The school reentry decision of poor girls. Structural estimation and policy analysis using PROGRESA database

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Abstract

In this paper I present a dynamic structural model of girls' schooling choices and estimate it using the Mexican PROGRESA database. This structural approach allows me to evaluate the effectiveness of several policies to increase school reentry rates for girls in low-income households. To increase school attendance among poor children in developing countries, policy makers have implemented conditional cash transfers programs. While transfers have been successful in keeping girls at school, they do not increase school attendance among girls who dropped out of school. Cash transfer programs may fail because most of poor, dropout girls leave school to stay at home helping in housework, rather than working for a salary. Results suggest that effective policies to increase school reentry rates for poor girls are free access to community nurseries and kindergartens, availability of secondary schools and reductions in class size.

JEL classification I21; I28; J16; O15

Keywords Policy Evaluation; Dynamic discrete choice structural models; School choices for girls; School reentry; PROGRESA

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1 Introduction

In this paper I evaluate the effectiveness of alternative policies to persuade dropout girls in poor families to go back to school and continue with their education. I discuss the differential effect that several policies have on reentry decisions and on enrollment decisions. I quantify the effect of demand-side policies such as conditional cash transfers and availability of daycare centers for young children. I also present results of the effect on school attendance of supply-side policies such as reduction in class size and increase in the number of communities where a secondary school is available. The analysis is based on a dynamic behavioral model of school choices for girls. The structural parameters of the model are estimated using the Mexican PROGRESA database.

The motivation behind this study is threefold. First, in the paper I address a relevant policy concern: how to increase educational participation in developing countries. Despite the efforts made by policy makers in increasing enrollment rates, educational participation is far from targets proposed by several international institutions[1]. UNESCO (2007) reports that between 2000 and 2006, the total number of out of school children in low-income countries decreased by 41%. Yet, in 2006 almost one in five of children of primary school age were not in school. Secondary net enrolment rates have been gradually increasing by around 2 to 3 percentage points per year in most regions. Still, in 2005 three in five children of secondary school age in low-income countries were not in school. To increase school attendance rates among poor children in developing countries, policy makers have implemented conditional cash transfers programs[2]. While transfers have been successful in keeping boys and girls at school, there exist evidence that they do not increase girls' reentry rates.

Second, in this paper I contribute with the evaluation of a well-known anti-poverty program, PROGRESA. I quantify the effect of PROGRESA grants on reentry decision for girls using a dynamic behavioral model of school choices. The methodology applied allows to perform a counterfactual analysis. The analysis of the effect of PROGRESA grants on reentry decision has been seldom discussed. Behrman, Sengupta, and Todd (2001), using difference-in-difference estimation techniques, conclude that PROGRESA grants increase reentry rates and this effect is lower for girls than for boys. Valdes (2007) addresses the analysis of the effect of PROGRESA grants on reentry rates by estimating a reduced form equation for schooling enrollment and finds that grants increase reentry rates among boys but do not affect girls' reentry rates.

Third, this study contributes to a growing literature that addresses empirical questions

[1]For example, universal primary education is Goal 2 of both Education for All movement and the Millennium Development Goals adopted by UN Member States in 2000

[2]Examples of cash transfer programs are PROGRESA in Mexico, PRAF in Honduras, Red de Protección Social in Nicaragua and Familias en Acción in Colombia.

using discrete choice dynamic programming models of individual behavior. These models are attractive because structural parameters have a clear interpretation within the theoretical model and they are useful tools for the evaluation of counterfactual policies (Aguirregabiria and Mira (2007)). Miller (1984) and Keane and Wolpin (1997) propose and estimate dynamic models of occupational choices. Attanasio, Meghir, and Santiago (2005) and Todd and Wolpin (2006) use dynamic behavioral models to evaluate the PROGRESA program.

In this paper schooling choices for girls in poor families are modelled following the individual decision approach as in Attanasio, Meghir, and Santiago (2005), where boys decide whether to attend school or to work. For families with many children the value of retaining a girl at home becomes more relevant since they are a good help in housework. As girls may dropout from school to stay at home I depart from Attanasio, Meghir, and Santiago (2005) by allowing girls to choose among three alternatives: attend school, stay at home and work. Under this framework a girl schooling decision can be assumed to be made by her parents in an altruistic fashion. That is, they choose the alternative that maximize their daughter inter-temporal welfare independently of the decision they make for their other children. I relax the assumption allowing the value of each alternative to be affected by family composition in two ways. Unobserved individual heterogeneity and the utility a girl derives from staying at home are affected by family characteristics.

The estimated model fits girls' schooling choices reasonable well. It replicates patterns observed in the actual distribution of schooling choices by ages: for each particular age reentry rates are lower than enrollment rates; reentry and enrollment rates decrease as age increases, and reentry rates decrease quicker than enrollment rates. It also replicates main features of the distribution of schooling choices by stock of education: reentry and enrollment rates decreases as the stock of education increases and, in the last grade of primary school and in the last grade of junior secondary school reentry and enrollment rates go down remarkably. It is observed in the data that most girls that were attending school in the previous academic year (non-dropout girls) are still in school in the current year while only 40% of girls who were out of school (dropout girls) come back. The estimated model is able to match these differences in the distribution of schooling choices between non-dropout and dropout girls. It rationalizes these differences by showing that persistence is relevant in the decision of attending school. The model also contributes to understand the reasons that make a girl dropout from school. A girl's decision to drop out of school is related to her age, the composition of her family and her mother's labor participation, but unrelated to unobserved characteristics of the girl, such as her unobserved ability at school. As her value at home increases with the number of members in her family and with her age, she leaves school not to work but to stay at home helping in housework. Additionally, results suggest that alternative policies to cash transfers, such as free access to community nurseries and kindergartens, availability of secondary schools, and reductions in

class size, effectively increase school reentry rates for poor girls.

The paper is organized as follows. In Section 2 I present the theoretical model. Section 3 presents the main features of the PROGRESA program. Section 4 describes characteristics of the PROGRESA database. It provides some main statistics that focus on the differences between dropouts and non-dropouts. In Section 5 I discuss the empirical implementation of the model. In Section 6 I present results of the estimation of the structural parameters and of the counterfactual analysis. Finally, Section 7 concludes the paper with its main results.

2 The Data

2.1 Description of PROGRESA

The Education, Health and Nutrition program, PROGRESA, was first implemented by the Federal Government of Mexico in 1997, with the aim of helping the poorest families in rural communities. A fundamental characteristic of the program is that aid is conditioned on a specific behavior of the beneficiary. This conditionality aims to guarantee that the program does not lead to undesired outcomes, such as distortions in work decisions, and that it successfully accomplishes its initial objectives.

The program comprises actions in three major areas: education, health and nutrition. The expected outcomes were higher literacy rates, enrollment rates and completion rates; lower child mortality rates and higher vaccination rates; and lower rates of undernourishment. The program is targeted at family level. A family is qualified as being poor and thus eligible for the program according to a single index. This index contains information on family income and housing characteristics like presence of running water, electricity, pipes, etc.[3] Eligibility is independent of residence and family size and composition. All aid is given to the mother as there exist evidence that mothers are better than fathers at allocating family resources[4].

The education component includes monthly grants for children of a family qualified as beneficiary. To be given a grant, children need to be less than 18 years old, enrolled in school between the 3^{rd} year of primary school and the 3^{rd} year of junior secondary school, and to fulfill a minimum attendance requirement. The grants are not assigned based on academic achievement. A child who does not pass a grade is still eligible for the grant in the following year. But if the child fails the same grade twice, she/he losses eligibility. The grant increases with the years of schooling completed. In the junior secondary level the grant is slightly higher for girls, since there exist evidence that in poor families girls are more likely to dropout of school and that

[3]For a complete analysis of the targeting see Skoufias, Davis, and Behrman (1999a) and Skoufias, Davis, and Behrman (1999b).

[4]See Rubalcava and Thomas (2000) for a discussion.

Table 1: Grant amount and household income and consumption (in Mexican pesos)

Monthly grant		Jul - Dic, 98	Ene - Jun,99
Primary School			
3		70	75
4		80	90
5		105	115
6		135	150
Secondary School			
1	girl	195	210
	boy	185	200
2	girl	220	235
	boy	195	210
3	girl	240	255
	boy	205	225
Monthly maximum support by means of grants per family		420	465
Annual aid for school supplies			Academic year 98/99
Primary School			135
Secondary School			170

Monthly Household Income and Consumption	Nov 98
Income	1071
Consumption	630

Source: Data on grants from Histórico de apoyos monetarios. SEDESOL 2005. Data on income and consumption from Albarran and Attanasio (2002)

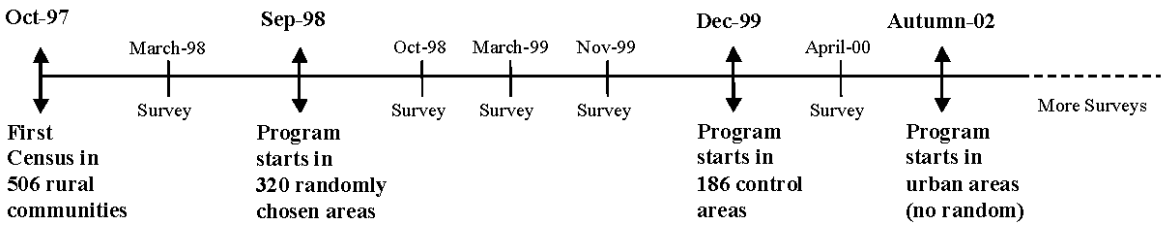
they dropout earlier than boys. Additionally, beneficiaries receive an annual grant for school supplies. In Table 1 there is a description of grants amounts. An eligible family was entitled to receive at most 420 pesos per month by means of scholarships in the second half of 1998. This amount represents 40% of the mean monthly family income and 67% of the mean monthly family expenditure in consumption. Thus, scholarships are potentially an important source of household's resources.

2.2 Evaluation of PROGRESA

Mexican authorities have intended to evaluate the program since its beginning, not only to measure results and impacts but also to provide information that allow for a redesign of policies. Accordingly, in 1997 and 1998 a high quality data set was collected in 506 communities where the program was to be implemented, and several surveys were carried out afterwards. In October 1998, the program was implemented in 320 randomly selected communities (treated communities) while in the remaining 186 communities (control communities) the implementation was

postponed until December 1999[5]. In Figure 1 below, I present the timing of the program.

Figure 1: Timing of the PROGRESA program



There exist a large literature on the evaluation of the average effect of PROGRESA schooling grants. Authors agree in their main conclusions: the program has increased enrollment rates for those children who received the grants, and this positive effect is higher on girls and on children who attend secondary school. We can distinguish two approaches in this literature according to the methodology applied. Researchers exploited the random assignment of the program at a village level and calculated difference and difference-in-difference estimators. Schultz (2004) is one of the main references. Then, researchers turned to analyze how to improve the effectiveness of the program estimating structural dynamic models of discrete choice[6] to simulate schooling decisions under alternative policies. Attanasio, Meghir, and Santiago (2005) models schooling as an individual decision and Todd and Wolpin (2006) which uses a model of parental decisions about fertility and child schooling.

2.3 Summary statistics

The sample used for the estimation of the model includes observations for females from 8 to 17 years old from the October 1998 survey that was conducted one year after the implementation of the program[7]. This includes 9,174 girls belonging to 6,303 families. To identify dropout girls I use information from the October 1997 survey. In particular, I use the following question: "Is she attending school now?" A girl is considered a "dropout girl" if the answer is "no", and a

[5]The quality of the randomization has been extensively documented in Behrman and Todd (1999), who conclude that, at least at community level, the implementation of the random assignment was performed successfully.

[6]Eckstein and Wolpin (1989), Rust (1994) and Aguirregabiria and Mira (2007) are exceptional surveys on the estimation of structural dynamic models of discrete choice.

[7]I do not include 6 and 7 years old girls because PROGRESA grants are given to those children that have completed at least 2^{nd} grade in primary school. So a children aged 7 or less is not entitled to receive a grant. Additionally, even thought the entrance in primary school is delayed one or two years, enrollment rates in 1^{st} and 2^{nd} grade in primary school were above 96% in the 1998 survey.

Table 2: Distribution of choices for Non-dropout and Dropout Girls

Choice	Non-dropout	Dropout	Total
school	7,276	516	7,792
	(92.3)	(40.0)	(84.9)
work	110	95	205
	(1.4)	(7.4)	(2.2)
home	498	679	1,177
	(6.3)	(52.6)	(12.8)
Total	7,884	1,290	9,174

Percentages in parenthesis.

"non-dropout girl" if the answer is "yes". The sample consist of 7,884 (86%) non-dropout and 1,290 (14%) dropout observations.

By the time of the October 1998 survey, 85% of girls were enrolled in school, 2.2% were working for a salary and 12.8% were neither in school not working, so I assume they were at home helping in housework. The distribution of choices is not the same for non-dropout and dropout girls. As it can be seen in Table 2 most non-dropout girls were still at school in 1998 while more than 60% of dropout girls didn't go back to school and were mainly at home. For both groups the alternative of working for a salary is negligible.

Differences in the distribution of choices between non-dropout and dropout girls are even more important when they are analyzed by age and by stock of education, as it is shown in Figures 2 and 3 below[8]. In both graphs it is evident that girls leave school to stay at home, and not to work for a salary. Additionally, enrollment rates for non-dropout are always higher than for dropout girls. Looking at the distribution of choices by ages, enrollment rates decrease with age and the rate at which they decrease is higher for dropout girls.

There are two grades in which enrollment rates for non-dropout girls go down remarkably. Grade 6, when girls finish primary school, and grade 9, when girls finish secondary school. A similar situation occurs with reentry rates: they are at their minimum levels in grades 6 and 9.

[8]A complete report of distribution of actual choices can be found in the Appendix in Table 6 and in Table 7.

Figure 2: Distribution of choices by age

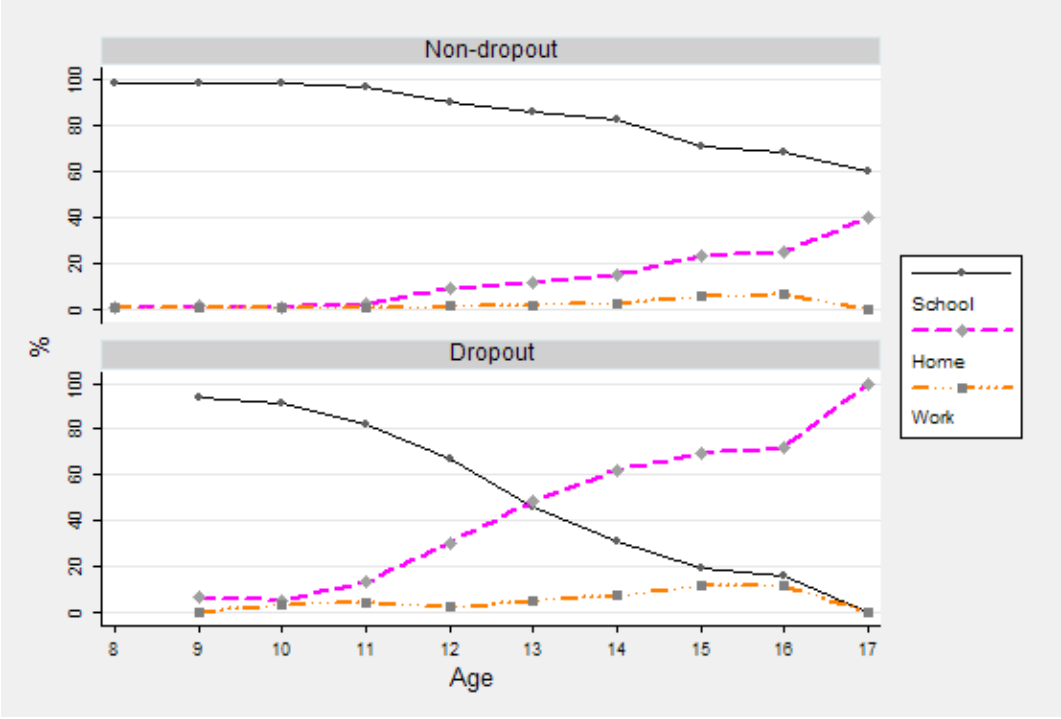
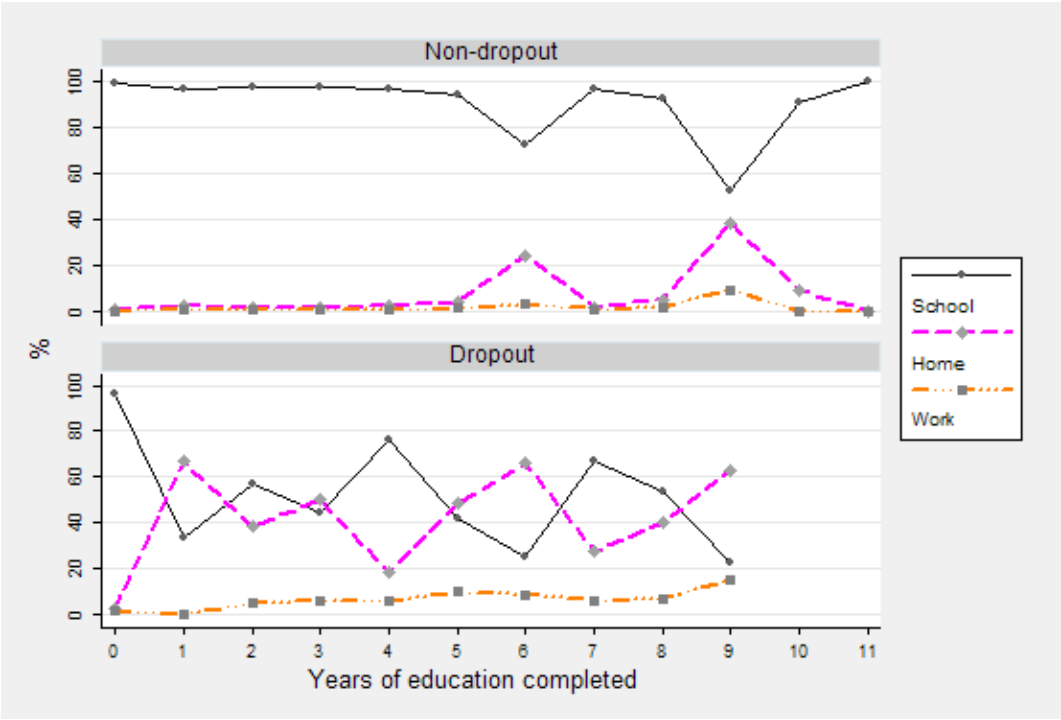


Figure 3: Distribution of choices by stock of education



The information contained in the PROGRESA surveys refers to individual characteristics, family composition, parents activities and background, and community characteristics. Descriptive statistics for selected variables for non-dropout and dropout girls are presented in Tables 3 and 4.

Table 3: Summary statistics for Non-dropout Girls

Variable	Mean	Std. Dev.	Min.	Max.
Age	11.04	(2.19)	8	17
Years of education	4.19	(2.1)	0	11
Potential monthly wage	374.32	(203.63)	11.82	1928.53
Percentage of girls belonging to a poor family	0.87	(0.34)	0	1
Percentage of girls whose father is present at home	0.93	(0.26)	0	1
Number of sisters	2.28	(1.12)	1	7
Number of brothers	1.27	(1.09)	0	6
Number of siblings aged 5 or less	1.16	(1.19)	0	11
Percentage of girls whose mother works	0.09	(0.28)	0	1
Mother's years of education	2.88	(2.54)	0	18
Percentage of girls that reside in a community with secondary school	0.35	(0.48)	0	1
Class size in primary school	25.27	(4.35)	16.66	38.5
Class size in secondary school	22.27	(4.38)	10.11	45

Table 4: Summary statistics for Dropout Girls

Variable	Mean	Std. Dev.	Min.	Max.
Age	13.59	(1.86)	9	17
Years of education	4.93	(2.01)	0	9
Potential monthly wage	491.15	(166.77)	102.66	1385.65
Percentage of girls belonging to a poor family	0.87	(0.34)	0	1
Percentage of girls whose father is present at home	0.93	(0.26)	0	1
Number of sisters	2.39	(1.18)	0	7
Number of brothers	1.29	(1.07)	0	5
Number of siblings aged 5 or less	1.14	(1.17)	0	7
Percentage of girls whose mother works	0.09	(0.28)	0	1
Mother's years of education	1.92	(2.09)	0	16
Percentage of girls that reside in a community with secondary school	0.22	(0.41)	0	1
Class size in primary school	26.32	(4.42)	16.66	38.5
Class size in secondary school	22.33	(4.94)	10.11	45

The mean non-dropout girl is 11 years old and has 4 years of education completed. Her mother has completed 3 years of education. She has two sisters and a brother older than six years, and one sibling aged less than 5. If she decides to work she can earn 375 pesos, an amount of money higher than the amount of the scholarship. In her municipality the mean class size is

25 students per class in primary school and 22 in secondary school. 87% of non-dropout girls belong to a poor family, only 9% of them has a working mother and 7% do not live with her father. 35% of non-dropout girls have a secondary school in their community of residence.

The mean dropout girl is 13 years old and has 5 years of education completed. Her mother has completed 2 years of education. She has two sisters and a brother older than six years, and one sibling aged less than 5. If she decides to work she can earn 490 pesos. In her municipality the mean class size is 26 students per class in primary school and 22 in secondary school. 87% of dropout girls belong to a poor family, 9% of them has a working mother and 7% do not live with her father. 22% of dropout girls have a secondary school in their community of residence.

Comparing both groups we can conclude that dropout girls have less educated mothers, a higher proportion of them have to travel to other community to attend secondary school and if they work they receive a higher salary than non-dropout girls.

3 Model and Empirical implementation

3.1 The general model

In this section, I present a dynamical behavioral model of schooling decision for girls aged 6 (the official age to enter school) to 17 (the stopping period)[9]. At each age t, a girl chooses one of three mutually exclusive actions: go to school ($a_{it} = 1$), work for a salary ($a_{it} = 2$) or stay at home to help in housework ($a_{it} = 3$). This is consistent with assuming that parents make decisions in the best interest of each of their children, so there are no interactions between the decisions of children that belong to the same family. Let Ω_{it} denote the state vector which contains all variables known by girl i at age t which have an impact on her current and future choices. Among other components, it also includes the girl's stock of education and she faces uncertainty about the evolution of her future stock of education. Denote by π^s_{tg} the probability of passing the grade at age t for grade g, that is the transition probability for the girl's stock of education. At age 18 girls either work and earn wages in accordance to their levels of education or stay at home.

Period t alternatives are chosen to maximize the intertemporal utility function

$$\mathbb{E}_t[\sum_{j=0}^{T-t} \beta^j u(a_{i,t+j}, \Omega_{i,t+j})|a_{it}, \Omega_{it}] + \beta^{T-t+1}\mathbb{E}_t[V^{T+1}(\Omega_{T+1})] \quad (1)$$

subject to the evolution of future values of the state variables, particulary to the probability of passing a grade π^s_{tg}. β is the intertemporal discount factor, $V^{T+1}()$ is the terminal value function,

[9]The reason for choosing 17 as the stopping age is that all women aged 18 or more in the database report not to be enrolled in formal education.

$\mathbb{E}_t$ is the expectation operator conditional on the state and $u(a_{it}, \Omega_{it})$ is the instantaneous utility function at age t for individual i that is specific for each choice a. By Bellman's principle of optimality, the choice specific value functions can be obtained using the recursive expression:

$$v(a, \Omega_{it}) \equiv u(a, \Omega_{it}) + \beta \mathbb{E}[\max_{a \in A} v(a, \Omega_{i,t+1})] \tag{2}$$

for $a = 1, 2, 3$ and $t \leq T - 1$, and $v(a, \Omega_{it}) = u(a, \Omega_{it}) + \beta \mathbb{E}[V^{T+1}(\Omega_{T+1})]$ for $a = 1, 2, 3$ and $t = T$. The optimal decision rule is then:

$$\alpha(\Omega_{it}) = \arg\max_{a \in A} v(a, \Omega_{it}) \tag{3}$$

In the database there is information on the individual's action a_{it} and a set of individuals characteristics X_{it}. From an econometric point of view, the state vector includes two subset of state variables: $\Omega_{it} = (X_{it}, \epsilon_{it})$. X_{it} are observed variables and ϵ_{it} are unobserved variables.

3.2 Utilities

Let $a_{it} = 1 \equiv w$, $a_{it} = 2 \equiv e$, $a_{it} = 3 \equiv h$ identify the alternatives of working, attending school, and staying at home respectively.

The per-period utility function of working is:

$$u(w, X_{it}) = \eta w_{it} + \epsilon_{it}^{w} \tag{4}$$

where w_{it} is the potential wage a girl can earn[10].

The per-period utility function of attending school is:

$$u(e, X_{it}) = \mu_i + \alpha_1 \eta G_{it} + \alpha_2 D_i + \alpha_3 AS_{i,98} + \alpha_4 CS_{i,98} + \alpha_5 S_{it} + \alpha_6' x_{it} + \epsilon_{it}^{e} \tag{5}$$

μ_i is the unobserved type, individual specific and time-constant. G_{it} is the potential grant amount, that takes a positive value if the child belongs to a poor family, resides in a treated community, and is attending a grade between 3^{rd} year of primary school and 3^{rd} year of junior secondary school. D_i is a dummy variable, which equals 1 if the child dropped out of school in the previous academic year[11]. $AS_{i,98}$ is a dummy equal 1 if there is a junior secondary school in the community where the girl resides (is a measure of the direct cost of attending secondary school). $CS_{i,98}$ is a municipality measure of class size. S_{it} is the girl's stock of education. x_{it} is

[10] Since in the survey it is reported only in a small percentage of the cases it is estimated by OLS. For more details see the Appendix.

[11] The dropout dummy is constructed using information on school attendance from the September 1997 survey. It is based on the same question used to construct the alternative chosen by the girl in 1998.

a set of individual and family characteristics that includes the age of the child, an indicator of the socioeconomic situation of the family and mother's schooling.

The per-period utility function of staying at home is:

$$u(h, X_{it}) = \delta_0 + \delta_1 D_i + \delta_2 MW_i + \delta_3 C5_{it} + \delta_4 SI_{it} + \delta_5 B_{it} + \delta_6 S_{it} + \delta_7' x_{it} + \epsilon_{it}^h \tag{6}$$

MW_i is a dummy variable equal to 1 if the mother works for a salary. $C5_{it}$ is the number of siblings aged less than 5 years old. SI_{it} is the number of sisters aged from 12 to 16, and B_{it} is the number of brothers from 6 to 18 years old.

3.3 Assumptions

On random shocks ϵ_{it}^a for $a = w, e, h$ is a random variable which affects the utility of action a in period t for individual i. It is observed by the individual but not by the econometrician. The ϵ_{it}^a's satisfy the conditional independence assumption, i.e., they are independent across choices, individuals and periods with distribution $F_\epsilon(.)$.

On utilities $u(a_{it}, \Omega_{it})$, the utility functions, are additively separable in observables and unobservables:

$$u(a_{it}, \Omega_{it}) = \tilde{u}(a, X_{it}) + \epsilon_{it}^a \tag{7}$$

Thus, the optimal decision rule becomes

$$\alpha(X_{it}, \epsilon_{it}) = \arg\max_{a \in A} v(a, X_{it}) + \epsilon_{it}^a \tag{8}$$

And, for any $(a, X) \in A \times \mathbb{X}$, the conditional choice probability is:

$$Pr(a|X) = \int \mathbf{1}[v(a, X_{it}) + \epsilon_{it}^a > v(a', X_{it}) + \epsilon_{it}^{a'} \forall a'] dF_\epsilon(\epsilon_{it}) \tag{9}$$

On unobserved heterogeneity Following Heckman and Singer (1984) there are M types of individuals, for M a finite set of types. μ_m is the parameter related to type m and π_m is the proportion of the population of that type[12]. Girls are heterogeneous in their ability at school. Each girl knows her own type but it is not observed by the econometrician.

On transition probabilities π_{tg}^s, the transition probability of the stock of education, is exogenous and does not depend on effort or on the willingness to continue schooling. It varies with the grade and the age of the individual[13] and it is known to the individual. Age of the girl,

[12]Types probabilities are estimated using a logit model. Types probabilities depend on family composition variables

[13]It is also different between those girls that receive PROGRESA grants and those who do not receive the aid, since the grant could be an incentive to perform better at school.

amount of the grant and salaries evolve deterministically[14]. Availability of secondary schools and class sizes remain constant since 1998. Girls' mothers stock of education is constant. To control for the socioeconomic situation of the family I use the poor family indicator reported in PROGRESA. This indicator do not vary across time. Girls expect that the composition of her family will not change after 1998. Work status for the girl's mother is assumed time-invariant and identified with her work status reported in 1998. If her father does not live with his family I assume he is not present at home in all periods. The number of sisters, brothers and sibling aged 5 years old or less evolve with the age of the siblings and I assume there are not newborn children through all periods.

On individual decision approach I assume that each girl is a single decision unit. The model presented so far is valid if it is the girl or her altruistic parents who decide girl's actions that maximize her lifetime welfare. In particular, interrelationship of schooling decisions across siblings are not directly considered. The individual decision assumption is relaxed in two ways. I allow girl's utility of staying at home to vary with several family composition variables. Additionally, the unobserved type, that enters the utility of attending school, is affected by the number of adults and children in the family and by the girl's birth order. It can be argued that parents make schooling decision for all their children simultaneously. Particularly, the decision of whether or not to send a daughter to school is affected by the number, ages, gender and action chosen for the other children in the family. In the model, to choose the action for a girl, parents take into account the number of children they have, their ages and their genders; parents also consider whether the mother is working outside the household and the total number of adults in the family.

3.4 Identification discussion

There are two concerns about the identification of the parameters in the proposed model: state dependence in the utility of attending school and identification of the effect of PROGRESA grants.

State dependence The number of years of schooling completed, or stock of education, affects the utility of attending school in the current period. As the stock of education is determined by past decisions of school attendance, it is correlated with the unobserved type μ_i. The initial condition problem is addressed following Attanasio, Meghir, and Santiago (2005), who include an equation for the probability of having completed $S_{it} = s$ years of schooling, $Pr(S_{it} = s)$. I model this probability as an interval regression probit model with grade specific (predetermined)

[14]The evolution of the amount of the grant from 1998 to 2007 is observed and reported in Oportunidades (2008). The evolution of salaries in the period 1998-2007 is constructed using observed salaries in 1998 and updating them with the annual increase in the minimum wage for Mexico reported in CONASAMI (2008).

cut-off points that depends on the term μ_i. The identification of the parameters of $Pr(S_{it} = s)$ relays on the availability of variables that affect this probability but do not affect the current utility of attending school. Those variables are one period lags of availability of secondary school and class size measures.

$$Pr(S_{it} = s|Z_{it}, \mu_i) = \Phi(s - (\zeta' Z_{it} + \xi\mu_i)) - \Phi((s-1) - (\zeta' Z_{it} + \xi\mu_i)) \tag{10}$$

where Z_{it} is a set of individual, family, and community characteristics that includes the age of the child, the dropout indicator, the mother's schooling level, the socioeconomic indicator of the family, availability of junior secondary school in 1997 and the municipality measure of class size at primary and junior secondary school in 1997. The load factor ξ governs the covariance between the probability of having a stock of education s and the utility of attending school.

I assume that state dependence is fully controlled by $Pr(S_{it} = s)$. In particular, I use as an exclusion restriction that given $Pr(S_{it} = s)$ types μ_m and types probabilities π_m do not depend on the initial condition (action chosen in period $t-1$). This is not a very strong assumption given that $Pr(S_{it} = s)$ depends on the dropout indicator, a variable that reflects the action chosen in period $t-1$.

Grant effect The effect of the grant in the utility of attending school is modelled as a proportion of the impact of the wage in the utility of working. Then, the model can reflect a different effect on the decision of attending school given by one peso received as a grant or one peso received as a salary. For the identification of both effects it is necessary to have two different sources of exogenous variation. Wages vary with girls' age and stock of education and a set of labor market variables at village level. The amount of the grant also varies with girls' age and stock of education, and, most importantly, it has an exogenous (random) variation between girls who reside in treatment and control communities.

3.5 Likelihood

Define $\theta^a = \{\eta, \alpha_1, ..., \alpha_6, \delta_0, ..., \delta_6\}$ as the set of parameters in utilities, and $\theta^s = \{\zeta, \xi\}$ as the set of parameters in the initial condition equation. Let's denote $\rho = \{\theta^a, \theta^s, \{\mu_m\}_{m=1}^M, \pi_m, \beta, \pi^s_{tg}\}$, the set that includes all the parameters to be estimated in the model and the transition probability of the stock of education. Suppose $\tilde{u}(a, X_{it}), V^{T+1}()$ and $F_\epsilon()$ are known up to ρ. A girl contribution to the likelihood is:

$$l_i(\rho) = \sum_a \mathbf{1}(a_{it} = a) \sum_m^M Pr(a|X_{it}, S_{it} = s, \mu_m, \theta^a, \pi^s_{tg}, \beta,) \times Pr(S_{it} = s)(S_{it} = s|\mu_m, \theta^s) \times \pi_m \tag{11}$$

and the sample log-likelihood is then $L(\rho) = \sum_i \ln l_i(\rho)$.

In order to evaluate the l_i for a particular value of ρ it is necessary to know the optimal decision rules $\alpha(X_{it}, \epsilon_{it}, \rho)$. Therefore, for each trial value of ρ the value functions $v(a, \Omega_{it})$ have to be calculated. The expression for the value functions at subsequent ages are computed recursively starting from age 18 and working backwards until the current age t. Under the assumption that the unobserved state variables ϵ_{it}^a are drawn from an extreme value distribution, conditional choice probabilities and recursive value functions in equation 2 have convenient (logistic) closed forms[15]. I estimate the model by a combination of maximum likelihood for $\theta^a, \theta^s, \{\mu_m\}_{m=1}^M, \pi_m$ and a grid search for the discount factor.

4 Results

4.1 Parameter estimates

Maximum likelihood estimates of the model's structural parameters are reported in Tables 9, 10 and 11 in the Appendix.

The estimated parameters in the three instantaneous utilities and in the stock of education equation have the expected signs. The utility of attending school is higher for younger girls, more educated, with more educated mothers, living in communities where there exists a secondary school and in municipalities where the mean class size is lower. Salaries have a positive effect on the utility of working. The utility of staying at home is higher for older girls, who are more educated, with less educated mothers, belonging to a family with at least one children aged 5 years old or less. This utility is higher if the girl's mother works outside the household. The stock of education of a girl is higher when she has a more educated mother, was enrolled in school in the previous year (non-dropout) and there is a secondary school in her village. On the other hand, girls belonging to poor families, who dropped out of school before 1997 and attending school in a municipality with higher class size have less years of education completed.

The model identifies two type of individuals. The high type individuals have a higher utility of attending school with an estimated unobserved effect equal to 9.4. The corresponding estimated value for low types is 5.5. The probability of being of high type is higher for the older girl in the family, whose mother do not work, and belongs to a family with a lower number of adults and children. Those girls who choose to attend school or to stay at home are of high type with probability above 95%. The probability of being high type is lower than 86% for those who choose to work. So unobserved heterogeneity partly explains why girls choose to work instead of attend school or stay at home. But it does not help to explain why a girl, once she decides not to work, decides to stay at home or to attend school. As it can be seen in Table 12 in

[15]See the Appendix for the explicit functional form of value functions, conditional choice probabilities and $\mathbb{E}max$ function.

the Appendix, unobserved heterogeneity does not contribute to explain differences in choices between non-dropout and dropout girls. In fact, new dropout girls, that is girls who were at school last year but are not attending school the current year, have the same probability of been high type than former non-dropout girls that choose to attend school.

4.2 Model Validity

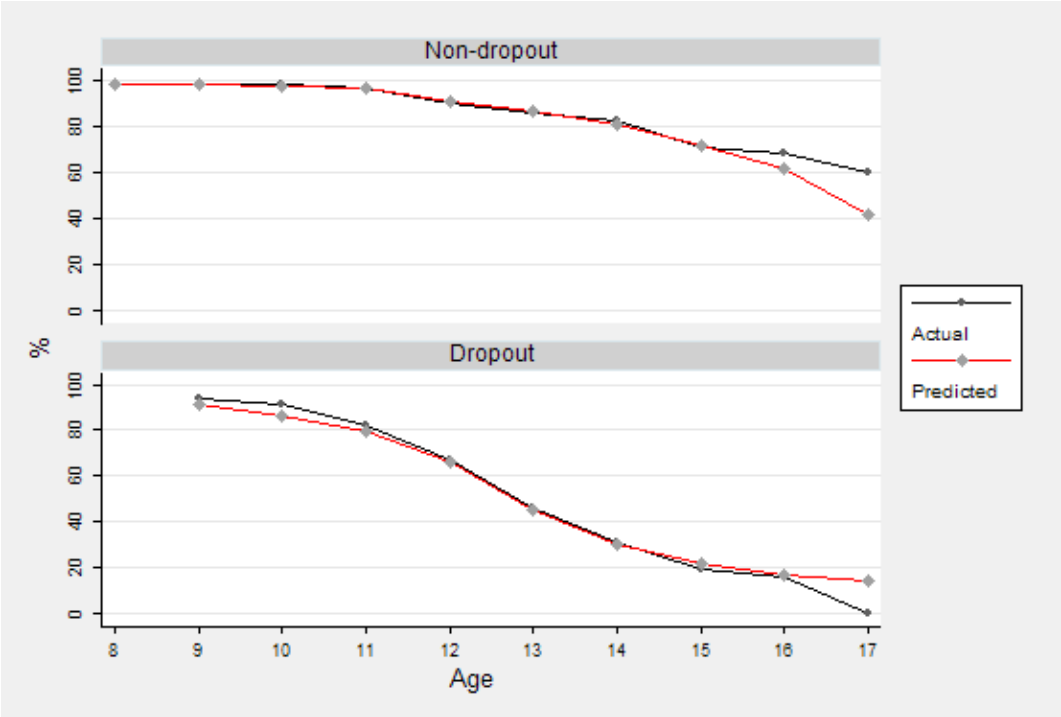
The validity of the estimates for the structural parameters relies strongly in the functional form assumptions made on utilities and on the initial condition equation. Thus, it is crucial to test the validity of the estimated model. In what follows I present several evidence on the validity of the estimated parameters.

First I compare the distribution of predicted choice probabilities obtained with the estimated parameters with the actual choices the individuals in the sample have made[16]. A complete report of distribution of actual and predicted choices can be found in the Appendix in Table 7 and in Table 7. The model does quite well in predicting distribution of choices by ages for non-dropout girls and dropout girls. As we can see in Figure 4 bellow, actual and predicted schooling enrollment rates are close for all ages except 17 years old[17].

[16]Predicted conditional choice probabilities are computed following Carro and Mira (2006). The procedure is explained in the Appendix.

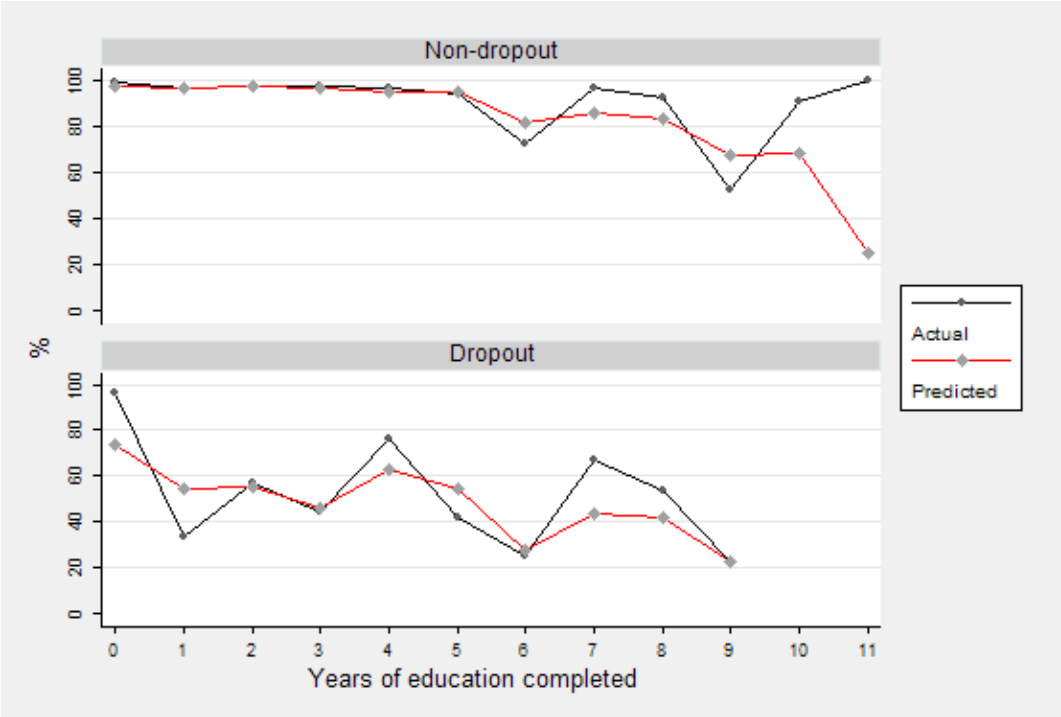
[17]The reason is the tiny number of girls aged less than 17 years old in the sample. It is 5 non-dropout and 3 drop-out

Figure 4: Actual and predicted enrollment rates by age (%)



Predicted choice probabilities by years of schooling completed reflect the main patterns in the actual distribution of choices: enrollment rates for non-dropout girls are always higher than for dropout girls; enrollment rates for both groups decrease as the stock of education increases; the lowest enrollment rate in primary school appears in the last grade, that is grade 6; and the lowest enrollment rate considering all grades come in the last year of junior secondary school.

Figure 5: Actual and predicted enrollment rates by stock of education (%)



Second, I compare the estimated grant effects with the estimates reported in Schultz (2004) and Valdes (2007). The effect of PROGRESA grants in the present model is computed by comparing the choices predicted when girls are receiving the grant with the choices predicted when the grant amount is set to zero for all girls. The results obtained in this paper agree with those reported elsewhere, suggesting that the model does well in fitting the effects of PROGRESA grants for non-dropout and dropout girls. A summary of results are presented in Table 8 in the Appendix.

4.3 Counterfactual analysis

Although PROGRESA grants do not increase school reentry rates among girls, perhaps other policies do. In what follows, I analyze the effectiveness of several policies by means of counterfactual exercises. Results are presented in Table 5 and details on the policies follows bellow.

Table 5: Increase in school attendance due to different policies (in %)

	Non-dropout		Drop-out	
Policy	Primary	Secondary	Primary	Secondary
Enrollment rate	97	80	59	28
PROGRESA grant	0.7	5.1	0.8	0.8
Duplicate PROGRESA grant in secondary	0.7	5.2	0.7	1.0
Free access to daycare center	0.0	1.0	1.2	1.7
Availability of secondary school in almost all villages	0.6	2.6	4.6	5.3
Reduction of class size to 25 children	0.2	0.5	1.5	1.1

Duplicate the amount of PROGRESA grants in secondary school: Enrollment rates in primary school is near 90% while the figure in secondary school is 67%. A policy intended to increase school enrollment could at most increase in 10% enrollment in primary school but more than 30% in secondary school. This fact makes it attractive the implementation of scholarships that give a higher amount of money in secondary school. The results show that for non-dropout the actual amount of the grant is already optimal since the response to the extra money is almost negligible. For dropout girls the effect is only 1%, confirming the initial hypothesis that cash transfers, no matter how much money they receive, do not substantially change their utility of attending school.

Community nurseries/kindergartens: Suppose all the children aged less than five in the family are sent to a (free) daycare center[18]. Girls will be no longer needed at home to look after them and may go back to school. In the model the utility of staying at home is (positively) related with the number of children aged less than five in the family. The effect of this policy on girls' school enrollment can be measured by simulating girls' choices after setting the number of children aged less than five equal zero. The effect of availability of nurseries on non-dropout girls is lower than the effect of PROGRESA grants while it is higher for dropout girls. A combination of both policies has the desired effect, increasing enrollment in secondary school for non-dropout in 6% and 2% for dropout girls.

Availability of secondary school in almost all villages As it is shown in Table 3 and Table 4 above, only in 34% of the villages where non-dropout girls reside and in 22% of the villages

[18]I do not discuss how the daycare center would be financed.

where dropout girls reside there exists a secondary school. No availability of a secondary school in a village implies transportation and time costs. Both costs decreases the utility of attending school. If the government establishes a secondary school in at least all villages where the demand is high enough, a positive effect on school enrollment and reentry rates could be expected. I simulate girls' choices by setting equal one the indicator variable of availability of secondary school for girls who reside in villages where the potential number of secondary school students is higher than 25. The result is promising for all groups, non-dropout and dropout girls attending primary and secondary school. In primary school enrollment rate increases 1% and reentry rate increases 5% while the figures in secondary school are 3% increment in enrollment rate and 5% increment in reentry rate.

Reduction in the class size The quality of the education process is an important determinant of the utility of attending school. In classrooms where the number of students is high teachers cannot pay enough attention to all of them and the acquisition of knowledge is likely damaged. Average class size in the villages analyzed is around 25, not a huge value. But in some villages classes have 45 students in secondary school and 39 in primary school. An improvement in school enrollment and reentry rates could be expected from a reduction in class size. The proposed policy is to reduce to 25 the mean number of students per class wherever it is necessary. Simulations of girls choices imposing this reduction in class size show that class size matter only for dropouts, and this policy is more effective in primary school.

5 Conclusions

In this paper I present a dynamic behavioral model of school choices for girls in poor families and estimate its structural parameters using the Mexican PROGRESA database. The estimated structural model fits girl's schooling choices reasonable well. It is able to replicate patterns observed in the actual distribution of schooling choices, and it also matches differences in the distribution of schooling choices between non-dropout and dropout girls. The model explains these differences highlighting the relevance of persistence in the decision of attending school and the importance of the girl's family composition. Results also suggest that unobserved heterogeneity in schooling decision does not explain differences between reentry and enrollment decisions.

The evaluation of PROGRESA grants resulting from the estimated model is consistent with previous literature. Grants are a good incentive to keep girls at school but the ones that are out of school do not come back. Simulations suggest that cash transfers do not increase school reentry rates even when the amount of the scholarship is duplicated. Since dropout girls are mainly at home helping to take care of the youngest children in the family, the availability of daycare centers implemented simultaneously with PROGRESA grants is efficient in increasing

both school enrollment and reentry rates. Both targets are also efficiently achieved by reducing transportation and time costs in secondary school. Reduction in class size increases reentry rates but it does not change enrollment rates.

The relevance of family characteristics in school choices for girls suggested by the present model, invites for future research. Probably one of the most natural extensions is the study of school reentry decisions in the context of a family decision model. The estimation of a model of family child schooling and fertility decisions, like the model presented in Todd and Wolpin (2006), allows relaxing the assumption that there is no newborn children in girls' families.

As a further step, it would be interesting to estimate a collective decision model in which parents make labor and consumption decisions along with schooling decisions for their children. Such a model would allow analyzing interrelations between parents' labor participation decisions and girls schooling choices in poor families. Results in the present study show that mothers' working status affects girls' utility of staying at home. It can be expected that a girl whose mother works in the labor market would be more valuable at home, replacing her mothers' housework. However, worker mothers in the sample have less children than mothers who stay at home. This family characteristic is coherent with the result suggested by the present model, namely that a girl whose mother works outside the household has a lower utility of staying at home. A collective decision model in which parents simultaneously decide their labor status and their children schooling would shed light in the relation between both decisions. In the framework proposed, it would be possible to analyze the effect of policies intended to increase children school participation on parents' labor participation and girls schooling.

Appendix

Value functions

The value function for choosing to attend school is:

$$\begin{aligned} v(s, X_{it}) = \tilde{u}(s, X_{it}) \\ &+ \beta \pi^s_{tg} \mathbb{E}_\epsilon [\max_{a \in A} \{v(a, X_{i,t+1}) + \epsilon^{(}_{it} a)\} | X_{it}, S_{i,t+1} = S_{it} + 1, a_{it} = s] \\ &+ \beta (1 - \pi^s_{tg}) \mathbb{E}_\epsilon [\max_{a \in A} \{v(a, X_{i,t+1}) + \epsilon^{(}_{it} a)\} | X_{it}, S_{i,t+1} = S_{it}, a_{it} = s] \end{aligned}$$

for $a = s, w, h$ and $t \leq T - 1$. At age $t = T \equiv 17$ it is:

$$\begin{aligned} v(s, X_T) = \tilde{u}(s, X_T) \\ &+ \beta \pi^s_{tg} V^{T+1}(X_{T+1}, S_{i,T+1} = S_{iT} + 1) \\ &+ \beta (1 - \pi^s_{tg}) V^{T+1}(X_{T+1}, S_{i,T+1} = S_{iT}) \end{aligned}$$

The value function for working (or staying at home) is:

$$\begin{aligned} v(w, X_{it}) = \tilde{u}(w, X_{it}) \\ &+ \beta \mathbb{E}_\epsilon [\max_{a \in A} \{v(a, X_{i,t+1}) + \epsilon^{(}_{it} a)\} | X_{it}, S_{i,t+1} = S_{it}, a_{it} = w] \end{aligned}$$

for $a = s, w, h$ and $t \leq T - 1$. At age $t = T \equiv 17$ it is:

$$v(w, X_T) = \tilde{u}(w, X_T) + \beta V^{T+1}(X_{T+1}, S_{i,T+1} = S_{iT})$$

I assume that girls do not attend school beyond 18 years old, so when they are 18 they have to decide wether to work or stay at home with her birth family or with her new family if she gets married[19]. The value of working is given by the salary an 18 years old girl can earn and her stock of education. The value of staying at home depends on the composition of her family and also on her stock of education. Unfortunately I do not have information on family composition at the age of 18 for girls in the sample. For this reason I cannot estimate separately parameters in both, the terminal value of staying at home and the terminal value of working. I estimate the parameters that affects the difference in the terminal value between both alternatives. This difference depends on the stock of education and on the salary. The terminal value function is:

$$V^{T+1} = \delta_5 S_{i,18} - \eta r w_i$$

[19]Most of the girls that get married in this villages stay in her new home taking care of her new family.

where rw_i is the real wage for adult workers in the community where the girl resides.

In all cases below, $\mathbb{E}max$ function are as follows:

$$\mathbb{E}_\epsilon[\max_{a\in A}\{v(a, X_{i,t+1}) + \epsilon_{it}^{(}a)\}|X_{it}, S_{i,t+1}, a_{it}] = ln(\sum_{a=1}^{3} exp(v_{a,t+1}(X_{t+1}))) + E$$

where E is the Euler constant (0.577215665). This expression is given by the extreme value distribution and by the conditional independence assumptions on $\epsilon_{it}^{(}a)$.

Conditional choice probabilities

Assuming the $\epsilon_{it}^{(}a)$ are drown from an extreme value distribution and are conditional independent, the probability of choosing action a at time t is:

$$\mathbb{P}(a_{it} = a'|X_{it}) = \frac{\exp v(a', X_{it})}{\sum_{a\in A} \exp v(a, X_{it})}$$

Predicted probabilities

Following Carro and Mira (2006), predicted conditional choice probabilities for each girl are computed as the weighted average of conditional choice probabilities for each unobserved type, with weights given by the ex post probability that the girl is of each type conditional on her stock of education and choice in Oct98.

$$\mathbb{P}_{ia} = \sum_{m}^{M} \mathbb{P}_{iam}\mathbb{P}(\mu_i|a_i, S_i)$$

$$\mathbb{P}(\mu_i|a_i, S_i) = \frac{\mathbb{P}(\mu_m, a_i|S_i)}{\mathbb{P}(a_i|S_i)}$$

$$\mathbb{P}(\mu_m, a_i|S_i) = \mathbb{P}(a_i|S_i, \mu_m)\mathbb{P}(\mu_m|S_i)$$

$$\mathbb{P}(a_i|S_i, \mu_m) = \mathbb{P}_{iam}$$

$$\mathbb{P}(\mu_m|S_i) = \frac{\mathbb{P}(S_i|\mu_m)\pi_m}{\sum_m^M \mathbb{P}(S_i|\mu_m)\pi_m}$$

$$\mathbb{P}(a_i|S_i) = \sum_{m}^{M} \mathbb{P}(a_i|S_i, \mu_m)\mathbb{P}(\mu_m|S_i)$$

where $\mathbb{P}_{iam}$ is the probability that girl i chooses action a if she is of unobserved type m, conditional on the state variables. $\mathbb{P}_{iam}$, $\mathbb{P}(S_i|\mu_m)$ and π_m are obtained from the model given parameter estimates.

Estimation of salaries

The salary for a girl i residing in village l that chooses to work is computed using the OLS parameters of the following equation:

$$ln(w_{il}) = \gamma_0 + \gamma_1 ln(w_l) + \gamma_2 S_i + \gamma_3 age_i + \gamma_4 distmetro_l + \gamma_5 distcab_l + \omega_{il}$$

where w_l is the agricultural wage in community l, $distmetro_l$ is the distance (km) from the community where the girl resides to the nearest metropolitan area and $distcab_l$ is the distance (km) from the community where the girl resides to the main city at her municipality.

Fit of the model

Table 6: Actual an predicted choices: Non-dropout observations (%)

Years of schooling	School		Work		Home	
completed	Actual	Predicted	Actual	Predicted	Actual	Predicted
0	99.2	97.7	0	1.2	.8	1
1	97	97.2	.8	1	2.3	1.7
2	97.4	98.1	1.1	.6	1.5	1.3
3	97.8	96.8	.7	.8	1.4	2.5
4	97.2	95.2	.6	1.1	2.1	3.7
5	94.8	95.1	1.2	1	3.9	3.9
6	72.6	81.8	2.9	3	24.4	15.2
7	97.4	85.9	.8	1.7	1.9	12.4
8	93.2	83.5	1.8	2	5.1	14.5
9	52.2	67.4	9.3	4.1	38.5	28.5
10	90.9	68.5	0	4.2	9.1	27.3
11	100	25.3	0	1.2	0	73.5

Table 7: Actual an predicted choices: Dropout observations (%)

Years of schooling	School		Work		Home	
completed	Actual	Predicted	Actual	Predicted	Actual	Predicted
0	96.3	73.4	1.2	6.9	2.4	19.7
1	33.3	54.8	0	8.2	66.7	37
2	56.9	55.3	4.6	8.5	38.5	36.2
3	44.2	45.7	5.8	10.2	50	44.1
4	75.9	63.1	5.7	4.6	18.4	32.3
5	42.1	54.6	9.6	7.3	48.2	38.1
6	25.5	27.7	8.5	7.1	66	65.2
7	66.7	43.9	6.1	6.7	27.3	49.5
8	53.3	42.1	6.7	4.5	40	53.4
9	22.2	22.3	14.8	5	63	72.7

Table 8: Comparison of results with related literature

	Non-dropout		Drop-out	
Author	Primary	Secondary	Primary	Secondary
Schultz (2004)	0.02	0.065	—	—
Valdes (2007)	0.01	0.061	-0.05	0.01
This paper	0.07	0.051	0.08	0.08

Estimation results

Table 9: Estimates of structural parameters: Instantaneous Utilities

Variable	Estimate	Standard Error
Schooling utility		
age	-9.79	0.94
stock of education	2.72	0.39
dropout indicator dummy	-1.51	0.19
PROGRESA grant effect	3.52	1.61
mother stock of education	0.35	0.65
poor indicator dummy	0.16	0.23
availability of secondary school	0.39	0.10
class size	-2.43	0.47
Working utility		
wage	1.71	1.42
Staying at home utility		
age	-3.57	1.02
stock of education	2.72	0.40
number of babies at home	1.82	0.41
number of sisters between 12 and 16	-0.51	0.72
number of brothers	1.12	0.98
mother stock of education	-1.27	0.69
worker mother indicator dummy	-2.51	0.22
poor indicator dummy	-0.01	0.23
dropout indicator dummy	0.53	0.19
father at home indicator dummy	-0.43	0.18
constant	3.62	0.74

Log-likelihood = -31968.63, Discount Factor = 0.95

Table 10: Estimates of structural parameters: Stock of Education equation

Variable	Estimate	Standard Error
mother stock of education	0.27	0.58
poor indicator dummy	-0.02	-0.11
dropout indicator dummy	-0.46	-0.75
dropout indicator*age	0.44	0.42
availability of secondary school in 1997	-0.14	-0.25
availability of secondary school*age	0.30	0.30
class size in 1997	-1.79	-2.22
class size*age	3.17	2.73
unobserved heterogeneity load factor	0.04	1.07

Table 11: Estimates of structural parameters: Types and Types probabilities

	Estimate	**Standard Error**
Unobserved type effect		
Type 1	9.49	0.81
Type 2	5.50	0.69
Variables in types probabilities		
birth order	0.85	0.61
number of adults in the family	-1.09	-1.23
number of children in the family	-0.31	-0.47
father at home indicator dummy	-0.55	-1.60
worker mother indicator dummy	-3.83	-8.26
constant	5.05	7.98

Reference category is Type 2

Table 12: Types distribution: Non-dropout and Dropout (%)

	Type 1: High Type		Type 2: Low Type	
Choice	Non-Dropout	Dropout	Non-Dropout	Dropout
School	95.8	95.3	4.2	4.7
Work	76.8	86.4	23.2	13.6
Home	95.7	96.5	4.3	3.5

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