Par. Trans. at 20	D	91.1	88.1	85.5	70.7	90.0	86.4
	S	92.7	84.5	86.8	72.5	91.3	85.4
Ave Par. Trans. at 20 if >0	D	9521	7206	6723	4859	8933	6765
	S	9914	7905	6189	4839	9025	7095
College Loans							
Ave Grants/Year if >0	D	3796	2419	2049	.	3453	2375
	S	5628	3464	1048	.	4521	3155
College Enrollment and Completion							
Fraction of Sems at 2-year	D	0.0	47.0	100.0	.	24.8	59.9
	S	0.0	45.6	100.0	.	26.6	56.3
Enrolled Part-Time[b]	D	7.0	13.7	30.5	.	10.0	27.5
	S	7.8	19.9	27.5	.	14.0	15.1
Completed BA	D	57.6	28.3	0.0	0.0	46.3	11.1
	S	79.8	24.6	0.0	0.0	60.7	13.2
Highest Grade Completed	D	15.8	15.8	13.6	12.0	15.6	14.0
	S	16.2	16.1	14.7	12.0	16.1	14.1
Ability and Labor Market Outcomes							
Ave AFQT Score	D	192	183	167	157	187	174
	S	191	178	165	164	186	168
Average Hourly Wage at 18	D	10.8	9.7	10.4	11.7	10.8	9.5
	S	9.7	9.8	10.1	11.1	9.5	11.5
Average Hourly Wage at 20	D	11.9	11.5	13.7	13.0	12.2	12.7
	S	11.2	11.9	12.0	12.6	11.4	12.0
Average Hourly Wage at 22	D	14.0	15.8	14.1	15.9	14.6	13.5
	S	14.0	14.2	14.2	14.2	14.1	14.1
Average Hourly Wage at 25	D	19.0	19.1	17.1	16.3	18.9	17.6
	S	20.1	16.9	16.8	16.9	19.3	16.7
Work PT While Enrolled[b]	D	31.2	35.1	27.5	.	32.0	27.7
	S	33.4	25.8	29.4	.	34.1	18.6
Work FT While Enrolled[b]	D	27.4	33.8	51.9	.	30.7	47.5
	S	33.7	35.5	36.6	.	35.5	30.1
Unemployed Before Enrolled	D	6.0	6.1	6.5	.	5.7	7.4
	S	8.3	5.0	8.9	.	7.5	12.1

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

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.[22] The results are displayed in Figures 15, 16, and 17. The relaxation of borrowing constraints causes very small increases in 2-year and 4-year college enrollment. The increase in loan limits causes an increase in bachelor's degree completion by age 25 of 1.1 percentage points.

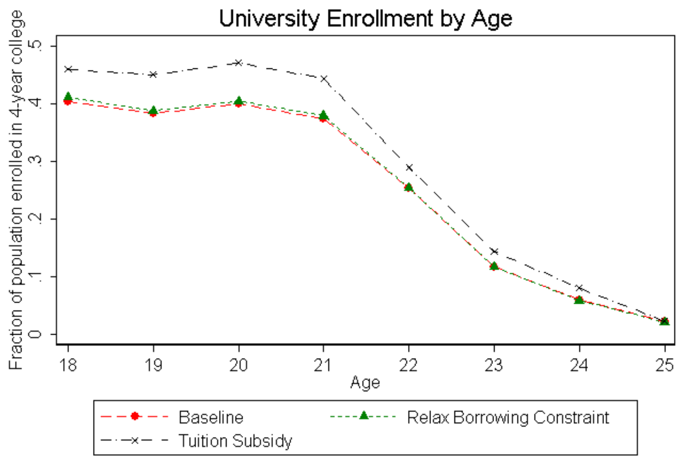

Figure 15: University Enrollment by Age

A tuition subsidy equal in dollar terms to the loan limit increase is much more effective at increasing enrollment and degree completion. Enrollment in 2-year colleges decreases slightly as students substitute toward 4-year colleges. Overall college enrollment increases on average 5.8 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 finds that a change of $1,000 (in 1990 dollars[23]) is associated with a change in enrollment of 5 percentage points. Under the tuition subsidy bachelor's degree completion increases by 7.4 percentage points.

Why are tuition subsidies more effective at increasing enrollment and degree completion? 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 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,[24] Since future labor market outcomes are

[22] All policy experiments relaxing borrowing constraints also increase the cumulative maximum students are allowed to borrow through the GSL program from $23,000 to $28,000

[23] This is equivalent to $1,445 in 2004 dollars

[24] The average youth attending school can only borrow $4,011 at age 18; he can borrow $1,386 from other sources and $2,625 from the GSL program. (See Table 16 and Appendix C.2). youths are balancing their desire to smooth consumption with a precautionary savings motive. The cost of tuition, room, and board at a 4-year college is $12,445. (See Table 17)

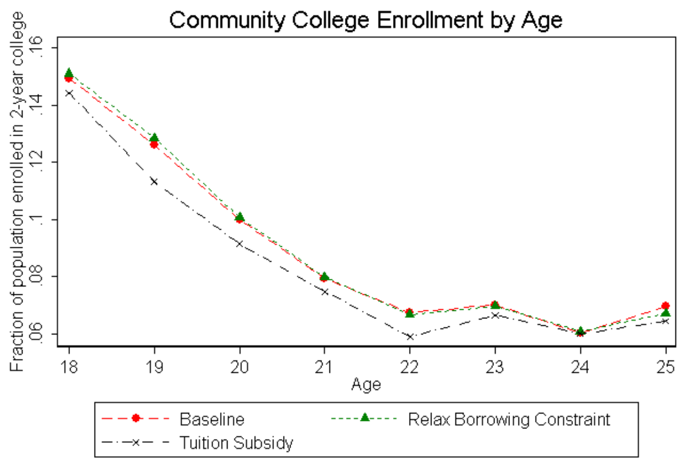

Figure 16: Community College Enrollment by Age

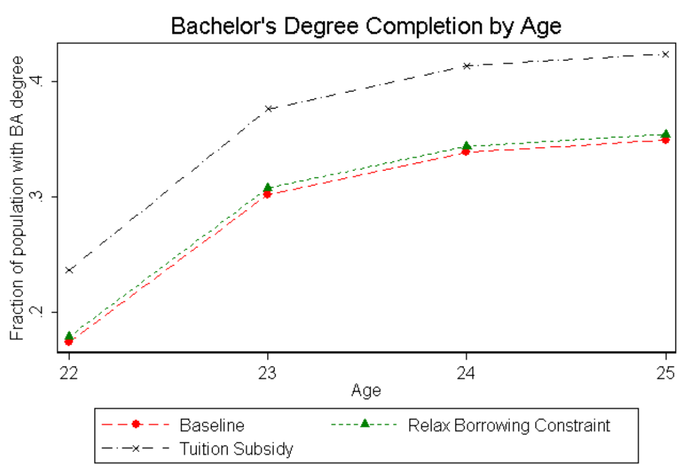

Figure 17: Bachelor's Degree Completion by Age

uncertain youths choose 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 $298 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.[25] 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.[26] 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 goverment 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. 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. 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. 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. The government can offer higher subsidy levels to lower income household while holding the cost of the subsidy constant 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 very difficult to determine

[25] 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.

[26] Cohort default rates are obtained from the US Department of Education Office of Student Financial Assistance Programs

analytically for the reasons noted above. My model 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.[27]

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.[28] The untargeted subsidy is $425, the low income subsidy is $1,725, the subsidy targeted toward the second income tercile is $1,550, and the high income subsidy is $800. The results of the experiments are displayed in Table 8 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 to high income households are more effective at increasing degree completion and earnings in the sample. The effects of the tuition subsidies on higher education outcomes are concentrated in the top two AFQT terciles, with the largest effects most often taking place in the second tercile. This indicates that students in the second AFQT tercile are most likely to be close to the margin of attendance.

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 income youths experience under the various policies. The returns in terms of income outweigh the costs for all the tuition subsidy programs. The cost per person for each subsidy is approximately $1000 whereas the return in each case is more than $3,000. The targeted tuition subsidy has the largest payoff, increasing average lifetime income by $3,270.[29]

9.3 Delayed Entry

Table 9 shows the effect of the various policies considered in the previous section on the fraction of students delaying entry to college. All of the policies slightly increase the fraction of students attending college and slightly decrease the fraction of those students delaying entry to college. 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 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). The effect of unemployment and wage shocks on delayed entry will be explored in future work.

9.4 Determinants of Educational Attainment: Parental Resources

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

[27] 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 (FAFSA) are required to report the income of their parents).

[28] It is difficult to design a 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 chosen by iterating between changing the amount of the subsidies, running the simulation, and evaluating how much the subsidy cost the government *ex post*.

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

Table 8: Changes in Youth Outcomes Under Various Policies[a]

	$AFQT_1$	$AFQT_2$	$AFQT_3$	All
Highest grade completed				
Baseline	13.24	14.42	15.72	14.45
Relax Borrowing Constraint	0.07	0.16	0.20	0.14
Untargeted Tuition Subsidy	0.06	0.16	0.20	0.14
Low Income Subsidy	0.11	0.14	0.17	0.14
Medium Income Subsidy	0.08	0.19	0.16	0.14
High Income Subsidy	0.03	0.15	0.22	0.13
Percent Completing Bachelor's Degree				
Baseline	8.61	31.70	64.93	34.90
Relax Borrowing Constraint	1.29	3.93	2.98	2.73
Untargeted Tuition Subsidy	2.48	5.83	5.75	4.68
Low Income Subsidy	3.41	5.32	4.89	4.53
Medium Income Subsidy	1.29	4.28	3.68	3.08
High Income Subsidy	3.44	6.43	6.10	5.32
Wages at 30				
Baseline	15.22	19.46	23.39	19.33
Relax Borrowing Constraint	0.08	0.22	0.23	0.17
Untargeted Tuition Subsidy	0.10	0.25	0.23	0.19
Low Income Subsidy	0.15	0.22	0.20	0.19
Medium Income Subsidy	0.07	0.24	0.19	0.17
High Income Subsidy	0.10	0.25	0.24	0.20
Present Discounted Value of Income[b]				
Baseline	540.51	643.39	735.20	639.12
Relax Borrowing Constraint	1.55	5.37	5.23	4.04
Untargeted Tuition Subsidy	2.17	5.75	4.94	4.28
Low Income Subsidy	3.38	4.97	4.43	4.26
Medium Income Subsidy	1.33	5.22	3.64	3.39
High Income Subsidy	2.37	5.94	5.18	4.49

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

Table 9: Percentage of students delaying entry to college

Years after HS graduation	0	.5+	1+	2+	3+	Never
Baseline	85.1%	14.9%	12.5%	11.0%	8.8%	34.5%
Relax Borrowing Constraint	85.7%	14.3%	12.5%	10.9%	8.4%	31.6%
Tuition Subsidy	86.3%	13.7%	11.4%	9.7%	7.8%	33.2%
Low Income Subsidy	86.6%	13.4%	11.3%	9.7%	7.4%	32.8%
Medium Income Subsidy	86.0%	14.0%	11.6%	10.1%	7.9%	31.8%
High Income Subsidy	85.9%	14.1%	11.8%	9.9%	8.1%	33.9%

made by parents during college years enter directly through parental transfers. Tables 10 and 11 replicate and extend the results in Belley and Lochner (2007) to assess the effect of parental income on educational attainment.

Table 10: Regression of Indicator for College Attendance by Age 21[a]

	Data	Simulation	Simulation
AFQT Q2	0.244**	0.211**	0.193**
	(0.033)	(0.015)	(0.012)
AFQT Q3	0.350**	0.352**	0.288**
	(0.032)	(0.015)	(0.012)
AFQT Q4	0.445**	0.419**	0.315**
	(0.035)	(0.016)	(0.013)
Parental Income Q2	0.101**	0.015	0.004
	(0.033)	(0.015)	(0.012)
Parental Income Q3	0.162**	0.103**	0.044**
	(0.033)	(0.015)	(0.012)
Parental Income Q4	0.223**	0.321**	0.156**
	(0.034)	(0.015)	(0.013)
Type 2			-0.425**
			(0.011)
Type 3			-0.636**
			(0.011)
Constant	0.334**	0.276**	0.647**
	(0.029)	(0.013)	(0.012)
R-squared	0.193	0.209	0.502
N	1247	6645	6645

[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 10 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 column match the broad patterns found in Belley and Lochner (2007).[30] The coefficients from the regression run on the simulated data match the AFQT coefficients very well and the broad pattern of the effects of parental income. The model slightly over predicts the effect of the highest parental quartile and under predicts the effect of the second parental income quartile. Table 11 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 greatly diminished. This indicates that much of the correlation between parental income and educational outcome is due to the correlation between parental income and unobserved

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

Table 11: Regression of Indicator for 4+ Years of College by Age 23[a]

	Data	Simulation	Simulation
AFQT Q2	0.218**	0.176**	0.167**
	(0.045)	(0.015)	(0.012)
AFQT Q3	0.346**	0.356**	0.305**
	(0.044)	(0.014)	(0.012)
AFQT Q4	0.520**	0.516**	0.416**
	(0.046)	(0.015)	(0.012)
Parental Income Q2	0.100*	-0.006	0.004
	(0.043)	(0.015)	(0.012)
Parental Income Q3	0.083	0.077**	0.047**
	(0.044)	(0.015)	(0.012)
Parental Income Q4	0.222**	0.338**	0.191**
	(0.046)	(0.015)	(0.012)
Type 2			-0.484**
			(0.010)
Type 3			-0.579**
			(0.011)
Constant	0.008	0.066**	0.414**
	(0.038)	(0.013)	(0.012)
R-squared	0.197	0.265	0.534
N	801	6645	6645

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

ability of youths. Parental income still has a direct effect effect on the educational attainment of youths after controlling for observed and unobserved ability. Youths from households in the highest income quartile are 15.6% more likely to attend college by age 21 and 19.1% more likely 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. The 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 12.

Table 12: Counterfactual Changes in Youth Outcomes[a]

	$AFQT_1$	$AFQT_2$	$AFQT_3$	Inc_1	Inc_2	Inc_3	All
Highest grade completed							
Baseline	13.24	14.42	15.72	13.75	13.93	15.69	14.45
Grants Independent of Income	-0.12	-0.06	0.15	-0.22	-0.03	0.22	-0.01
Equalize Parental Transfers	0.41	0.36	-0.04	0.83	0.49	-0.60	0.25
Percent Completing Bachelor's Degree							
Baseline	8.61	31.70	64.93	21.18	27.32	56.55	34.90
Grants Independent of Income	0.10	0.58	4.92	-1.22	1.02	5.85	1.85
Equalize Parental Transfers	0.63	1.62	-4.96	8.49	4.48	-15.84	-0.88

[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 12 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 counter-factual 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 and students from the lowest income tercile are hurt the most.

The direct effect of parental transfers is explored in Table 12 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 increase for youths from the lowest family income terciles and decrease dramatically for youths from the highest family income tercile. The effects across AFQT terciles are in general similar to those across parental income tercie due to the correlation between ability and parental income. This counterfactual exercise provides evidence that a substantial fraction of the correlation between parental income and educational attainment is due to the direct parental transfers youths receive while in college.

9.5 Determinants of Educational Attainment: Ability

(To be written)

This section will contain an analysis of the return to schooling for different ability levels in terms of wages and PDV of lifetime income. I will then compare this with the differential psychic costs for students of lower ability to show that psychic costs are a large deterrent to educational attainment.

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 increase bachelor's degree completion by at most 2.7 percentage points. Increases in tuition subsidies have larger impacts on educational attainment. Tuition subsidies targeted towards high 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.

In future work I will incorporate minorities into the estimation of the model presented in this paper. I will test for differences across groups in the coefficients estimates and use the model to explore the lower educational attainment of minorities. I will also extend the current model to include marriage and fertility decisions. I will then estimate the model separately for men and women and look for gender differences in the effects of borrowing constraints and tuition subsidies.

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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 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. The NLSY79 did not collect detailed retrospective college attendance histories before the first survey date, but 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 840 youths and 31,684 person-semester cells of valid data. The data is 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. I assume that the distribution of types in the NLSY79 is the same as in the NLSY97. I draw the types from this distribution and use the other initial conditions of NLSY79 respondents at age 25 to simulate wage and unemployment data. This estimation has not yet been performed, however. In this version of the paper I estimate the wage and unemployment processes outside the model.

The parameters of the wage equation that are used as the wage process for ages 25 and higher are reported in Table 13. The coefficients are consistent with what one would expect to find in a standard Mincer earnings equation. The returns to years of schooling at 2-year and 4-year colleges are quite similar, with a large payoff coming from completion of a Bachelor's Degree. This is consistent with the findings of Kane and Rouse (1995) about the similar return to credits at 2-year and 4-year colleges.

Table 13: NLSY79 Log Wage Regression[a]

VARIABLES	Log Wage
Years at University	0.0460**
	[0.0130]
Years at Community College	0.0460**
	[0.0156]
Bachelor's Degree	0.154**
	[0.0552]
Years of Experience	0.0705**
	[0.00606]
Experience Squared	-0.00149**
	[0.000189]
AFQT	0.00467**
	[0.000555]
Part Time Work	-0.0983*
	[0.0463]
Enrolled in School	-0.274**
	[0.0435]
Constant	1.303**
	[0.103]
Observations	27477
R-squared	0.237

[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 equation used to determine the probability of unemployment at ages 25 and higher are reported in Table 14. The probability of unemployment decreases with experience and is 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. I added years of schooling at 2-year and 4-year colleges and AFQT to the unemployment probit, but none of the coefficients was significantly different from zero so these variables are omitted from the equation.

Table 14: NLSY79 Unemployment Probit[a]

VARIABLES	Unemployment
Years of Experience	-0.000470**
	[0.000152]
Bachelor's Degree	-0.00362*
	[0.00159]
Not Working Previous Semester	0.137**
	[0.0172]
Observations	31684

[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 15 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 easier 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 15: Life Cycle Income Profile by Timing of College Entry

Age	19	20	21	22	23	24	25	26
No Delay	0	0	0	0	$\frac{W^C}{(1+r)^4}$	$\frac{(1+g)W^C}{(1+r)^5}$	$\frac{(1+g)^2W^C}{(1+r)^6}$	...
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) 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 5 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 $\upsilon_1 a_t$, the value of assets at age 40, and PDV which denotes the present discounted consumption value of wages between ages 41 and 65. The $\upsilon_1 a_t$ 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. υ_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).

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. There are indicator variables for each asset gridpoint 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, and parental income tercile indicators interacted with years of schooling completed at each college type.

In total there are 72 independent variables used each period in the Emax approximation regressions. The Emax values are evaluated at 300 randomly drawn state vectors each period and these points are used as data for the approximation regressions. 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 to the vector of shocks each period are approximated using Monte Carlo integration. 50 draws from the joint distribution of shocks are taken for each integral approximation.

C.2 Borrowing Constraint 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.[31] 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.[32] 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).[33] 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 16: 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	-1192	-1379	-1591	-1727	-1196	-913	-1386
19	-1806	-2094	-2416	-2629	-1820	-1362	-2104
20	-2712	-3161	-3592	-3897	-2804	-2048	-3152
21	-4022	-4675	-5188	-5629	-4204	-3084	-4625
22	-6062	-8087	-10806	-10623	-7334	-4742	-8304
23	-10440	-14837	-19795	-19751	-12727	-7979	-14995
24	-14727	-19284	-23444	-23963	-17221	-11577	-19126
25	-19663	-23464	-25838	-26619	-22699	-16084	-22971

[31] The Parent Loan for Undergraduate Students (PLUS) 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)).

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

[33] 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.

C.3 Auxiliary Models

The auxiliary models consist of moments and regressions 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. The models are:

1. Moments

    - Fraction of sample enrolled in each college type at each age[34]
    - Fraction of sample enrolled part time in each college type at each age
    - Fraction of sample completing a Bachelor's degree at each age for ages 22-25
    - 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.
    - Average highest grade completed at age 25
    - 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.
    - Fraction of sample working full-time, part-time, and not working while not enrolled in school
    - Fraction unemployed at each age, average wage if working at each age, and fraction working part time and full time at each age
    - Person specific variance of wages
    - Fraction receiving parental transfers at each age, average amount of transfers received if positive at each age
    - Fraction of population in debt, average asset holdings, and average asset holdings if borrowing at ages 20 and 25. Another set of the same moments evaluated only for those who have not enrolled in school.
    - Average asset holdings between ages 38 and 40 in the NLSY79

2. Regressions

    - Three equations of enrollment in 4-year college, enrollment in 2-year college, and not enrolling in college on AFQT tercile
    - Two equations of enrollment in 4-year college and 2-year college on previous period enrollment in each college type and age
    - BA degree completion on years of 2-year college completed, years of 4-year college completed, and AFQT tercile
    - Log wage on years of schooling at each college type, BA degree completion, experience, experience squared, AFQT, part time work, and school attendance
    - Log wage on previous period log wage
    - Unemployment on experience, experience squared, AFQT, and not working in the previous semester

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

- Receipt of parental transfers on family income, family income squared, age, previous semester school attendance, previous school attendance interacted with family income, and receipt of parental transfers during previous year
- Amount of parental transfers received if positive on family income, family income squared, years of school completed, age, enrollment in 4-year college, and enrollment in 4-year college interacted with family income
- Average 2-year grant amount on family income and family income squared
- Average 4-year grant amount on AFQT, AFQT squared, family income, and family income squared
- Assets at 25 on assets at 20, and assets at 20 on assets at 18
- Enrolled in college by age 21 on AFQT quartile and family income quartile, and only on family income quartile
- Completed 4 or more years of college by age 23 on AFQT quartile and family income quartile, and only on family income quartile

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 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).[35] In total there are 211 auxiliary parameters (there are 103 structural parameters being estimated).[36]

D Exact Functional Forms

D.1 Utility Function (g^u)[37]

$$
\begin{aligned}
u_t = \frac{c_t^{1-\rho}}{1-\rho} &+ [\gamma_1 AFQT_3 + \gamma_2 AFQT_2 + \gamma_3 AFQT_1 + \epsilon_t^U][I(s_t^U = .5) + \gamma_4 I(s_t^U = 1)] \qquad (16) \\
&+ [\gamma_5 AFQT_3 + \gamma_6 AFQT_2 + \gamma_7 AFQT_1 + \epsilon_t^C][I(s_t^C = .5) + \gamma_8 I(s_t^C = 1)] \\
&+ \gamma_9 age_t s_t^U I(age_t \geq 22) + \gamma_{10} age_t s_t^C I(age_t \geq 20) + \gamma_{11} I(s_t^U > 0) I(s_{t-1}^U > 0) \\
&+ \gamma_{12} I(s_t^C > 0) I(s_{t-1}^C > 0) + \gamma_{13} I(s_t^U > 0) I(s_{t-1}^U > 0) I(sem = 1) + \gamma_{14} I(s_t^C > 0) I(s_{t-1}^C > 0) I(sem = 1) \\
&+ \gamma_{15} I(s_t^U + s_t^C > 0) I(BA_t = 1) + [\gamma_{16} + \epsilon_t^w][I(h_t = .5) + \gamma_{17} I(h_t = 1)] \\
&+ \gamma_{18} I(h_t = 1) age_t + \gamma_{19} I(h_t = 1) age_t + \gamma_{20} I(h_t = 1) I(age \geq 23)
\end{aligned}
$$

[35] The likelihood contributions of the auxiliary models are weighted in the final sum to generate the likelihood function. Greater weight given to the models that describe the more important features of the data such as school enrollment and degree completion. The weighting matrices within and across auxiliary models are available upon request.

[36] Estimates of the auxiliary model parameters are available upon request

[37] $AFQT_i$ 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

$$+\gamma_{21}I(h_t=1)I(s_t^U=1)+\gamma_{22}I(h_t=.5)I(s_t^U=1)$$
$$+\gamma_{23}I(h_t=1)I(s_t^C=1)+\gamma_{24}I(h_t=.5)I(s_t^C=1)+\gamma_{25}I(h_t=1)I(s_t^U=.5)+\gamma_{26}I(h_t=.5)I(s_t^U=.5)$$
$$+\gamma_{27}I(h_t=1)I(s_t^C=.5)+\gamma_{28}I(h_t=.5)I(s_t^C=.5)+[\gamma_{29}I(s_t^U>0)AFQT_3$$
$$+\gamma_{30}I(s_t^U>0)AFQT_2+\gamma_{31}I(s_t^U>0)AFQT_1+\gamma_{32}I(s_t^C>0)AFQT_3+\gamma_{33}I(s_t^C>0)AFQT_2$$
$$+\gamma_{34}I(s_t^C>0)AFQT_1]I(age_t=18)I(sem=2)+\gamma_{35}I(s_t^U>0)I(S_t^U>2.5)$$
$$+\gamma_{36}I(s_t^U>0)I(age\geq 24)+\sum_{k=2}^{K}\gamma_{37,k}I(type=k)I(s_t^C+s_t^U>0)$$

D.2 Human Capital Function (g^{Ψ})[38]

$$\Psi_t=\exp\{\phi_0+\phi_1S_t^U+\phi_2S_t^C+\phi_3BA_t+\phi_4H_t+\phi_5H_t^2+ \phi_6AFQT+\sum_{k=2}^{K}\phi_{7,k}I(type=k)\} \tag{17}$$

D.3 Wage Function (g^w)

$$w_t=\Psi_t\exp\{\alpha_1I(h_t=.5)+\alpha_2I(s_t^C+s_t^U>0)+\epsilon_t^w\} \tag{18}$$

D.4 Unemployment Probability (J_t)[39]

$$\Pr(J_t=1)=\Phi[\xi_0+\xi_1\Psi_t+\xi_2I(h_{t-1}=0)] \tag{19}$$

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

D.5.1 Grants at 4-year college

$$grant_t=\zeta_0^U+\zeta_1^UAFQT+\zeta_2^U\frac{AFQT^2}{1000}+\zeta_3^UInc +\zeta_4^U\frac{Inc^2}{1000}+\sum_{k=2}^{K}\zeta_{5,k}I(type=k) \tag{20}$$

D.5.2 Grants at 2-year college[40]

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

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

$$\underline{a}^o=-exp\{\mu_0+\mu_1\Psi_t+\mu_2\Psi_t^2+\mu_3I(age_t\geq 23)\} \tag{22}$$

[38] H_t denotes years of work experience

[39] Φ indicates the normal cumulative distribution function.

[40] 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.7 Degree Completion (BA_t)

$$\Pr(BA_t = 1|Eligible) = \Phi[\nu_0 + \nu_1 S_t^U I(S_t^U > 4.5) + \nu_2 S_t^U I(S_t^U > 5.5) + \nu_3 \Psi_t + \nu_4 \Psi_t^2] \tag{23}$$

D.8 Parental Transfers Probability (P_t)

$$\Pr(P_t = 1) = \Phi[\lambda_0 + \lambda_1 Inc + \lambda_2 \frac{Inc^2}{1000} + \lambda_3 I(s_{t-1}^C + s_{t-1}^U > 0) + \lambda_4 I(s_{t-1}^C + s_{t-1}^U > 0) Inc + \lambda_5 I(P_{t-1} = 1) + \lambda_6 age_t + \lambda_7 \Psi_t + \lambda_8 I(age_t > 23)] \tag{24}$$

D.9 Amount of Parental Transfers (tr_t)

$$tr_t = \exp\{\chi_0 + \chi_1 I(s_t^U > 0) + \chi_2 I(s_t^U > 0) Inc + \chi_3 (S_t^U + S_t^C + 12) + \chi_4 age_t + \chi_5 Inc + \chi_6 \frac{Inc^2}{1000} + \chi_7 \Psi_t\} \tag{25}$$

D.10 Type Probability Distribution[41]

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

D.11 Terminal Value Function (V^{TERM})[42]

$$V^{TERM} = PDV + \upsilon_1 a_t \tag{27}$$

D.12 Distribution of Shocks[43]

$$\begin{pmatrix} \epsilon_t^C \\ \epsilon_t^U \\ \epsilon_t^h \\ \epsilon_t^w \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_C^2 & & & \\ \sigma_{CU}^2 & \sigma_U^2 & & \\ \sigma_{Ch}^2 & \sigma_{Uh}^2 & \sigma_h^2 & \\ \sigma_{Cw}^2 & \sigma_{Uw}^2 & \sigma_{hw}^2 & \sigma_w^2 \end{pmatrix} \right]$$

E Parameter Values

E.1 Calibrated Parameter Values

E.2 Estimated Parameter Values

[41] Coefficients for type 1 are all normalized to 0

[42] See Appendix C.1 for details about PDV, the present discounted value of future wages

[43] Currently all covariances between shocks are set to zero.

Table 17: Calibrated Parameter Values

Description	Symbol	Value	Source
Tuition at 2-year college	κ^U	\$1,698	IPEDS data on enrollment weighted average tuition at 2-year colleges from 2001-2005
Tuition at 4-year college	κ^U	\$7,219	IPEDS data on enrollment weighted average tuition at 4-year colleges from 2001-2005
Cost of room and board at 2-year college	.	\$3,631	IPEDS data on room and board at 2-year colleges from 2001-2005
Cost of room and board at 4-year college	.	\$5,226	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
Interest rate	r	6%	Average interest rate on Stafford Loans from 2001-2005[a]
Minimum Level of Earnings	w^{MIN}	\$1,035	Estimated using NLSY97 data on average unemployment insurance and welfare benefits received by youths in my sample

[a] The average variable interest rate quoted on Stafford Loans over this time period is 4.2%. In 2008 the variable interest rate on Stafford loans was 4.21% whereas the fixed interest for the subsidized loans was 6%. Since I do not model interest rate uncertainty, I set the interest rate to 6% in the model.

Table 18: Estimated Parameters

Description	Symbol	Estimate
Utility Function		
Psychic costs of 4-year college attendance		
$AFQT_3$	γ_1	-78.104
$AFQT_2$	γ_2	-92.845
$AFQT_1$	γ_3	-113.29
Psychic costs for 4-year college full time shifter	γ_4	1.2332
Psychic costs of 2-year college attendance		
$AFQT_3$	γ_5	-68.444

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Description	Symbol	Estimate
$AFQT_2$	γ_6	-45.546
$AFQT_1$	γ_7	-57.199
Psychic costs for 2-year college full time shifter	γ_8	1.15
Attending 4-year college after age 22	γ_9	-1.8319
Attending 2-year college after age 20	γ_{10}	-1.9329
Persistence in college attendance		
4-year college	γ_{11}	139.16
2-year college	γ_{12}	115.26
Fall to spring in 4-year college	γ_{13}	42.048
Fall to spring in 2-year college	γ_{14}	55.027
Attending school after completing BA	γ_{15}	-114.76
Work preferences		
Preference for working part-time	γ_{16}	-26.21
Preference for working full time shifter	γ_{17}	6.0116
Work full-time interacted with age	γ_{18}	2.1262
Work part-time interacted with age	γ_{19}	-1.0077
Work full-time after age 23	γ_{20}	11.777
Working while attending college		
Work full-time 4-year college full-time	γ_{21}	-66.741
Work part-time 4-year college full-time	γ_{22}	-35.213
Work full-time 2-year college full-time	γ_{23}	-57.637
Work part-time 2-year college full-time	γ_{24}	-28.515
Work full-time 4-year college part-time	γ_{25}	-51.227
Work part-time 4-year college part-time	γ_{26}	-33.765
Work full-time 2-year college part-time	γ_{27}	-34.28
Work part-time 2-year college part-time	γ_{28}	-20.085
Starting 4-year college semester after high school grad		
$AFQT_3$	γ_{29}	40.57
$AFQT_2$	γ_{30}	68.681
$AFQT_1$	γ_{31}	53.744
Starting 2-year college semester after high school grad		
$AFQT_3$	γ_{32}	15.298
$AFQT_2$	γ_{33}	13.497

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Description	Symbol	Estimate
$AFQT_1$	γ_{34}	10.701
Continuing in 4-year college after completing 3 years	γ_{35}	36.92
Attending 4-year college after age 24	γ_{36}	28.24
Unobserved heterogeneity in psycic costs of schooling		
Type 2	$\gamma_{37,2}$	-40.137
Type 3	$\gamma_{37,3}$	-83.335
Human Capital Function		
Constant	ϕ_0	2.4211
Years at 4-year college	ϕ_1	.01661
Years at 2-year college	ϕ_2	.01438
BA degree completion	ϕ_3	.19953
Years of experience	ϕ_4	.0853
Years of experience squared	ϕ_5	-.00283
$AFQT$	ϕ_6	.00048
Type 2	$\phi_{7,2}$	-.16827
Type 3	$\phi_{7,3}$	-.29793
Wage Equation Parameters		
Part-time work	α_1	-.059
Enrolled in school	α_2	-.09916
Unemployment Probability Parameters		
Constant	ξ_0	-1.1009
Human capital	ξ_1	-.05544
Not working in previous semester	ξ_2	.85216
Grant Function		
Grants at 4-year college		
Constant	ζ_0^U	10131
$AFQT$	ζ_1^U	-92.756
$AFQT^2/1000$	ζ_2^U	335.24
Family income	ζ_3^U	-27.304

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Description	Symbol	Estimate
$Inc^2/1000$	ζ_4^U	78.342
Type 2	$\zeta_{5,2}^U$	-369.65
Type 3	$\zeta_{5,3}^U$	-691.31
Grants at 2-year college		
Constant	ζ_0^C	1394.2
Family income	ζ_1^C	-12.819
$Inc^2/1000$	ζ_2^C	21.739
Asset Lower Bound		
Constant	μ_0	.40799
Human capital	μ_1	.61955
Human capital squared	μ_2	-.00451
Age 23 or older	μ_3	.10499
Degree Completion Probabililty		
Constant	ν_0	-2.8282
Years at 4-year college if > 4.5	ν_1	-.00418
Years at 4-year college if > 5.5	ν_2	.05854
Human capital	ν_3	.17375
Human capital squared	ν_4	.00014
Parental Transfers Probabililty		
Constant	λ_0	1.1806
Family income	λ_1	.00086
$Inc^2/1000$	λ_2	-.00176
Attending college previous semester	λ_3	.10697
Attending previously interacted with family income	λ_4	.00361
Parental transfers previous semester	λ_5	2.3987
Age	λ_6	-.16983
Human capital	λ_7	.09491
Age>21	λ_8	-.15615

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Description	Symbol	Estimate
Amount of Parental Transfers		
Constant	χ_0	10.909
4-year college attendance	χ_1	.29342
4-year attendance interacted with family income	χ_2	.00213
Years of schooling	χ_3	.00393
Age	χ_4	-.13941
Family income	χ_5	.00435
$Inc^2/1000$	χ_6	-.0115
Human capital	χ_7	.03433
Type Probability Distribution		
Type 2		
Constant	$\pi_{0,2}$	-1.9082
$AFQT_1$	$\pi_{1,2}$	.49919
$AFQT_2$	$\pi_{2,2}$	1.0917
Inc_1	$\pi_{3,2}$	.29442
Inc_2	$\pi_{4,2}$	1.6039
Type 3		
Constant	$\pi_{0,3}$	-2.0386
$AFQT_1$	$\pi_{1,3}$	.9011
$AFQT_2$	$\pi_{2,3}$	.48223
Inc_1	$\pi_{3,3}$	1.5307
Inc_2	$\pi_{4,3}$	.86397
Terminal Value Function		
Assets	υ_1	.03404
Shock Distribution		
Preference for 2-year college	σ_C	31.28
Preference for 4-year college	σ_U	31.549
Preference for work	σ_h	5.6131
Wage	σ_w	.0783