The Effect of Financial Aid and Tax Policies
on Educational Choices

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Abstract

As the number of university students in the United States has increased in the last 30 years, the cost of obtaining higher education has doubled in real terms. The government heavily intervenes in this market through a variety of policy instruments. In order to evaluate the effects of these policies, I build a dynamic life-cycle model featuring educational and labor force participation choices, as well as consumption and savings decisions. The model is estimated with the method of simulated moments using a longitudinal sample of white, black, and Hispanic young men from the 1997 issue of the National Longitudinal Survey of Youth. The agents differ in observed characteristics and unobserved abilities. The model incorporates both increasing tuition costs and the main features of the U.S. federal income tax. In particular, it takes into account the structure of the Lifetime Learning Tax Credit. The estimates are used to simulate the impact of some policy changes. I find a sizeable effect on college enrollment from a generalized tuition reduction, as well as a large increase in graduate school attendance from making the Lifetime Learning Tax Credit refundable.

Keywords: education choices, labor supply, taxes, lifetime learning tax credit

JEL Classification Codes: H3,I2,J2

1   Introduction

As the number of university students has increased in the last three decades, the cost of enrollment has doubled in real terms. To mitigate the negative effects of hight tuition costs on the poorest students, both the states and the federal government intervene in this market using a variety of policy tools. Nevertheless, the degree of heterogeneity in education attainments across individuals with different backgrounds is striking.

In order to evaluate the effects of these policies, I build a dynamic life-cycle model of education and labor force participation choices. In recognition of the importance of education financing problems, the model incorporates decisions about asset allocations as well as borrowing. The model is estimated with the method of simulated moments using a longitudinal sample of white, black, and Hispanic young men from the 1997 issue of the National Longitudinal Survey of Youth. In order to capture the degree of heterogeneity in this population, the agents in the model are allowed to differ on both observable traits and unobservable abilities. In particular, they are allowed to receive different transfers, contingent on enrollment, according to the wealth of their families. Moreover, people of different races are allowed to receive different wage offers.

The return to education in this model varies across individuals. My findings show that approximately one person out of ten enjoys a return of about 7% per each additional year of schooling. For the rest of the population on the other hand, an additional year spent studying increases offered wages by about 3.5%. As in many previous models in this area of research, individuals are allowed to work while in school, thus providing an extremely important avenue in which to relax the tightness of the budget constraint.

The choice of accounting for savings and borrowings greatly enhances the realism of the model, but it comes at the cost of dramatically increasing the computational time to solve and estimate the model. Following the paper by Lee and Wiswall (2007), I parallelize the minimization algorithm to cut the estimation time by a factor of about ten.

My work builds upon the wealth of literature on life-cycle labor supply and educational choices. In particular, the works by Keane and Wolpin (1997) and Keane and Wolpin (2001) represent major contributions to this area of research; even though the solution method and the econometric strategy that I use are different from theirs, I acknowledge borrowing from

them in the specification of the model.

Moreover, a few other elements distinguish my paper from the previous literature. In particular, this model incorporates all the major rules of the actual U.S. federal income tax code. This feature has two important implications. First, unlike in previous life-cycle models of educational choices, the incentive to study longer is lowered by the progressivity of the income tax. By attaining an higher level of education, individuals commit themselves to face higher marginal taxes in the future because their gross incomes would probably fall into higher tax brackets. The tax code, however, allows for very low tax liabilities if working while enrolled in college or graduate school. This topic has been treated in a very limited number of empirical studies. The works by Heckman, Lochner, and Taber (1998) and Taber (2002) are the most notable examples of this strand of literature. These authors study the effects of fundamental changes to the tax structure and to the tax base. On one hand they incorporate the life-cycle decisions of the agents in an overlapping-generation framework; on the other, they restrict the schooling choices to a binary decision between attending college or not.

By explicitly accounting for the rules of the tax code, my model is well suited to conduct *ex-ante* experiments about the effects of modifications of the tax rules on educational choices. Introduced in 1997, the Lifetime Learning Tax Credit provides up to $2,000 in tax relief for taxpayers who pay qualified educational expenses. This credit can be claimed directly by any independent student (24 years old or older). I use the estimated model to simulate the effects of changing the rules governing this tax credit. Even though some reduced-form estimates of the impact of tax credits on college enrollment have already been conducted, to the best of my knowledge, this paper is the first attempt to estimate their effects in a dynamic and structural framework.

Another distinctive feature of my model is the treatment of the enrollment costs. Unlike previous analysis of human capital accumulation in the life-cycle, my model explicitly incorporates tuitions which are increasing over time in real terms. In the period under analysis the average tuition and fees for undergraduate institutions was growing at an annual real rate of about 3%. Such a large increase in the cost of attending college over time is likely to have some effects on educational choices, by making any delay in enrollment less attractive.

Finally, this is also one of the first studies to use the 1997 version of the National Longitudinal Survey of Youth (NLSY97) for structural estimation analysis. On the contrary, most

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of the literature on this topic has used data from the NLSY79. By focusing on a cohort born in 1980 I can provide a better picture of the incentives faced by the individuals who were in their college years at the beginning of the 2000s. Obviously, an analysis based on this sample is better suited to provide both a clearer picture of today's challenges and more focused policy recommendations.

The solution and the estimation of this model requires a few assumptions. As in Keane and Wolpin (2001), the identification of the parameters of the transfer function comes from the differences in the observed behavior of individuals with different initial characteristics; in the case of my model, parental wealth in 1997 is allowed to have an effect on the amount of transfers received by the students. This assumption is required because of the features of the dataset: unfortunately, the NLSY97 doesn't record the full amount of the yearly transfers for all the individuals. As most of the previous literature on the topic, this paper focuses only on the male subpopulation. Both the data and the literature on gender economics tell us that the effect of fertility on labor supply and education choices is much stronger for females. The extension of this work to women would require explicitly modelling the endogenous fertility choices; for computational reasons, they are overlooked in this version of my research. The same motivation is the basis of the decision of not modelling marital choices.

Finally, this study carries the powerful features and limitations of all partial equilibrium models. It is possible that the transfers received by the individuals would change in the presence of a radically changed scenario for tuition subsidies. Moreover, it is also possible that more generous tax based incentives for higher education would be in part captured by the universities themselves by raising tuition. Recent literature on the effect of the tax credits on undergraduate enrollment seems to indicate that these effects are indeed present, but of limited scope (Long, 2003).

The estimated model fits the data reasonably well, especially in regards to enrollment rates in high school and college. The parameters are reasonable and within the range of the values of the existing previous literature. The model is used to run a few policy experiments. First, I simulate the effect of a generalized tuition cut by 5%, which is found to generate an increase in the college enrollment rate of 18 and 19 year olds of about 2.5 percentage points. When I simulate changes to the structure of the Lifetime Learning Tax Credit, I find that making the tax credit refundable would have the greatest impact on the number of people

enrolled in post-graduate programs. Because of their relatively small incomes, most young people have very limited or null tax liabilities. By making the Lifetime Learning Tax Credit refundable, every enrolled student can potentially benefit from the full amount of the tuition relief.

The rest of the paper is organized as follows. Section 2 presents some background information about recent trends in education attainments and government policies for higher education. Section 3 provides a brief overview of the relevant literature. Section 4 presents the basic setup of the model, the sources of heterogeneity, and the solution method. Sections 5 and 6 provide an overview of the chosen econometric strategy and the sources of data, respectively. Sections 7 and 8 present the results of the estimates and the fit of the data. In section 9 I provide the results of the policy experiments, and in section 10 I conclude.

2   Post-secondary enrollment and public interventions

According to the Department of Education (Snyder, Dillow, and Hoffman, 2009), the number of students enrolled in post-secondary institutions grew from about 11 million in the fall of 1975 to slightly less than 19 million in the fall of 2007[1]. In the same period, the proportion of 20 to 24 years olds enrolled in any school increased from 22 to about 36 percent. The number of degrees conferred increased as well. The number of bachelor degrees awarded was less than one million in 1975; today it is about 50 percent higher[2]. The number of masters degrees doubled to 600,000, whereas the number of PhDs went from 33,000 to 63,000.

Clearly, these figures mask a large degree of heterogeneity. A recent report from the National Center of Education Statistics (Aud, Fox, and KewalRamani, 2010) sheds light on differences in attainments by race[3]. In 2008 72% of white high school graduates enrolled directly in college[4]. This figure was 62% for Hispanics and only 56% for blacks. As minorities are associated with lower levels of parental income and wealth, a lower enrollment rate for them is not surprising. A report from the Congressional Budget Office (Alsalam and Giertz, 2004) highlights some differences in educational choices across students with different backgrounds.

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[1]Table 3 in Snyder, Dillow, and Hoffman (2009).
[2]The majority of these degrees are now conferred to women.
[3]This is the focus of a seminal study by Cameron and Heckman (2001).
[4]Up from 50% in 1980

In 2001, about 56% of all 18 to 24 year old high school graduates from low income families were enrolled in college. On the other hand, some 84% of those from wealthy families were attending college[5].

On one hand, as shown in Figure 1, higher educational attainments are correlated with higher labor incomes. On the other, the cost of attaining a post-secondary degree is high and has been growing over time. Figure 2 shows the value of the average tuition, fees, room and board for 2 and 4 years colleges in the U.S.. In 2007 dollars, the average cost of going to college has increased from about $7,500 in 1975 to about twice as much today. The bold line represents the cost to attend private institutions, the thin line the cost for public colleges. The majority of college students are actually enrolled in the latter (74% of them in the fall of 2007).

It is therefore not surprising that the majority of government spending on higher education comes in the form of direct tuition subsidies through public schools. As reported by Kane (2006), this amounts to a staggering $63 billion for the fiscal year 2005.

As reported by the Congressional Budget Office (Alsalam and Giertz, 2004), the Federal Pell Grant Program is the major source of federal grants for low income families. The federal government provides about $12 billion in means-tested Pells Grants to college students (Kane, 2006). A second source of federal aid for students is the Stafford Loan Program, which guarantees the loans taken out by the student and, under certain need-based circumstances, forgives the interest while in college. If the student doesn't qualify for this policy, he or she can still apply for an "unsubsidized" Stafford Loan, which accrues interest, but is guaranteed by the government against the default of the borrower. As reported by the College Board (Baum, Payea, and Steele, 2009), in 2007-08 35% of undergraduate students took out federal Stafford Loans.

The 1997 Taxpayers' Relief Act introduced a new set of tools to subsidize higher education. In this case, the aid from the federal government came in the form of two new tax credits, the Hope and the Lifetime Learning Tax Credits[6]. They quickly became a very important part of federal student aid. As reported by the College Board (Baum, Payea, and Steele, 2009), in

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[5]The same report also mentions that, although the proportions have been growing over time, the gap between them has remained quite stable.

[6]An early description of these new policies can be found in Kane (1998).

2008 about 8.5 million taxpayers claimed these and other tax-based education benefits[7]. The Joint Committee for Taxation of the United States Congress estimates that the federal costs of the Hope and Lifetime Learning Tax Credits for the period 2009-2013 will be about $26.7 billion and $13.4 billion, respectively (Joint Committee for Taxation, 2009).

The Hope Tax Credit can be claimed by the family of any dependent student in the first two years of undergraduate college education. It consists of a credit of up to $1,600 per student, provided some income and other requirements are met[8] (Internal Revenue Service, 2009).

The Lifetime Learning Tax Credit can be claimed by any taxpayer who incurs some qualified education expenses (i.e., tuition, net of any grant or scholarship). The value of the credit is 10% of the education-related expenses, up to $2,000[9]. Only taxpayers with an adjusted gross income of less than $50,000 can obtain the full credit. The amount of the credit is reduced between $50,000 and $60,000. It can't be claimed if the income is higher than that. More importantly, the tax credit is *non-refundable* that is, it can't reduce someone's tax liabilities below zero. The credit is available to anyone meeting these requirements, without any restriction on the type of educational institution or the year of enrollment.

This tax credit can be claimed by any independent student. A student is considered independent if he or she is older than 23 years old, or if he or she is enrolled in graduate school[10].

Some scholars (Dynarski and Scott-Clayton, 2006) have pointed out that the new tax credits may have a small effect on enrollment in college. Because of the their non-refundable nature, the full credits are available only to middle income families. In other words, the Hope and the Lifetime Learning Tax Credits may actually subsidize college enrollment for people who would have gone to college anyway.

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[7]The other major tax benefit for higher education is the tuition deduction, introduced in 2001.

[8]The Hope Tax Credit requires that the student for whom the credit is claimed does not have any drug conviction on record. With the American Recovery Act of 2008, this tax credit has been modified and now it goes under the name of American Opportunity Tax Credit.

[9]The rules for this tax credit has changed only a little over time. Between 1998 and 2002, the value of the maximum credit was $1,000. After a reform in 2003, the value of the maximum credit has been kept at $2,000 since then. This means that the value of the credit has slightly fallen in real terms. On the other hand, the phaseout thresholds have changed over time and kept about the same value in real terms. Further informations about the parameters for this tax credit in the past can be found in the older versions of the IRS Publication 970 (http://www.irs.gov/pub/irs-prior/).

[10]Moreover, any taxpayer who is married is considered independent anyway.

3   Literature review

Education makes up a significant portion of lifetime investments of young individuals and their families. Economists have long been interested in explaining the determinants of different schooling attainments and their effects on future earnings. Many studies have highlighted the increased return to college education (e.g. the work by Katz and Murphy (1992)), which has been particularly striking since the 70s. The work by Card (2001) is a seminal contribution to the literature in the area of the estimation of the returns to schooling. More recent contributions to this area of research are surveyed in Belzil (2007), whose work also draws an interesting comparisons among different approaches to the study of this topic.

The study by Keane and Wolpin (1997) is probably the most relevant one in this particular area of research. Using the methodology developed in a earlier paper of theirs (Keane and Wolpin, 1994), and data for young white men from the NLSY79, these authors deliver one of the first estimates of a dynamic model of educational and career choice. Each year, the agent in the model draws a new preference shock for a career alternative. The model is used to simulate the effect of a $2,000 (in 1987 dollars) tuition subsidy, which results in a 3.5-percentage-point increase in high-school graduation rates and a 8.4-percentage-point increase in college graduation rate.

The same authors extend their work (Keane and Wolpin, 2001) in a richer model that also features borrowing constraints and parental transfers. This model is used to carry over a series of simulations. They find that the reduction of borrowing constraints has a very small impact on school completion levels. On the other hand, providing a direct subsidy to attending college has a large effect.

This modelling framework has been successfully applied to other issues and other countries as well. For example, the recent works by Todd and Wolpin (2006) and Attanasio, Meghir, and Santiago (2005) use similar structural dynamic models to evaluate the effects of the social program PROGRESA in Mexico.

A slightly different approach is the one taken in the study by Arcidiacono (2004), which features a three-period model of college and major choice. In the first period, individuals choose whether to enter the labor force or to study; in this case, they choose the major too. In the second period, students learn about their abilities and may change their majors or drop

out. Finally, in the third period, everyone is working. This piece of research is particularly effective in pointing out the heterogeneity in the return to college education across majors.

Even though most of the research aimed at evaluating the effect of educational policy changes has been conducted in a structural framework, some scholars have proposed other approaches. For instance, Dynarski (2002) uses the introduction of the Georgia Hope scholarship in 1993 as a natural experiment to measure the effects of this particular state program to lower the cost of college: she finds that the college attendance rate increased by 4-6 percentage points for each $1,000 in subsidies.

The debate about potential tax reforms usually lacks a complete analysis of their effects on human capital accumulation. If the agents are forward-looking and choose their optimal education levels evaluating their future after-tax gains, a simple increase in the tax rate could make further education less attractive through a reduction in the net financial benefit from it. In the case of progressive taxation, the theoretical effects could be larger, because a higher education attainments move individuals towards higher tax brackets. In that case, marginal returns from additional education are reduced more than the marginal costs (the forgone earnings with a lower level of education). This is the focus of many theoretical studies, such as the ones by Heckman (1976), Trostel (1993), Judd (1998), and Hogan and Walker (2007).

Quite surprisingly, there are only a few applied studies on the topic. A paper by Heckman, Lochner, and Taber (1998) extends the dynamic framework of the overlapping generations model by Auerbach and Kotlikoff (1987), introducing skill formation (in the form of both formal schooling and on-the-job training) and allowing for various forms of heterogeneity. It considers the effects of two potential tax reforms, namely the "flat wage tax" and the "consumption tax" ones. The partial equilibrium effect of progressive taxation on human capital accumulation (but not the general equilibrium one) is found to be sizable.

More recently, the empirical study of Taber (2002), building upon the Heckman, Lochner, and Taber (1998) work, studies empirically the effect of the actual U.S. tax system on human capital accumulation. According to this general equilibrium study, there are small long run effects and larger, but short-lived, short run effects. .

The literature on the impact of tax credits for higher education expenses is rather limited. A notable exception is the work by Long (2003) which uses several data sources to analyze the effect of the introduction of the Hope and Lifetime Learning Tax Credits in 1997 on

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families, students, and colleges. She finds that the bulk of the benefits are concentrated among middle-income families.

In terms of the structure of the model and the estimation technique, my paper is close to the studies of French (2005) on retirement behavior and of Eckstein, Ge, and Petrongolo (2010) on minimum wages. It is similar to the former in the treatment of wage uncertainty through Gaussian quadrature techniques, and to the latter in regards to the way unobserved heterogeneity is incorporated in a model estimated with the method of simulated moments.

4 The Model

4.1 The set-up

In each period t the individual chooses consumption, labor force participation and whether or not to enroll in an education program. He is allowed to save and to borrow (at a rate of r). When making these decision, he faces uncertainty about his future labor income. Each agent starts solving his optimization problem when he turns 17. For the sake of simplicity, the model assumes that each agent dies with probability one at age 85[11]. From ages 35 to 64, the agent is assumed to be working full time. The only available choice is how much to consume. The agent retires when he turns 65 years old.

Until age 35, the agent can choose among four possible alternatives, which are mutually exclusive. Each choice is associated with different benefits and costs. The agent can be a student without supplying any labor to the market. On the other hand, a student can be working while enrolled in school. The agent can also decide not to enroll at all and to work instead. Finally, someone may choose to be idle that is, to be neither in school nor active in the labor force.

If the agent is attending school, he has to pay tuition, which is an increasing function of educational attainment and time. It depends on education level because college tuition is higher than high school one. It depends on time, because the tuition cost increases in real terms over time. I will denote tuition with $Tuition(E_t, t)$.

On the other hand, a student in school receives some transfers from his family (or from

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[11] An earlier version of the model incorporated mortality risk. Given that the main focus of the study is the optimal behavior of young men (before the age of 30), mortality risk plays a minor role.

the government). The logarithm of received transfer is modelled as a deterministic function depending on the level of parental wealth and the age of the student. Because the data does not report the full amount of the received transfers, the specification of the transfer function must be parsimonious. As in Keane and Wolpin (2001), the identification of the parameters in this function will come from the observation of the pattern of selected alternatives, rather than from actual transfer data. Transfers are denoted with $Tr(Fam, Age)$.

In each period the agent receives a new wage offer. In *any* period a student can decide to drop out of school if he receives a sufficiently high wage offer. On the other hand, people can enroll again in school after working for some time. This feature of the model is very important to capture two phenomena. First, because of liquidity constraints, some may decide to postpone college enrollment in order to raise enough income to finance their studies in the meantime. Second, many graduate students have some full-time working experience at the time of their enrollment.

The logarithm of the hourly wage in period t, $ln(w_{it})$, is a function of some observed and unobserved characteristics of the individual, plus a iid shock, $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$. I assume that the individual receives a new wage offer at the beginning of each period, but he is uncertain about the realization of the shock in future periods. Thus, the hourly wage can be written as:

$$ln(w_{it}) = \alpha_0 + \alpha_1 age_{it} + \alpha_2 age_{it}^2 + \alpha_3(\tau)edu_{it} + \alpha_4 BA_{it}$$
$$+\alpha_5 Black_i + \alpha_6 Hispanic_i + \epsilon_{it}$$

(1)

where edu_t is the number of years of education at time t. The returns to one year of education depends on the unobservable characteristics of the individual (the type τ). This feature of the model allows me to take into account the well-known correlation between educational attainments and inborn skills. Further explanations about the treatment of permanent unobserved heterogeneity are provided in section 4.2. The coefficient α_4 measures the wage premium from graduating from college, while α_5 and α_6 measure the extent of some race-related distortions on the labor market.

In accordance with the modal behavior observed in the data, I restrict the possible choices about the number of hours worked to a discrete set. This assumption has become very common in the literature on static and dynamic labor supply. An early example is the study

by Eckstein and Wolpin (1989) on female labor force participation. In this particular case, I allow people to choose between working zero or 1,000 hours while they are studying, and between zero and 2,000 hours if they are not enrolled in any educational program.

Therefore, the amount of the gross labor incomes can take the following values:

$$Y_t = \begin{cases} w_t \cdot 2000 & \text{if } L_t = 2000, S = 0 \text{ (i.e. full-time job, no schooling)} \\ w_t \cdot 1000 & \text{if } L_t = 1000, S = 1 \text{ (i.e. part-time job and schooling)} \\ 0 & \text{otherwise} \end{cases} \quad \text{when } t < 35$$

Contrary to most of the literature on this area of research, my model incorporates taxation. The monetary gain from working is therefore the net-of-tax one. I denote the tax function with $\chi(Y_t)$. This function computes the net-of-tax labor income, given the amount of the gross income, the age of the taxpayer, the fiscal year, and whether the taxpayer is enrolled in any educational program or not. The model simulates these amounts taking into account the actual rules of the U.S. Federal Tax Code from 1997 to 2010[12]. In particular, the rules for the standard deduction, the personal exemption, and the Lifetime Learning Tax Credit are implemented. The source of the tax parameters is the Tax Policy Center of the Urban Institute and the Brookings Institution[13].

Formally, the sequential problem faced by each agent can be written as follows:

$$Max_{\{C_t,S_t,L_t\}}E \sum_{t=17}^{T} \beta U(C_t, L_t) \tag{2}$$

subject to an asset accumulation constraint:

$$A_{t+1} = A_t(1+r) + \chi(Y(L_t)) + S_t \cdot (Tr(Fam, Age) - Tuition(E_t, t)) - C_t \tag{3}$$

where S_t is an indicator that takes value one if the agent is in school (it is zero otherwise). In that case, as explained above, the agent has to pay tuition and receives some transfers.

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[12] I assume that everyone files his tax return as single and takes the standard deduction. Computational reasons impose some restriction on the way models of educational attainment with taxes address the issue of the marital status. For example, Taber (2002) assumes that each married male worker is married to a woman who earns exactly 80% of his income.

[13] http://www.taxpolicycenter.org

These two factors play an important role in shaping his budget constraint. A_t is the amount of the net worth enjoyed by the agent. It can be positive or negative; that is, the agent is allowed to borrow (even though he has to repay all his debt eventually).

The within-period utility function takes the following form:

$$U(C_t, L_t) = \frac{C_t^{1-\gamma}}{1-\gamma} + \phi \mathbf{1}\{L_t > 0\} \tag{4}$$

where γ is the coefficient of relative risk aversion, and ϕ is a parameter measuring the disutility from working.

4.2 Heterogeneity

Some of the students come from affluent families, some from low-income and low-education backgrounds. Some are "naturally" endowed with higher-than-average abilities. In recognition of this phenomena, my model features several sources of heterogeneity, both observed and unobserved. To begin with, people are allowed to differ by race (white, black, or Hispanic). This difference plays a role in the offered wage function. Moreover, the agents are split in two groups according to the net worth of the family in 1997[14]. The wealth of the family is allowed to determine part of the amount of the transfers received by the agents if they decide to be in school.

Clearly, these sources of heterogeneity are not sufficient to fully explain the differences in the observed behaviors of young men. In particular, much of the literature in labor economics is concerned with the effect of unobservable abilities on educational choices[15]. To incorporate unobserved ability in a dynamic structural model is quite demanding. Starting with the seminal article by Heckman and Singer (1984), the literature on estimation of structural dynamic models has developed a technique to deal with these sources of unobserved heterogeneity. The standard assumption is that the population is made of a discrete (and small) number of types (or groups) that are endowed with particular characteristics that don't change over time[16].

I assume that the population is composed of two skill types. The probability of a young

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[14]Young men from families whose net worth in 1997 was above the median are assigned to the "wealthy" category.

[15]See, for example, Lang (1993) or Card (2001).

[16]For two examples of the application of this technique to the estimation of a dynamic model with the Method of Simulated Moments, see Ge (2008) and Eckstein, Ge, and Petrongolo (2010).

man being of skill 1, π_1, is modeled as follows:

$$\pi_1 = \frac{exp(Z\delta)}{1 + exp(Z\delta)} \qquad (5)$$

where δ is a parameter to be estimated and Z is a constant vector[17].

Finally, the agents face different conditions because of the realization of the shock to their wage offers. People with the same set of state variables may take different optimal choices because of that.

4.3   Model solution

Optimal decisions depend on the state variables, $X_t = (A_t, Age, edu_t, \epsilon_t)$, preferences ($\gamma$, ϕ, and β), and the parameters that determine the pattern of the wage (including type and race) and the characteristics of the transfer function (including family type).

The sequential problem can be rewritten so that the value function is the solution to:

$$V_t(X_t) = max_{(C_t, S_t, L_t)}\{U(C_t, L_t) + E_t\beta V_{t+1}(X_{t+1})\} \qquad (6)$$

subject to (3) and (1). The decision rules are computed via value function iteration, starting at time T and working backwards. Because the space spanned by the state variable A_t is continuous, standard dynamic discrete choice approaches cannot be implemented. The state space is discretized into a finite number of points on a grid and the value function is evaluated at those points. I use a Gaussian quadrature procedure to integrate the value function with respect to the shock to the wage[18].

As explained above, my study incorporates permanent unobserved heterogeneity. The model is solved once for each type. When I simulate the model, I assign a type to each simulated individual according to the following procedure. As customary in this kind of models, at time $t = 0$ I draw a realization of a uniform random variable for each observed agent, $u_i \sim U[0,1]$. I then compare it with the probability of being of type 1, π_1. If $u_i < \pi_{1i}$

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[17]In an earlier version of this study, while focusing only on a subsample of whites, I allowed the unobservable ability to be correlated with some individual characteristics. In that case Z contained a constant, the percentile score in the ASVAB test, and the years of schooling of both parents. When I extend my analysis to the full sample, many observations of background characteristics are missing. This is particularly true for minorities.

[18]My `Fortran 90` implementation of the code for the Gaussian quadrature follows closely the `Matlab` one by Miranda and Fackler (2004)

individual i is considered to be a member of the group of people having "type 1" abilities. Conversely, if $u_i \geq \pi_{1i}$ individual i is assigned "type 2" abilities. The parameter governing the probability of being a type 1 agent is estimated together the other parameters. Therefore each moment produced by the model is a weighted average of the realizations of individuals of different type.

For the sake of saving computational time, the terminal value function is computed at time $t = 35$ as the present discounted value of the future lifetime utility. I assume that from that point on, each individual receives a wage that is a deterministic function of his state variables at time $t = 35$ and that the only decision is how much to consume in each point in time until the final period T. Therefore the agent's problem is simply to find the value of the yearly consumptions which maximize his remaining discounted lifetime utility subject to a budget constraint; over his life-cycle, the agent can finance his expenditures only by his initial assets (which can be negative) and by the discounted sum of all his net-of-taxes future wages. Formally, at time $t = 35$ each individual faces the following problem:

$$Max_{\{c_t\}_{t=35}^T} \sum_{t=35}^{T} \beta^{t-35}(\frac{c_t^{1-\gamma}}{1-\gamma} + \phi) \tag{7}$$

subject to:

$$\sum_{t=35}^{T} \frac{c_t}{(1+r)^{t-35}} = A_{35} + \sum_{t=35}^{64} \frac{\chi(2000 \cdot \tilde{w}_t)}{(1+r)^{t-35}} \tag{8}$$

where:

$$ln(\tilde{w}_t) = \alpha_0 + \alpha_1 age_t + \alpha_2 age_t^2 + \alpha_3(\tau)edu_{35} + \alpha_4 BA_{35}$$
$$+\alpha_5 Black + \alpha_6 Hispanic \tag{9}$$

5 Estimation

The goal is to estimate some of the parameters governing the wage pattern and the preferences (γ,ϕ), as well as the determinants of type-probability. The estimation strategy is the Method of Simulated Moments, which was first proposed by McFadden (1989). The goal is to find a vector of parameters such that the profiles observed in data and the simulation outputs are as close as possible. Let m_j^D be the j-th moment in the data and m_j^S the j-th simulated moment.

The latter is found as an average across all the simulated individual observations, that is as $m_j^S = \frac{1}{NS} \sum_{s=1}^{NS} m_j^s(\theta)$ where θ is the vector of parameters to be estimated. The vector of moment conditions is:

$$g(\theta)' = [m_1^D - m_1^S(\theta), \ldots, m_J^D - m_J^S(\theta)]$$

The set of the estimates are the ones such that:

$$\hat{\theta} = argmin\{g(\theta)'Wg(\theta)\}$$

where the weighting matrix W is a diagonal matrix whose entries on the main diagonal are the inverse of the variances on the sample moments.

The MSM estimator was shown to be consistent and asymptotically normally distributed. The variance of the estimator is estimated as follows:

$$\hat{V} = (1 + \frac{obs}{sim}) \cdot (\hat{D}'W\hat{D})^{-1} \qquad \text{and} \qquad \hat{D} = \frac{\partial g(\theta)}{\partial \theta}\mid_{\theta=\hat{\theta}}$$

where obs is the number of observations, and sim the number of simulated individuals. $\hat{D}$ is a matrix which contains the first derivatives of every moment with respect to every parameter[19].

The moments used in the estimation include:

- the proportion of young men in school, school and part-time work, and full time work each year, by net worth of the family;

- the average observed wage by age and education attainment;

- the average observed wage by age and race;

- the mean assets at age 20 and age 25, by net worth of the family;

- the probability of being in school at period t, conditional on being in school in period $t - 1$.

Overall, the estimation procedure involves 132 moments. I estimate 15 parameters, so the model is overidentified. Each group of parameters is identified from a different set of moments. The disutility of working is identified using the proportions of people in the labor force each

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[19]See for example Adda and Cooper (2003) for an introduction to this estimation methodology.

year. The wage parameters are identified using the observed average hourly wage moments. The longitudinal moments help to identify the proportion of type 1 individuals in the population. As in Keane and Wolpin (2001), the identification of the parameters of the transfer function relies on the differences in the enrollment behavior across men with different family background. Like in Cagetti (2003), the pattern of asset accumulation is used to identify the coefficient of relative risk aversion.

The methodology implies iterating between the solution of the dynamic programming and the minimization of the objective function. For each set of the parameters, the life-cycle model is solved as described above; then, using the optimal decision rules, the behavior of 9,000 simulated individuals is reproduced. The moments in the model can therefore be computed with Monte Carlo integration. A value for the objective function is returned to the minimization algorithm. The minimization stops if the returned value of the objective function is the minimum; otherwise a new set of the parameters is used and the process is started over.

The estimation is carried out with a direct search approach, namely the Nelder and Mead (1965) algorithm[20]. This method is particularly appropriate to minimize functions that could be discontinuous. In fact, instead of relying on derivatives to move towards the bottom of the objective function, it is based on the comparison of the value of the function at different trials of the parameters. On the other hand, this method could be quite time consuming. In order to save computational time, following the paper of Lee and Wiswall (2007) I modified the original algorithm so it can be run in parallel over a cluster[21].

6 Data

The data used comes from the National Longitudinal Survey of Youth 1997 (NLSY97), a panel data of individuals who were 12 to 17 years old when first interviewed in 1997. The survey sample was designed to represent U.S. residents in 1997 who were born between 1980 and 1984 and originally included 8,984 respondents. The NLSY97 collects information about

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[20]The Fortran implementation of the Nelder-Mead algorithm used is a modification of the NAG library public-domain one.

[21]The parallelization of the Fortran code is achieved through the MPI libraries. The program runs on 12 processors.

labor market and education choices and is therefore well-suited for my research purposes.

The first twelve waves of the survey are publicly available and are used here. Some sample restrictions are imposed. First of all, I focus only on men. The literature on labor economics has recognized that the impact of fertility decisions on labor market and education outcomes are much stronger for women. Focusing on men only I can avoid modelling fertility explicitly. This is the also the avenue of research followed by previous structural analysis of education choices[22]. Moreover, I restrict my attention to the 1980 cohort only, which is the one with the longest history in the panel. Furthermore, I keep in the sample only the observations of the individuals who are interviewed in each wave of the survey.

Overall, these operations come at the cost of reducing the sample size to 300 young men, which are observed in 12 consecutive years[23]. The use of the NLSY97 sample weights for this specific subpopulation ensures the representativity of my sample. In particular, 70% of the observed individuals are whites, 14.85% blacks, and 15.01% Hispanics.

In the estimation of the model, the decision period is assumed to be the calendar year, rather than the academic semester or the academic year. This decision is driven by the fact that the NLSY97 reports data on yearly income and hours worked. Therefore, as in Lee and Wolpin (2006), a rule must be followed to allocate the individuals into the four possible choice categories. An individual is assigned to the schooling category if he reported to be attending school in the fall. If the individual reported to have worked less than 200 hours, then he is classified either in the "school-only" category or the "idle" category, according to the schooling classification above.

Data on earned gross wages are observed for the subset of young men who choose to work. Nominal wages and any other monetary value are deflated and expressed in 1997 dollars using the CPI computed by the Bureau of Labor Statistics. Hourly wages are computed dividing the yearly incomes by the reported number of hours worked. As explained above, I don't use reported hours in the solution of the dynamic programming.

The distribution of the young men in the sample across the four possible choices is shown in Table 1. Two features are worth mentioning. As expected, the percentage of people in

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[22]Ge (2008) structurally estimates a model of education and marriage choices for women using data from the NLSY79.

[23]Since the NLSY97 collects wage information with a one-year lag, I can't observe wages in the last year of the panel (2008).

the labor force increases over time and we can see discrete drops in the number of people enrolled in school at the typical high school and college graduation ages. Moreover, young men typically work while in school; the percentage of students who don't work is always quite small and drops over time. Therefore, the explicit modeling of work effort while in school is likely to be important to grasp the full picture of how education is financed. At age 26, about 14% of the young men in the study are still enrolled in a program. The "idle" option is chosen by few people every year, although some fluctuations can be observed.

The representativity of my sample is confirmed by a simple comparison between these figures and the ones reported in the latest release of the Digest of Education Statistics (Snyder, Dillow, and Hoffman, 2009), which shows enrollment rates by years, sex, race, and age-groups.

Net worth is defined in this study as the difference between non-housing assets and debts. This measure is very widespread across individuals. Table 2 shows the average net asset holdings by age. Because the NLSY97 reports complete informations about assets only at age 20 and 25, I can show descriptive statistics only at these two points in the life-cycle. At age 20, the average net worth is about $1,200, while it is about twice as big five years later, at age 25. In both cases, four people out of ten have more debts than assets. The distribution is characterized by a wide range; nevertheless, a large portion of youth hold a negligible amount of net assets. Other interesting features emerge by looking at the average assets and debts by education attainments (Table 3). At age 25, the average amounts of both assets and debts are higher for college graduates than for individuals without any higher-education degree. On one hand, college graduates can save more because of their higher salaries. On the other hand, many of them have to borrow large sums of money to pay for their education.

A first descriptive analysis of the data reveals a large degree of heterogeneity in behavior. The enrollment rate for whites at age 17 is almost 91%, but only 82% for blacks. At age 20, the enrollment rate is about 41% for whites, 29% for blacks, and 37% for Hispanics. Individuals from poor families are less likely to be enrolled in school at each point in their life-cycles.

Some of the parameters of the model are not estimated. Table 5 reports them. The figures for college tuition and fees are taken from the Digest of Education Statistics (Snyder, Dillow, and Hoffman, 2009). College costs are the 1998-99 average tuition and fees for all (public and private, 2 and 4-years) institutions in the U.S.[24]. The figure for tuition and fees for Graduate

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[24]Table 331 in Snyder, Dillow, and Hoffman (2009)

School comes from a recent report from the National Center for Education Statistics (Aud et al., 2010). In both cases, the figures are expressed in 1997 dollars. Since the average real increase in tuition costs in the period considered here was about 3%, the same increase to the tuitions is faced by the agent in the model. Therefore, unlike the previous literature on this topic, my model explicitly incorporates increasing tuition costs.

7   Results of the estimation

The structural estimates of the life-cycle model described above are shown in Table 6. The coefficient of relative risk aversion is 2.86, in line with most of the literature on life-cycle behavior. Using the data from the Survey of Consumer Finance, Cagetti (2003) finds values ranging between 2.57 and 4.05. Gourinchas and Parker (2002) find values in the range of 0.28 to 2.29, according to the education levels. French (2005) finds a coefficient of relative risk aversion between 0.566 and 6.00, according to the specification. Both the risk aversion and the disutility parameters are precisely estimated.

The parameters for the wage equations are within reasonable values as well. Being older is associated with higher wage offers (because of the accumulated experience). One more year of education increases the wage per hour by about 7% for type 1 individuals, and by about 3.5% for type 2 individuals. Moreover, college graduation is found to have a large and significant effect. Belzil (2007) reviews the findings on the return to education from both the instrumental variable literature and the structural one. He reports that most of the structural estimation exercises find returns ranging from 4% to 7% per year. Somewhat higher coefficients are found by the natural experiments or instrumental variable literature (10 to 15%). Keane and Wolpin (1997) find a return of 2.4% for blue-collar workers and 7% for white-collar workers. Similar findings are reported in Lee and Wolpin (2006). Belzil and Hansen (2002) use a very flexible wage equation that allows for the return to education to vary according to the level of completed schooling. In that case, the average return is estimated to be about 5%, while the return to one more year of college is about 10%.

The intercept in the wage offer equation is allowed to vary across racial groups. In this case, due to the small sample size, the estimates are not precise. Nevertheless, as reported by

previous literature on the topic, blacks and Hispanics receive lower offers[25].

The proportion of type 1 in the population is estimated to be about 9%. The transfers received while studying is found to decrease with age, while young men from richer families receive much higher amounts than the rest of the population. The estimates imply that a 19-year-old student would receive about $2,500 in transfers if coming from a poor family, and more than $4,000 if from a more affluent background.

8   Model Fit

Before turning to the simulation of policy changes, I present some evidence of the fit of my estimated model to the data. Table 7 compares selected outcomes in the model with the actual data. As explained above, the data moments are weighted by the panel sample weight in the NLSY97; the moments in the model are computed as the result of Monte Carlo integration over all the relevant simulated individuals.

Figure 3 compares enrollment rates in the data with those resulting with the simulation of the model using the optimal parameters. The two series are pretty close one to another. In particular, the model is able to replicate both the level and the trends in enrollment over time. The model slightly overestimates the percentage of people enrolled for ages 24 to 27. Heterogeneity in enrollment behavior is higher in the later stage of the life-cycle: this feature makes the replication of the average enrollment rate for this period more difficult to obtain.

In terms of educational attainments, the model replicates the main features of the data extremely well. The percentage of people with at least a college degree is 34.47 in the model and 34.17 in the data. Moreover, the simulations are consistent with the large difference in attainments by family background which can be observed in the data. On one hand, half of men from rich families have at least a college degree by the time they turn 26; on the other, only one in five men from poor families obtains the same level of education (both in the model, and in the data).

Figure 4 plots *accepted* wage by age and race. These hourly wages are effected by selection into the labor force in the same way in the model as in the data. In every case the simulated

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[25]Altonji and Blank (1999) estimate a series of wage equations using data for the CPS for 1995. The implicit estimated difference in wages controlling for some individual characteristics is as low as -15% for minorities.

wage is very close to the observed one. The model is also able to replicate the main differences in accepted wages by educational attainment. At age 26, high school graduates earn about $9 per hour (in both the data and the model), while college graduates earn slightly more than $17 per hour worked (see Table 7).

As regards the net worth of the agents, my model can't fully capture the extent of their dispersion in the population at age 20. This result can be explained with the fact that the simulation procedure assumes that every agent in the sample enjoys the same initial level of asset at age 17. On the other hand, by age 25 the distribution and the mean value of the assets in the simulation are very close to the ones in the data. The average net worth is about $2,000 in both cases. 16% of the young men in the sample have a net worth worth of less than -$10,000 (about 17% in the model), 25% between that amount and zero (28% in the model), 29% between zero and $10,000 (29% in the model), and finally 29% more than $10,000 (25% in the model).

9   Policy Experiments

The aim of this study is to build a framework that can be used to simulate the likely impact of a series of different policies. In particular, in this section, I show the results of two sets of policy experiments. The first one, a reduction in tuition costs, is admittedly not novel. Other studies have carried out similar experiments, albeit using slightly different modelling and estimation strategies. On the other hand, the fact that I am using a new data set and the fact that I am not restricting my focus to while males as in most of the previous literature, make the results interesting in their own right. The second set of policy experiments is based on the simulation of changes to the rules of the tax-based education incentives. To the best of my knowledge, this is the fist paper to tackle this issue in a structural approach.

In the first case (Table 8), I allow for a generalized tuition reduction of 5%. This policy translates into an increase of the probability of college enrollment among 18 and 19 years old of about 2.5 percentage points. Moreover, the policy is effective in increasing the percentage of people completing their undergraduate studies by the age of 22 by about 3.5 percentage points. In this model, the agents face a series of incentives to complete their education early in their lifetime. First, the opportunity cost of attending school is increasing over time because

of the structure of the offered wage (which depends on age). Second, the amount of the transfers received is decreasing over time. Third, the agents face tuitions which increase over time in real terms. As stressed in other models of human capital accumulation, if education is costless, it is optimal for the agents to devote the first part of their life-cycle to their education (Ben-Porath, 1967). Clearly, some agents may be prevented from obtaining the optimal level of education by liquidity constrains. This policy experiment simulates the removal of this obstacle, by making the access to college significantly less expensive for everyone.

Because I model the schooling decision in a life-cycle framework (instead than in a static, or a two-period model), I can evaluate the dynamic effects of some policies addressed to increase educational attainments. Forward looking individuals react to expected future policies in advance. The second column of Table 8 shows the results from focusing the full tuition reduction in the last two years of college. By making the last two years of college less expensive, this policy influences the optimal decision to enroll in college in the first place. I find large effects on enrollment (an increase of about 3 percentage points) and attainments at age 22 (an increase of about 2 percentage points).

How does this estimate compare with the findings of previous studies? Keane and Wolpin (1997) find that halving tuition costs increases the college graduation rate by about one third. The same authors, in a later study of theirs (Keane and Wolpin, 2001), find that a tuition subsidy of $3,000 dollars[26] increases the number of people with at least some college education by about 66%.

Given the very nature of studies based on the "natural experiment" approach, the comparison with the findings of this literature is not straightforward. Nevertheless, some similarities can be found. Dynarski (2003) investigates the effects on attendance of the elimination of the Social Security Student Benefit Program in 1988. She finds that a reduction of aid by $1,000 translates into a decreased probability of attending college by 3.6 percentage points. The same author (Dynarski, 2002) finds similar results exploiting the introduction of the Georgia Hope Scholarship as a natural experiment. A review by Kane (2006) summarizes the existing literature on the topic and reports that many studies find that a $1,000 difference in tuition is associated with a 6 percentage point difference in college-going rate.

Table 9 shows the results of the simulations of possible changes of the rules of the Lifetime

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[26]In 1987 dollars.

Learning Tax Credit. This tax credit can be claimed directly by the student only if he is independent (i.e. if he is not claimed as a dependent child on his parents' tax return); anyone who is 24 years old or older, or enrolled in graduate school, is considered independent according to the tax code. For this reason, I focus my attention to the effects of this tax credit on graduate school enrollment only.

The Lifetime Learning Tax Credit can't be claimed by anyone with a gross adjusted income which is above a certain threshold[27]. The first experiment consists in raising the phaseout threshold in every year by 50%. As expected, the percentage of people enrolled in graduate school is not affected by this policy: very few students between the age of 24 and 26 have such high incomes while working only part-time. Because of the limited tax liabilities of most students, increasing the maximum available credit by 50% has a relatively small effect too.

Other scholars have predicted that a non-refundable tax credit could have only a small effect on the decision to enroll in college (Dynarski and Scott-Clayton, 2006). Also in the case of graduate education, a refundable tax credit would allow more people to take advantage of the full amount of the credit. Under the current rules, because of very limited (or even null) tax liabilities, graduate students obtain only a fraction of it. This is the hypothesis which motivates the last two policy experiments. In the first case, I make the tax credit partially refundable, up to the limit of $1,000 (in 1997 dollars). In this case, the enrollment rate in graduate school increases by about 3 percentage points. The effect is even higher when the tax credit is made fully refundable.

10   Conclusions

In this paper I have structurally estimated a dynamic life-cycle model of education and labor force participation decisions. The model allows for several sources of observed and unobserved heterogeneity, as well as for savings and borrowings. Moreover, it accounts for the major rules of the U.S. federal income tax. The model is estimated with the method of simulated moments using a sample of white, black, and Hispanic young men from the NLSY97.

The estimates imply that parental transfers contribute to explain part of the differences in enrollment pattern in the population of young men in the 2000s: individuals from wealthier

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[27]$50,000 in 2009

families receive larger income support while studying. The return to education is found to vary across individuals. About one out of ten students enjoys a return of 7% per each additional year of education. For the rest of the population, additional schooling increases offered wages at a much lower rate, about 3.5% per year.

The model is used to simulate the effects of financial aid and tax policies on educational choices. In particular, I find a sizeable effect of a generalized tuition cut on college enrollment among 18 and 19 years old. Moreover, I find that graduate school enrollment can be increased by making the Life-Time Learning Tax Credit refundable. This finding can be explained by the fact that most students have very small or even null tax liabilities; therefore they cannot take advantage of the existing tax credits for higher education.

A series of extensions to this model can be envisaged. First, I do not model the choice among different college types. This limitation can be overcome by adding preference shocks to the specification of the model. Second, by explicitly allowing for fertility and marital choices, this model can be extended to include women behavior. Considering the recent trends in college enrollment by gender, this is likely to be a very promising avenue for future research.

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Figure 1: Median annual earnings of people 25 years old and older by educational attainments and gender (from the Digest of Education Statistics (2009)).
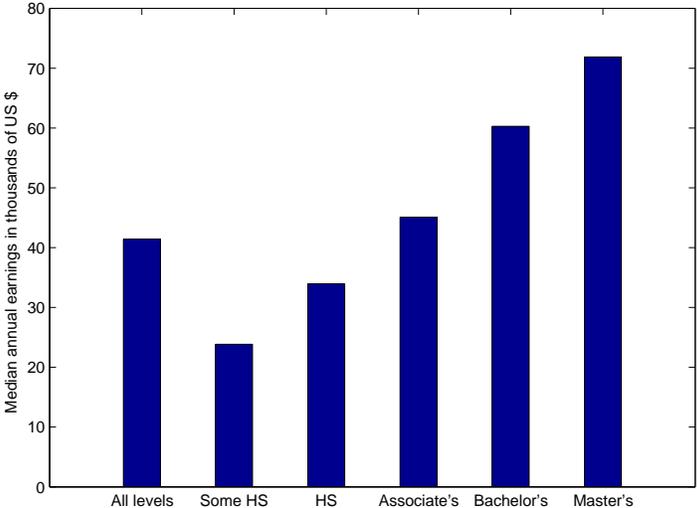

Figure 2: Tuition, room, and board for all institutions (thousands of 2006-07 dollars). Source: NCES, Higher Education General Information Survey.
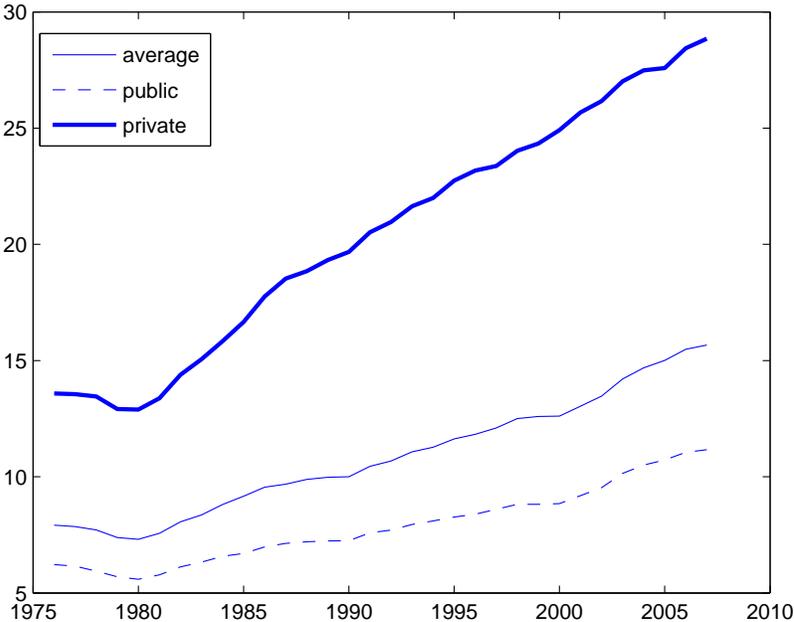
Table 1: Descriptive statistics about observed choices (%)

Age	School No Work	School Part-Time Job	Work	Home
17	55.38	33.58	4.04	7.00
18	37.93	34.25	19.92	7.90
19	16.29	32.01	40.92	10.78
20	11.23	27.40	50.42	10.95
21	12.46	26.53	51.24	9.78
22	9.53	22.96	56.53	10.98
23	6.43	16.87	66.49	10.21
24	5.20	9.97	74.54	10.29
25	2.59	12.98	77.64	6.79
26	2.71	11.24	77.12	8.93
27	3.78	11.64	77.38	7.20

Source: my calculations on the NLSY97 male sample (1980 cohort).

Table 2: Net worth by age

Age	Net worth	% in [-2,000;+2,000]	% Negative
20	1,226	58.83	37.28
25	2,705	40.98	40.24

Source: my calculations on the NLSY97 male sample (1980 cohort).
Data in 1997 dollars.

Table 3: Assets and debts by education attainment (age 25)

	College Graduates	Non College Graduates
Average asset	28,829	8,769
	(61,034)	(27,700)
Average debt	21,565	6,772
	(25,582)	(10,306)
% with negative net worth	42.53	40.15

Source: my calculations on the NLSY97 male sample (1980 cohort).
Data in 1997 dollars.

Table 4: Average earnings by age

Age	Average Earnings	(sd)	Obs.
17	3,572	4,092	194
18	6,508	6,791	193
19	10,059	8,646	220
20	12,657	9,012	229
21	15,095	10,804	210
22	16,198	11,239	235
23	22,777	17,083	222
24	23,122	13,503	224
25	26,276	16,717	240
26	29,540	20,834	252
27	31,599	24,681	257

Source: my calculations on the NLSY97 male sample (1980 cohort).

Data in 1997 dollars.

Table 5: Parametrization

Parameter	Value	Source
Interest rate (r)	0.03	Cagetti (2003)
First-year college tuition	$ 5,046	Snyder, Dillow, and Hoffman (2009)
First-year graduate school tuition	$ 13,940	Aud, Fox, and KewalRamani (2010)

Tuition are expressed in 1997 dollars.

Table 6: Estimates

Parameter		Estimate	(s.e.)
Log hourly wage:			
Constant	α_0	0.5929	0.1138
Age	α_1	0.0573	0.0070
Age squared	α_2	-0.00028	0.00010
Return to education (type 1)	$\alpha_{3,1}$	0.0664	0.0164
Return to education (type 2)	$\alpha_{3,2}$	0.0347	0.0079
BA	α_4	0.1776	0.0620
Black	α_5	-0.1881	0.2859
Hispanic	α_6	-0.2034	0.1263
Variance of wage shock	σ_ϵ^2	0.0969	0.0022
Preferences:			
Coefficient of relative risk aversion	γ	2.860	0.149
Disutility from working	ϕ	-11.077	3.174
Log Transfers:			
Constant	tr1	-2.523	0.297
Rich family	tr2	0.5304	0.2655
Age	tr3	-0.06135	0.0088
Probability of being type 1:			
Constant	δ	-2.257*	0.3040
*it implies that $\pi_1 = 0.0947$			

The estimation is conducted with the method of simulated moments.

The asymptotic standard errors are computed with finite difference methods.

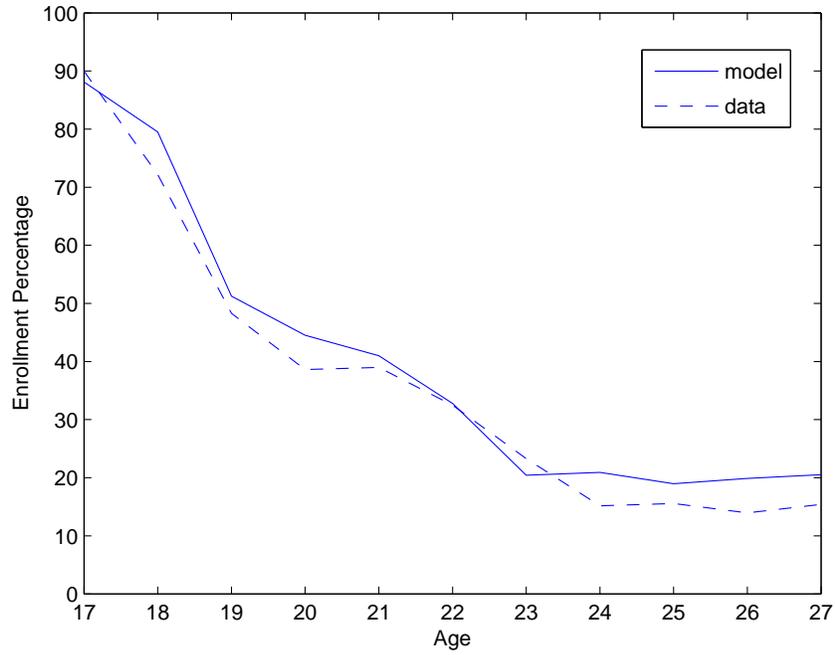Figure 3: Enrollment rates by age in the model and in the data.

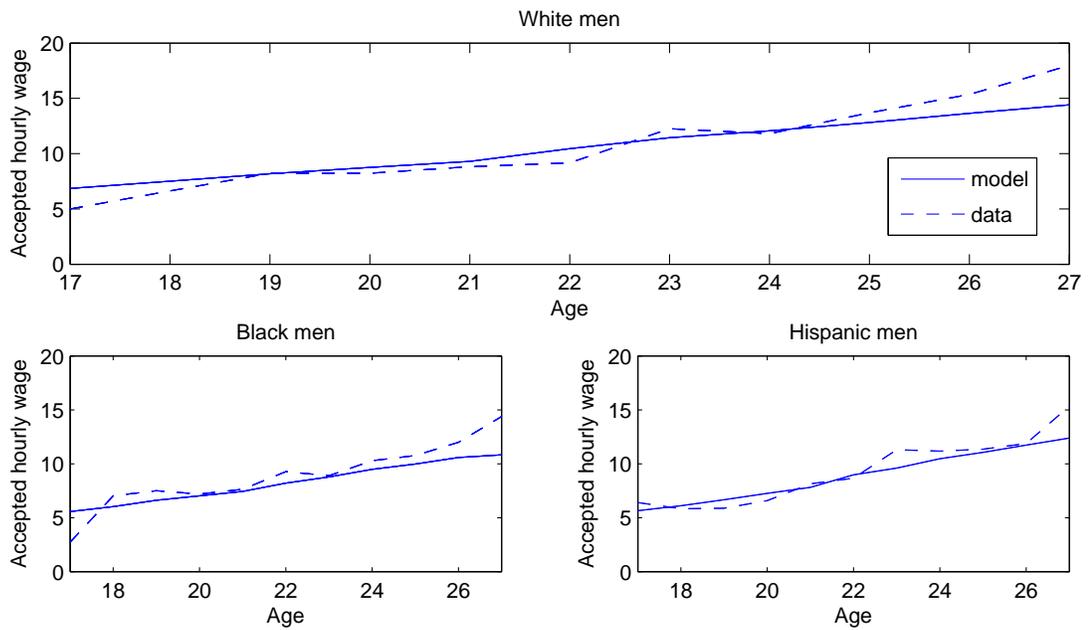Figure 4: Accepted wages by age and race in the model and in the data.

Table 7: Model fit for selected outcomes

	Data	Model
Average wage by educational attainment at age 26[a]		
High school degree	8.966	9.314
Some college	13.43	10.49
College degree (or higher)	17.33	17.42
Educational attainment at age 26[b]		
College degree or higher (overall)	34.17	34.47
College degree or higher (poor family)	17.56	19.87
College degree or higher (rich family)	49.28	47.76
Net worth at age 20[b]		
Mean[a]	1,226	-1,286
Less than $-10,000	7.01	11.53
Between $-10,000 and $0	30.28	40.56
Between $0 and $10,000	53.25	47.56
More than $10,000	9.47	0.13
Net worth at age 25[b]		
Mean[a]	2,705	2,183
Less than $-10,000	16.01	16.81
Between $-10,000 and $0	24.93	28.06
Between $0 and $10,000	29.23	29.70
More than $10,000	29.83	25.43

(a) In 1997 US $. (b) Percentage

Table 8: Simulation of a 5% college tuition cut

	Baseline	Tuition Cut	Tuition Cut (last 2 years of college)
Percent with a BA at 22	20.64	24.21	23.67
Probability of college enrollment (18-19)	51.84	54.35	54.05

Table 9: Simulation of tax-credit reforms

	Grad School enrollment rate (24-26 years old)
Baseline	11.82
Phaseout threshold up by 50%	11.82
Maximum credit up by 50%	13.00
Refundable credit up to $1,000^a	15.16
Fully refundable credit	15.88

(a) In 1997 US $