The re-enrollment decision of poor girls. Structural estimation and policy analysis using PROGRESA dataset

María Nieves Valdés*†

Preliminary version. Do not quote.

Universidad Carlos III de Madrid

April 18, 2008

Abstract

This paper examines alternative policies designed to persuade poor drop-out girls to go back to school and continue with their education. Until the age of 18 girls have to choose every year between three activities. Go to school, work in an unskilled job or stay at home. Poor families typically have several members, mostly children, with the consequent increase in housework. For these families the value of retaining a girl at home becomes more relevant since they are a good help in those activities. Hence, monetary transfers could not provide the right incentives to send them back to school. I formulate and estimate a dynamic behavioral model of girls schooling choices. I estimate the structural parameters of the model using the Mexican PROGRESA dataset. PROGRESA is a Mexican anti-poverty program that includes a schooling grant scheme for poor children. I include in the model a set of parameters to measure the effect of PROGRESA grants on girls choices. Although grants were a good incentive to keep girls at school, the ones that were out of school do not came back. The alternative policy analyzed that seems to succeed in sending drop-out girls back to school is free access to community nurseries and kindergartens.

JEL classification I21; I28; J16; O15

Keywords Poverty Program Evaluation; Dynamic structural models; School choices for girls; School re-enrollment; PROGRESA

*Email: mvaldes@eco.uc3m.es.

†Special thanks to Pedro Albarrán and Ricardo Mora for their advice, remarks and comments.

1 Introduction

This paper examines alternative policies designed to persuade poor drop-out girls to go back to school and continue with their education. Until the age of 18 girls that belong to poor families have to choose between three alternative activities. They share with boys two alternatives: go to school or work in an unskilled job. Girls also can stay at home. Since poor families are more likely to have several children and girls can help in rasing up the youngest siblings the value for the family of retaining them at home becomes important. If a girl have already dropped-out from school and is fully engaged in home activities, sometimes even replacing a non-present mother, the value of going back to school, that is the value of having this girl re-enrolled at school could be much more lower than the value of her current activity or even the value of working for a monetary salary. Hence, monetary transfers could not provide the right incentives to send them back to school.

In order to identify and evaluate the effectiveness of alternative policies I formulate and estimate a dynamic behavioral model of girls schooling choices. I estimate the structural parameters of the model using a reach Mexican dataset collected for the implementation and evaluation of an anti-poverty program for rural communities, called PROGRESA. This program comprises three major areas one of which, the subject of this paper, is education. In particular, program beneficiaries are given financial aid conditional on school attendance. The use of this dataset allows me to include in the model the parameters of PROGRESA grants and use it as a benchmark policy.

The scheme of PROGRESA grants considers two important facts of enrollment rates in poor regions in Mexico. While in primary school enrollment rates are almost 100%, they decrease in secondary school. And enrollment rates for girls in secondary school are even lower than for boys. For these reasons, PROGRESA grant amount increases in secondary school and, at this level of education, is higher for girls. Besides gender and education level, the grant amount is the same for all children. However, for beneficiaries that differ in some characteristic the incentive provided by the same amount of money could be different. If it could be obtained a more efficient effect on a particular group of beneficiaries by changing the design of the program, the average effect would be also higher. In a previous work[1] I compare the effects of PROGRESA grants on school enrollment for two different groups of beneficiaries, drop-outs and non-drop-outs. Drop-outs are those children who where not enrolled in school when the program was implemented. They have to decide wether to go back to school while non-drop-outs decision is about continuing on school. I quantify the differential impact of PROGRESA education grants on drop-outs and

[1] Valdes (2007)

non-drop-outs by estimating a reduced form equation for schooling decision. The general conclusion is that PROGRESA did send drop-outs back to school. It had a larger effect on drop-outs than on non-drop-outs. However, for the particular group of girls who dropped out of school just before attending secondary school PROGRESA grants only had a minor effect. This last finding highlights the fact that determinants of the schooling decision are different for young girls and that PROGRESA grants do not provide a strong enough incentive to send them back to school.

There exist a numerous literature on the evaluation of the average effect of PROGRESA schooling grants. All papers agree in their main conclusions: the program has increased enrollment rates for those children who received the grants, its effect is higher on girls and it is higher on children that attends secondary school. We can distinguish two branches in this literature defined by the methodology applied in the estimation of the grants effects. Both branches were developed sequentially in time. First, researchers were interested in a valid quantification of the average effect. Exploiting the random assignment of the program at a village level, they calculate difference and difference-in-difference estimators. Schultz (2004) is a good example in this branch. Once the average success of PROGRESA grants was established, researchers started to analyze how to improve the effectiveness of the program. They estimate the structural parameters of dynamic models of discrete choice[2] to identify alternative subsidy schemes with a greater impact on schooling decisions. Two relevant papers in this branch are Attanasio, Meghir, and Santiago (2005) and Todd and Wolpin (2003).

In this paper I model schooling decisions for poor girls following the individual decision approach used by Attanasio, Meghir, and Santiago (2005). The main difference from their work is the introduction of a third alternative for these young women that is staying at home. Even thought this is not a model of family decision as in Todd and Wolpin (2003) I allow the utility of going to school to depend on family characteristics by modelling the unobserved individual heterogeneity as a function of those characteristics. The main conclusions of this work are the following. Although grants were a good incentive to keep girls at school, the ones that were out of school do not came back. The alternative policy analyzed that seems to succeed in sending drop-out girls back to school is free access to community nurseries and kindergartens.

The paper is organized as follows. Section 2 presents the main features of the PROGRESA program. Section 3 describes characteristics of the PROGRESA data base. It provides some main statistics that focus on the differences between drop-outs and non-

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

drop-outs. In Section 4 I present the theoretical model and in Section 5 I discuss its empirical implementation. In Section 6 I present results from the estimation of the parameters of the model. Finally, Section 7 concludes the paper with its main results.

2 The PROGRESA program and its education component

The Education, Health and Nutrition program, PROGRESA, was 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 tries 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 education component includes monthly grants for children of a family qualified as beneficiary. They 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 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 by years of schooling. 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 drop-out of school and that they also tend to drop-out earlier than boys. Additionally, beneficiaries receive an annual grant for school supplies. The health component of the PROGRESA program consists of a basic package of free health services, nutritional supplements, and informative talks on health, nutrition, fertility, and hygiene. Special attention is paid to pregnant women and children younger than five years. Finally, the nutrition component of the program supplies beneficiary families with a monthly monetary payment intended to improve amount and diversity of food consumption and thus increase the nutritional status, in particular of children. This aid is independent of residence, and size, and composition of the family. All aid is given to the mother of the family as there exist evidence that mothers are better than fathers at allocating family resources.

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 like presence of running water, etc.[3]

Some numbers can provide a better understanding of the extent and significance of PROGRESA as an anti-poverty policy. In 1997 the program reached 6,357 communities, giving aid to 300,705 families. This implied transfers for 34 million USD (approx. 340 million Mexican pesos). After two years of being implemented the program included nearly 2.6 million families in 72,345 communities in all 31 Mexican states. It reached around 40% of all rural families and nearly 12% of all families in Mexico. Total annual transfers of the program in 1999 were around 710 million USD, equivalent to 0.15% of Mexican GDP. 40% were educational transfers, 42% food transfers and 18% was spent on health transfers. Among the total annual cash transfers of 578 million USD, education transfer accounted for 51%. In 1999 the program distributed 273 million USD in education grants[4].

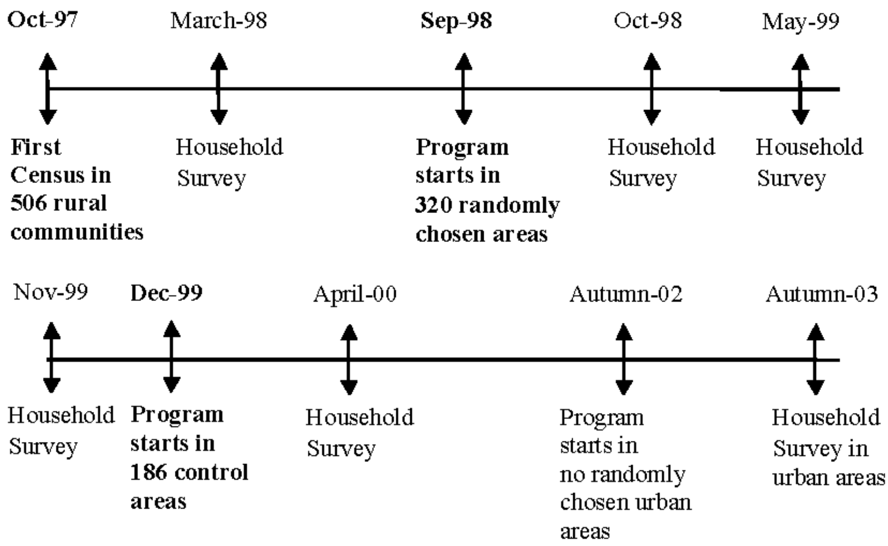
Given the financial importance of PROGRESA, Mexican authorities have intended to evaluate the program since its beginning, not only to measure results and impacts but also to provide information that allow for a redesign of policies. Accordingly, in 1997 and 1998 a high quality data set was collected 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.

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

[4] For more details on PROGRESA costs see Coady (2000).

[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.

Figure 1: Timing of the PROGRESA program



3 The Data

I use the observations for females from 8[6] to 17 years old from the October 1998 survey that was conducted one year after the implementation of the program. This includes 9,175 girls belonging to 6,303 families. By the time of the survey, 85% of them where enrolled in school, 2.2% where working for a salary and 12.8% where neither in school not working, so I assume they are at home involved in household work. However, distribution of choices is not the same for non-drop-outs and drop-outs girls. As it can be seen in Table 1 most non-drop-outs girls are remains in school in 1998 while more than 60% of drop-outs girls didn't go back to school and are mainly at home.

Differences in the distribution of choices between non-drop-out and drop-outs are even more important when analyzing by age, as it is shown in Figure 2 below.

The information obtained with PROGRESA surveys refers to individual characteristics, family composition, parents activities and background and community characteristics. Differences in selected characteristics between non-drop-outs and drop-outs girls are presented in Tables 2 and 3.

[6]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 1: Distribution of choices for Non-drop-outs and Drop-outs

Choice	Non-drop-out	Drop-out	Total
school	7,378	415	7,793
	(92.1)	(35.8)	(84.9)
work	127	78	205
	(1.6)	(6.7)	(2.2)
home	510	667	1,177
	(6.4)	(57.5)	(12.8)
Total	8,015	1,160	9,175
	(100.0)	(100.0)	(100.0)

Percentages in parenthesis below.

Figure 2: Distribution of choices by age for Non-drop-outs and Drop-outs

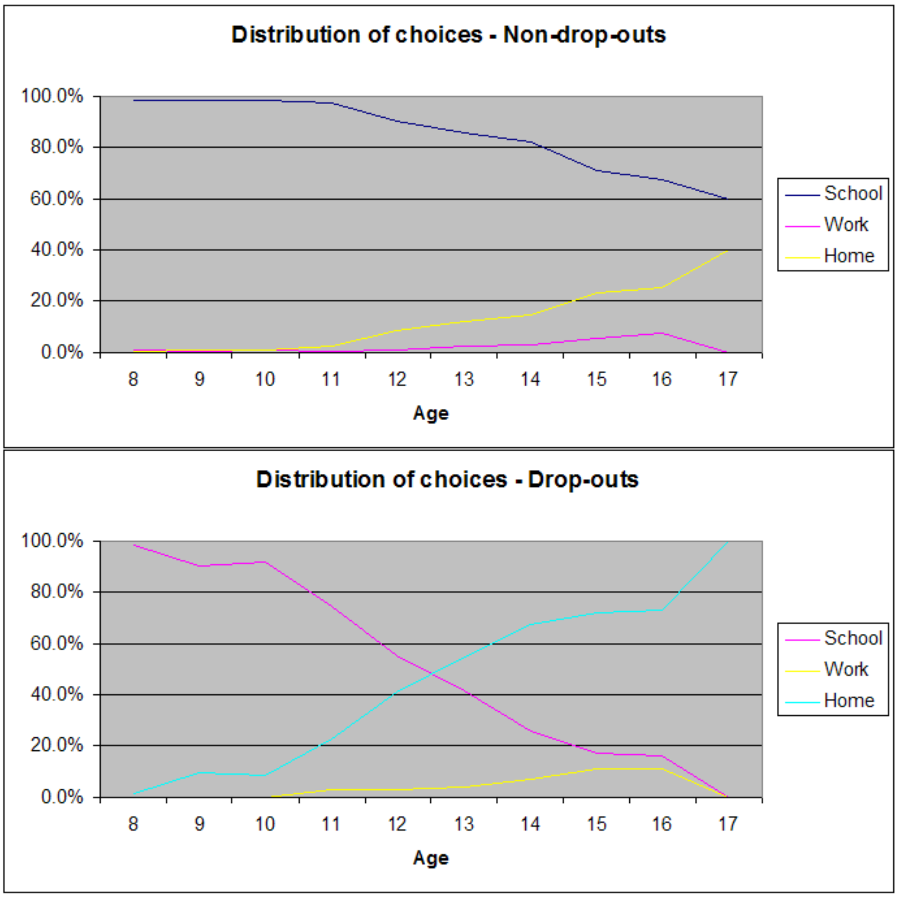


Table 2: Summary statistics for Non-drop-outs

Variable	Mean	Std. Dev.	Min.	Max.
Years of education	4.31	2.07	0	11
Potential monthly wage	359.4	82.10	247.68	652.94
Percentage of girls belonging to a poor family	0.87	0.34	0	1
Percentage of girls with father not present at home	0.07	0.26	0	1
Number of sisters	2.05	1.13	0	7
Number of brothers	1.11	1.02	0	6
Number of children aged less than one year old	0.82	0.96	0	6
Proportion of girls with mother pregnant	0.04	0.19	0	1
Proportion of girls with worker mother	0.09	0.29	0	1
Mother's years of schooling	2.87	2.53	0	18
Proportion of girls with a sister that left the family to be married	0.04	0.2	0	1
Proportion of girls with secondary school in her community	0.34	0.47	0	1
Class size in primary school at municipality level	25.28	4.34	16.66	38.5
Class size in secondary school at municipality level	22.3	4.41	10.11	45

Table 3: Summary statistics for Drop-outs

Variable	Mean	Std. Dev.	Min.	Max.
Years of education	4.8	2.26	0	9
Potential monthly wage	452.78	84.33	248.53	619.84
Percentage of girls belonging to a poor family	0.87	0.34	0	1
Percentage of girls with father not present at home	0.07	0.26	0	1
Number of sisters	2.1	1.13	0	7
Number of brothers	1.13	1.03	0	4
Number of children aged less than one year old	0.78	0.94	0	5
Proportion of girls with mother pregnant	0.04	0.19	0	1
Proportion of girls with worker mother	0.08	0.27	0	1
Mother's years of schooling	1.86	2.06	0	16
Proportion of girls with a sister that left the family to be married	0.06	0.24	0	1
Proportion of girls with secondary school in her community	0.22	0.42	0	1
Class size in primary school at municipality level	26.34	4.48	16.66	38.5
Class size in secondary school at municipality level	22.12	4.8	10.11	45

4 The Model

This is a dynamical behavioral model of schooling decision for girls aged 6 to 17. At each age, from the official age to enter school ($t = 6$) to the stopping period ($t = T \equiv 17$), a girl (or her parents) chooses one of three mutually exclusive actions: go to school ($a_{it} = 1$), work in an unskilled job for a salary ($a_{it} = 2$) or stay at home to help in domestic housework and in taking care of the youngest children in her family ($a_{it} = 3$). I assume that parents make decisions in the best interest of each of their children, so there are no interactions between the decisions of children in 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 includes the girl's stock of education and she faces uncertainty about the evolution of her future stock of education. Define π^s_{tg} the probability of successfully passing the grade at age t for grade g, that is the transition probability of the stock of education. At 18 girls work and earn wages depending on their level of education or they stay at home. This implies that they are not allowed to go to school above age 17.

Period t alternatives are chosen to maximize the intertemporal utility function

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

subject to the evolution of future values of the state variables, particulary to the probability of successfully passing a grade π^s_{tg}. β is the discount factor, $V^{T+1}()$ is the terminal value function, $\mathbb{E}_t$ is the expectation operator conditional on the state and $u(a_{i,t}, \Omega_{i,t})$ is the instantaneous utility function at age t 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:

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

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

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

5 Empirical implementation

5.1 Likelihood

I am interested in the estimation of the structural parameters in preferences and the discount factor β. 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: $\Omega_{it} = (X_{it}, \epsilon_{it})$. $\epsilon_{it}(a)$ is a random variable which determines the utility of action a in period t. It is observed by the individual but not by the econometrician. The $\epsilon_{it}(a)$'s satisfy the conditional independence assumption, i.e., they are independent across choices, individuals and periods with distribution $F()$. I assume the transition probability of the stock of education, that is the probability of successfully passing a grade, is exogenous and do not depend on effort or on the willingness to continue schooling. However, I allow this probability to vary with the grade and the age of the individual[7] and I assume it is known to the individual.

The utility functions are additively separable in observables and unobservables:

$$u_(a_{it}, \Omega_{it}) = \tilde{u}(a, X_{it}) + \epsilon_{it}(a) \tag{4}$$

with this assumption the optimal decision rule is:

$$\alpha(X_{it}, \epsilon_{it}) = \arg\max_{a \in A} v(a, X_{it}) + \epsilon_{it}(a) \tag{5}$$

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

$$\mathbb{P}(a|X, \theta) = \int \mathbf{1}[v(a, X_{it}) + \epsilon_{it}(a) > v(a^{'}, X_{it}) + \epsilon_{it}(a^{'}) \forall a^{'}] dF_{\epsilon}(\epsilon_{it}) \tag{6}$$

Suppose $\tilde{u}(a, X_{i,t}), V^{T+1}()$ and $F()$ are known up to a vector of parameters θ and permanent component μ_m that allows for unobserved heterogeneity in individuals preferences. Specifically, I allow for unobserved individual heterogeneity in the utility of going to school and it can be interpreted as individual ability, effort, etc. μ_m, for $m \in M$ a finite set of individual types, is the parameter related to type m and π_m is the proportion of the population of that type[8]. Each girl knows her own type but it is not observed by the econometrician. Another concern in this model is state dependence. The number of years of schooling completed, or stock of education, affects the utility of attending school in the current period. And the stock of education is determined by past decisions of

[7] I also allow this probability to be different between those girls that receive PRGRESA grants and those who do not receive the aid, since the grant could be an incentive to perform better at school.

[8] Types probabilities are estimated using a multinomial logit model. Types probabilites depend mainly on family composition variables

school attendance. As a consequence, the stock of education, could be correlated with the unobservable type.I address the initial condition and its related unobserved heterogeneity problem including in the model an equation for the probability of having completed s years of schooling that varies with each type. A girl contribution to the likelihood conditional on the unobserved type is:

$$l_i(\theta, \Omega_{it}, \mu_m) = \prod_t \mathbb{P}(\alpha(X_{it}, \epsilon_{it}, \theta) = a_{it} | X_{it}, \theta, \mu_m) \tag{7}$$

and the sample log-likelihood is then:

$$L(\theta, \mu) = \sum_i \ln \sum_m l_i(\theta, \Omega_{it}, \mu_m) \pi_m \tag{8}$$

In order to evaluate the l_i for a particular value of θ it is necessary to know the optimal decision rules $\alpha(X_{it}, \epsilon_{it}, \theta)$. Therefore, for each trial value of θ 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 $\epsilon_{it}(a)$ are drawn from an extreme value distribution, the conditional choice probabilities and recursive value functions in 2 have convenient (logistic) closed forms[9]. I estimate the model by a combination of maximum likelihood and a grid search for the discount factor.

5.2 Utilities

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

The per-period utility function of going to school is:

$$u(s, X_{it}) = \mu_i + \alpha_1 \eta grant_{it} + \alpha_2 \eta D_i grant_{it} + \alpha_3 S_{it} + \alpha_4' X_{it}^s + \epsilon_{it}^s \tag{9}$$

μ_i is an unobserved factor, individual specific and time-constant. $grant_{it}$ is the potential grant amount, that takes a value different from zero only 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[10]. D_i is a dummy variable, that takes a value of 1 if the child dropped out of school before the program started. S_{it} reflects the number of years of schooling successfully completed. And X_{it}^s is a set of individual, family, and community characteristics affecting schooling utility that includes

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

[10] $grant_{it} > 0$ defines the treatment group while $grant_{it} = 0$ defines the control group.

the age of the child, an indicator of the socioeconomic situation of the family, mother's schooling, availability of junior secondary school (only for individuals in secondary school, is the measure of direct cost of secondary school), a municipality measure of class size at primary and junior secondary school, an indicator of treatment communities and state (region) variables.

The per-period utility function of working is:

$$u(w, X_{it}) = \eta w_{it} + \epsilon_{it}^{w} \tag{10}$$

where w_{it} is the potential wage a girl can earn[11].

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

$$u(h, X_{it}) = \delta' X_{it}^{h} + \epsilon_{it}^{h} \tag{11}$$

X_{it}^{h} is a set of individual and family characteristics that affects the utility of staying at home and includes age of the child, stock of education, an indicator of the socioeconomic situation of the family, mother's stock of education, mother's work status, mother's current pregnancy indicator, number of siblings aged less than 5 years old and number of sisters aged 6 or more[12].

5.3 Initial condition equation

The probability of having successfully completed s years of schooling is:

$$\mathbb{P}(S_{it} = s | Z_{it}, \mu_i) = \Phi(s - (\zeta' Z_{it} + \xi \mu_i)) - \Phi((s-1) - (\zeta' Z_{it} + \xi \mu_i)) \tag{12}$$

where Z_{it} is a set of individual, family, and community characteristics that includes the age of the child, drop-out identifying dummy, mother's schooling, an indicator of the socioeconomic situation of the family, availability of junior secondary school in 1997 (the year before PROGRESA was implemented) and a 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 going to school.

The identification of the parameters of this equation relays on the variables present in this probability that do not enter the utility of schooling. Those variables are the lagged (1997) availability of secondary school and class size measures. This probability is modelled as an interval regression probit model with grade specific (predetermined) cut-off points.

[11]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.

[12]δ' includes an intercept.

6 Results

6.1 Parameter estimates

Maximum likelihood estimates of the model's structural parameters are presented in Tables 4, 5 and 6.

Table 4: **Estimates of structural parameters: Instantaneous Utilities**

Variable	**Estimate**	**Standard Error**
Panel A: Schooling utility		
age	-5.64	0.040
stock of education	3.34	0.056
drop-out indicator dummy	-1.93	0.209
PROGRESA grant effect in primary school	0.18	0.021
PROGRESA grant differential effect in primary for drop-outs	-0.20	0.147
PROGRESA grant effect in 6th grade	-0.34	0.080
PROGRESA grant differential effect in 6th grade for drop-outs	0.60	0.055
PROGRESA grant effect	1.28	0.238
mother stock of education	0.16	0.165
poor indicator dummy	0.49	0.039
treatment indicator dummy	0.17	0.100
state1 (regional indicator dummy)	0.46	0.094
state2 (regional indicator dummy)	0.53	0.048
current availability of secondary school	0.37	0.057
current class size	-2.57	0.066
Panel B: Working utility		
wage	4.47	0.007056877
Panel C: Staying at home utility		
age	3.74	0.061
stock of education	3.44	0.127
mother stock of education	-0.51	0.040
number of babies at home	0.25	0.069
mother pregnant indicator dummy	0.38	0.628
worker mother indicator dummy	-2.40	0.021
number of sisters	0.01	0.053
poor indicator dummy	0.54	0.055
constant	0.43	0.009

Log-likelihood = -31876.82

Most of the estimated parameters have the expected signs in the three instantaneous

Table 5: **Estimates of structural parameters: Stock of Education equation**

Variable	**Estimate**	**Standard Error**
age	1.61	0.098
mother stock of education	0.09	0.066
poor indicator dummy	-0.08	0.114
drop-out indicator dummy	-0.21	0.043
availability of secondary school in the previous year	0.01	0.134
class size in the previous year	-0.29	0.037
unobserved heterogeneity load factor	-0.04	0.006

Table 6: **Estimates of structural parameters: Types and Types probabilities**

Variable	**Estimate**	**Standard Error**
Type 1 mass point	8.47	0.690
Type 2 mass point	5.85	0.806
birth order	-38.04	0.020
number of adults in the family	4.91	0.700
number of children in the family	0.69	0.489
father at home indicator dummy	-0.70	0.192
worker mother indicator dummy	-20.69	0.459
constant	21.76	0.768

Reference category is Type 2

utility equations and in the stock of education equation[13]. The utility of attending school is higher for younger girls, more educated, with more educated mothers, living in communities where there exist a secondary school and in municipalities where the mean class size is lower. Salaries clearly have a positive effect on the utility of working. The utility of staying at home is higher for older girls, with less educated mothers, belonging to a poor family, with children aged 1 year old or less. This utility is higher if the girl's mother is pregnant and lower if her mother works outside the household. The stock of education of a girl is higher when they have a more educated mother, where in school in 1997(non-drop-outs) and there were a secondary school in her village. On the other hand, girls belonging to poor families, who dropped-out of school before 1997 and facing higher class size at school have less years of education completed.

The model identifies two type of individuals. 91% belong to the high type group and 9% belong to the low type group of individuals. The high type individuals have a greater utility of attending school with an estimated unobserved effect equal to 8.47(the figure for low types is 5.85). The probability of being high type, or having a higher utility of attending school, is higher for the youngest girls in the family, with a non-worker mother and a higher number of adults at home. In Table **??**f I compare the distribution of types by choice between non-drop-outs and drop-outs.

Table 7: **Types distribution: Non-drop-outs and Drop-outs (%)**

	Type 1: High Type		Type 2: Lower Type	
Choice	Non-Drop-out	Drop-out	Non-Drop-out	Drop-out
School	92.81	35.76	84.39	35.96
Work	0.71	5.42	10.36	22.47
Home	6.47	58.82	5.25	41.57

6.2 Model Validity

The validity of the estimates of structural parameters relies strongly in the functional assumptions made on utilities and initial condition equation. This made crucial to test the validity of the estimated model. I present in what follows several evidence on the

[13]The exceptions are two parameter values. The effect of PROGRESA grants in 6^{th} grade, and its differential effect on drop-outs. I expected the mean effect to be positive and the differential effect on drop-outs to be negative, as in the case of primary school. Also the effect of belonging to a poor family in the utility from attending school was expected to be negative, since poor families face higher economic restrictions.

validity of the estimated parameters.

First I compare the predicted choices based obtained with the estimated parameters with the actual choices the individuals in the sample have made. The percentage of choices correctly predicted range between 77% and 89% depending on the rule applied to obtain the predicted choice. As it can be seen in Tables 8 and 9 below, it fits better the choices made by non-drop-outs girls. A more detailed analyzes at different levels,i.e. predicted choices by ages, stock of education, family and household characteristics, is left for the future.

Table 8: **Actual an predicted choices: Non-drop-outs observations(%)**

Choice	Actual	PC1	PC2	PC3
School	92.05	99.25	78.35	81.95
Work	1.58	0.07	7.57	3.69
Home	6.36	0.67	14.07	14.36

Table 9: **Actual an predicted choices: Drop-outs observations(%)**

Choice	Actual	PC1	PC2	PC3
School	35.78	24.66	6.29	9.05
Work	6.72	2.84	24.48	8.45
Home	57.50	72.50	69.22	82.50

Second, I can compare the estimated grant effects of the present model with the estimated grant effects in Valdes (2007) where the validity of the estimates relays basically on the randomization of the assignment of the treatment. The effect of PROGRESA grants in the present model is computed by comparing the predicted choices using the complete set of estimated parameters with the predicted choices using the estimated parameters where the PROGRESA grant coefficients are set to zero. By doing so, I obtained an increase in the proportion of non-drop outs girls that attend school of 3% and no change in the proportion of drop-out girls that attend school. In Valdes (2007) the probability that a non-drop-out girl attend school is increased by the grant in 3.5%, while no grant effect is found for drop-out girls. Hence, the model does well in fitting the effects of PROGRESA grants for non-drop-outs and drop-outs girls. An analyzes of this results by school levels is left for the future.

6.3 Simulation

Since PROGRESA grants seems not to obtain the desired outcome in girls that have to be re-enrolled in school, it is important to analyze the effect of different policies. From the estimated parameters of the present model, we can conclude that one of the main determinants of the utility of staying at home for a girl is the number of young siblings she has at home. So it become interesting to see the effect on girls choices of having no children aged less than one year old at home. This can be interpreted as the family having access to free community nurseries. The result for a policy combining PROGRESA grants and free community nurseries is as follows. The proportion of non-drop-out girls attending school is 3.15% higher from a reduction of 0.5% in the proportion of worker girls and a reduction of 2.65% in the proportion of girls that stay at home. The proportion of drop-out girls attending school is 0.5% higher from an increment of 0.2% in the proportion of worker girls and a reduction of 0.7% in the proportion of girls that stay at home.

The evaluation of alternative policies such as in the distribution of the grant amount, conditioning the amount on gender, drop-out status and family composition variables is left to the future.

7 Conclusions

The main conclusions of this work are the following. Although grants were a good incentive to keep girls at school, the ones that were out of school do not came back. I found some evidence suggesting that an effective policy to send drop-out girls back to school is the availability of free community nurseries and kindergartens.

Appendix

Value functions

The value function for choosing to attend school is:

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

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

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

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

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

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

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

I assume that girls do not attend school beyond 18 years old, so when they are 18 they have to decide wether to work, stay at home or get marry and leave her family household[14]. The value of working is given by the salary they can earn, and wage varies mainly with the stock of education reached by the individual. The value of staying at home, either if they are with their families or after they get married, depend on family composition[15]. The terminal value function is:

[14] Most of the girls that get married in this villages leave her family and start a new family or they go to live with her husband's family and stay in her new home taking care of her new family.

[15] If a girl leaves her family after getting married I cannot follow her in following surveys. That is, I do not have information about her new family composition. The solution I adopted is to assume that her new family has exactly the same composition as her own family. This is not a strong assumption since families in this villages do not vary so much at least in number of children and working status of the spouse of the head of household.

$$V^{T+1} = \frac{(1-\pi_{18}^h)\lambda_1}{(1+exp(-\lambda_2 S_{i,18}))} + \frac{\pi_{18}^h \lambda_3}{(1+exp(-\lambda_4 children_{i,18})+exp(-\lambda_5 mgirl_{i,18})+exp(-\lambda_6 workm_{i,18}))}$$

where π_{18}^h is the probability of staying at home at age 18[16]; *children* is the number of children aged 17 or less in the family; *mgirl* is a dummy equal 1 if a head of household's daughter has migrated out of girl's i family for getting married; *workm* is a dummy equal 1 if girl i has a worker mother.

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

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

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

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:

$$ln(w_{il}) = \gamma_0 + \gamma_1 ln(w_l) + \gamma_2 S_i + \gamma_3 age_i + \gamma_4 distmetro_l + \gamma_5 distcab_l + \omega_{il} \quad (13)$$

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.

References

Aguirregabiria, V., and P. Mira (2007): "Dynamic discrete choice structural models: A survey," *University of Toronto. Department of Economics*, Working Paper 297.

Attanasio, O., C. Meghir, and A. Santiago (2005): "Education choices in Mexico: using a structural model and a randomized experiment to evaluate Progresa," *Institute for Fiscal Studies, Working Paper*, EWP05/01.

[16]Calculated as the proportion of 18 years girls that are not working and not attending school.

Behrman, J., and P. Todd (1999): "Randomness in the Experimental Samples of PROGRESA (Education, Health, and Nutrition Program)," *International Food Policy Research Institute, Washington, D.C. Research Report.*

Coady, D. P. (2000): "The application of social cost-benefit analysis to the evaluation of Progresa. Final Report," *International Food Policy Research Institute, Washington, D.C. Research Report.*

Eckstein, Z., and K. Wolpin (1989): "The specification and estimation of dynamic stochastic discrete choice models: a survey," *Journal of Human Resources*, 24, 562–598.

Oportunidades (1999): "Reglas de operacion vigentes," *Secretaria de Desarrollo Social del Gobierno de Mexico downloadable from www.oportunidades.gob.mx.*

Rust, J. (1994): "Structural estimation of Markov decision processes," *Handbook of Econometrics*, Vol.1A, McFaden D, Engel R (eds).

Schultz, P. (2004): "School subsidies for the poor: evaluating the Mexican Progresa poverty program," *Journal of Development Economics*, 74, 199–250.

Skoufias, E., B. Davis, and J. Behrman (1999a): "A. Final Report: An Evaluation of the Selection of Beneficiary Households in the Education, Health, and Nutrition Program (PROGRESA) of Mexico," *International Food Policy Research Institute, Washington, D.C. Research Report.*

——— (1999b): "B. An Addendum to the Final Report: An Evaluation of the Selection of Beneficiary Households in the Education, Health, and Nutrition Program (PROGRESA) of Mexico. Targeting the Poor in Mexico: Evaluation of the Selection of Beneficiary Households into PROGRESA," *International Food Policy Research Institute, Washington, D.C. Research Report.*

Todd, P., and K. I. Wolpin (2003): "Using a social experiment to validate a dynamic behavioral model of child schooling and fertility: assessing the impact of a school subsidy program in Mexico," *Penn Institute for Economic Research, Working Paper Series*, 03-022.

Valdes, M. N. (2007): "Did PROGRESA send drop-outs back to school?," *Universidad Carlos III de Madrid. Department of Economics*, Mimeo.