BANCO CENTRAL DE RESERVA DEL PERÚ

General Equilibrium Analysis of Conditional Cash Transfers

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DT. N° 2014-015
Serie de Documentos de Trabajo
Working Paper series
Diciembre 2014

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Resumen

Las transferencias condicionales en efectivo es una de las más importantes políticas de lucha contra la pobreza en todo el mundo. En este documento, se estudia los efectos económicos de este programa mediante el uso de un modelo estilizado de equilibrio general. Se estudia los efectos sobre la producción, el capital humano, la pobreza, el bienestar y la distribución del ingreso. El análisis cuantitativo revela la alta capacidad de reducción de la transmisión intergeneracional de la pobreza. En términos agregados el aumento del bienestar es pequeño, pero varía según los agentes. Por último, se muestra que la reducción de la pobreza y de la desigualdad se da por la acumulación constante de capital humano.

Abstract

Conditional Cash Transfer (CCT) program is one of the most important anti-poverty policies worldwide. In this document, I study the economic effects of this program by using a stylized dynamic general equilibrium model. I look at the program's impact on output, human capital, poverty and income inequality. I also study its welfare implications and its effects on the intergenerational transmission of poverty. The quantitative analysis reveals that a long-term implementation of this anti-poverty program helps to reduce the intergenerational transmission of poverty. In aggregate terms the welfare gain is small, but varies across agents; the winners are those who are in the lower tail of the income distribution and the losers are those located in the upper tail. Finally, this program increases the human capital of households and, through this channel, induces a consistent reduction of both poverty and income inequality.

JEL Classification: D52, D58, D62, D64, I30, I32, I38.
Keywords: Poverty, Welfare, Cash Transfer, General Equilibrium, Inequality, Overlapping Generations.

1 Introduction

Poverty is widespread in developing economies.[1] According to the World Bank, around 20% of the population in developing economies spend less than $2 a day; this high incidence of poverty seems to be robust

*I am grateful to professors Yongsung Chang and Arpad Abraham for valuable advice and support. I thank Mark Bils, Mark Aguiar, Jay Hong, Josh Kinsler, William Hawkins, Ronni Pavan, Flavio Cunha, Gustavo Ventura, David Coady, Douglas Mckee, Minjae Song, William Schwert, Michal Kuklik and the participants at the Rochester Macro/Applied Student Workshop for their helpful comments. All remaining errors are my own.

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[1] In this paper I adopt the standard and widely used definition of poverty: A person is in poverty when he does not attain a minimum level of well-being. Empirically, the minimum level of well-being is defined in monetary terms as the poverty line. People whose consumption is below the poverty line are considered poor. The proportion of poor people in the population defines the poverty rate.

to several specifications of the threshold used to identify the population's poverty status. These economies have been implementing many anti-poverty policies, and the most widely used intervention in recent years is the so-called conditional cash transfer (CCT) program (Coady et al., 2004).

Conditional cash transfer programs have become one of the most important anti-poverty policy interventions after one such program was successfully implemented in Mexico in the late 1990s.[2] The main feature of this type of program is that the government provides monetary transfers to families in poverty. The transfers are conditional upon children's school attendance and participation in other complementary anti-poverty policies, such as food supplements.[3] The strength of this program is based on its well-designed goals: The short-run goal of the program is to increase school attendance and to reduce school drop out rates by providing monetary compensation for each child the family sends to school. The long-term goal is to reduce the vulnerability of the population in poverty by promoting human capital production.

The positive outcomes of conditional cash transfer programs have been extensively documented over the last two decades by studying mainly the benchmark Mexican CCT program. This literature provides evidence of the effectiveness of the program in the short-term: an increase in enrollment rates, a reduction in child labor, a reduction in school drop out rates and a reduction in poverty. However, since the benchmark CCT program started in 1997, the available information is not yet suitable for evaluating its effects in the following three categories: long-term effects, welfare implications and intergenerational transmission of poverty.

The long-term effects comprise the study of the outcomes[4] of this program when it is implemented continuously over a long period of time. Some efforts have been made to identify these long-term effects; however, this is part of a growing literature that has provided only partial answers.

The welfare analysis of the CCT program has interesting implications, since our concern is to identify the winners and losers if the government decides to implement this program. In other words, we may be able to see if individuals have enough incentives, generated by the program, to support the anti-poverty policy. The literature in this area is scarce, and our study may uncover some features of the welfare effects of this program.

The literature on the intergenerational transmission of poverty or, more generally, the poverty trap literature, has pointed out that children inherit poverty from their parents with a positive probability. Whether the CCT program reduces the persistence of poverty is an open question.

In this paper, I use a competitive general equilibrium model that will allow us to uncover the effectiveness of a CCT program along these three dimensions. Our contribution to the macro and development literatures is that I use the neoclassical growth model with heterogeneous agents to study one of the most widely used anti-poverty policies. Since the approach is mainly theoretical, I will provide complementary evidence of the effects of CCT programs that may be used, together with the current knowledge of its effects, to guide

[2]Currently, CCT programs have spread to several countries, among them: Mexico, Brazil, the UK, Colombia, Peru, Nicaragua, and Bangladesh.

[3]The program in Mexico covered around 2.6 million beneficiaries in 2000; the transfers represent around 30% of the beneficiaries' incomes, which in aggregate terms represents 0.2% of Mexico's GDP (Coady and Lee-Harris (2004)

[4]I am interested in outcomes such as output, income inequality, poverty, wages, years of education, and human capital.

anti-poverty interventions in developing economies.

Our approach captures the following features of an economy in which the anti-poverty CCT program under consideration is implemented. I model both parent and child labor supply decisions; given that a cash transfer can be seen as an additional source of household income, the income effect induced by this transfer may affect the allocation of resources within the household. I model schooling choice; this is one of the most important features of the model, since the goal of the program is to promote early school attendance. I model human capital accumulation over the life cycle of the household members; it is the main channel by which the CCT program attempts to reduce household vulnerability in the long-run. In our model economy, the government has incentives to promote schooling of the population, since schooling has a positive externality that affects workers' productivity. Finally, I use flexible prices (wage and interest rate) in order to capture the price changes induced by the conditional transfers.

The results of our simulations reinforce the well-known positive outcomes of the Mexican-type conditional cash transfers program. The general equilibrium effects of this program are significant enough such that in the long-run, the program delivers a remarkable increase in output (6.5%), human capital (6.7%), and years of education (10.9%), and a reduction in poverty (21.6%) and income inequality (3.0%). However, most of these effects may be observable during the lifetime of the current generation, which implies that the long-term effects of this program are stronger than its short-term effects.

Regarding the welfare implications of this program, I find that the aggregate welfare effect is small (0.85%); however, the majority of households will gain in welfare terms after the implementation of the CCT program. Finally, poor parents are able to educate their children by using the resources provided by the CCT program. As a result, the intergenerational correlation of poverty decreases and the program will deliver a noticeable reduction in the poverty trap in the long-run.

1.1 Related literature

The effectiveness of CCT programs has been studied from several perspectives during the last two decades. In this section I briefly describe some of these efforts in order to locate the contribution of our study to this specialized literature.

The most extensive literature that has studied CCT programs has used the experimental design approach. This branch of the literature has mostly evaluated the Mexican case, since it provides a suitable source of data. Additionally, there is a growing literature that has applied this methodology to other developing countries with results similar to the Mexican case. The evidence provided for Mexico seems to be optimistic; several studies (Behrman et al. (1999); Schultz (2000)) conclude that the program increases the enrollment rate, reduces the drop-out rate, and reduces the poverty rate, among other positive outcomes.

CCT programs have also been studied by using structural models of individual behavior (schooling choice models) in Todd and Wolpin (2006) and Attanasio et al. (2005). This approach tries to capture the fact that a cash transfer program may change the relative price of education and child labor (the opportunity cost of attending school). This approach allows evaluation of the effectiveness of the program along several dimensions that were not suitable to the experimental approach. However, this approach is still a partial equilibrium analysis, and the results derived from the Mexican case are consistent with the results found in the previous literature.

Our justification is that this policy may not only have direct partial equilibrium effects but it may also affect the behavior of the agents, especially if the program is implemented continuously over a long period of time, and it may have secondary effects induced by price changes. Under a general equilibrium framework, I may be able to measure not only the direct effects of the program, but I may also be able to uncover the indirect effects induced by the anti-poverty policy intervention that work through changes in prices such as wages and interest rates.

The general equilibrium effects of CCT programs have been studied using computable general equilibrium models (CGE). This methodology was applied to evaluate the effects of a cash transfers program in Mexico by Coady and Lee-Harris (2004). Additionally, several other studies have used CGE models to analyze policy interventions and their effects on poverty and inequality (Hans et al. (2002a), Hans et al. (2002b); Robilliard et al. (2001)). The general idea of this methodology is that policy intervention instruments are linked to poverty indicators by using the relationship among national accounts, social accounting matrixes and household surveys. In short, the structure of the national accounts (aggregate variables) is linked to household survey data (microeconomic variables) using elasticities and/or coefficients such that the effect of economic shocks on poverty and inequality can be evaluated through these elasticities. Under the competitive approach used in this paper, I have consistency at both the macro and the individual levels, and I will be able to properly measure both the welfare and the long-run effects of the CCT program.

Our study is also related to the literature that addresses the role of early childhood education from a macro-quantitative perspective. This topic has been covered in several studies, among them Aiyagari et al. (2001) and Restuccia and Urrutia (2002). These documents evaluate the role of early childhood investment in education and the intergenerational correlation of income in the United States.

The rest of the paper is organized as follows. In section 2 I describe the features of our model economy. In section 3 I describe the calibration procedure. In section 4 I present the results. In section 5 I summarize the findings.

2 The Model

I use a dynastic overlapping generations model (DOLG) with incomplete markets.[5] The basic framework of the DOLG model is extended in such a way that it captures most of the features of an economy in which an anti-poverty conditional cash transfers program is implemented.

2.1 Environment

The model represents a closed economy inhabited by households that are heterogeneous in ability. There are N types of ability, each of them indexed by i $(i = 1, 2, ..., N)$. The ability distribution is known and I denote

[5]The DOLG model has been implemented in several studies. Fuster et al. (2003), Fuster et al. (2007) and Restuccia and Urrutia (2002).

the measure of households of type i by α_i. Without loss of generality I normalize the number of households to 1 $(\sum \alpha_i = 1)$. Each household has two members: a parent and a child.

Each household belongs to a dynasty that lives forever. A household is born at the beginning of the first period with two members: a 36-year-old parent and a 6-year-old child. Each household lives for 30 years. The life-cycle feature of the model may be summarized by the following events that happen during the household's lifetime: During the first 6 periods the parent works and the child attends primary school. From period 7 through 12 the child may attend secondary school or may work, according to the parent's decision at the beginning of period 7. From period 13 through 17, the child may attend tertiary school or may work, according to the parent's decision at the beginning of period 13.[6]

From period 18 through period 30 the parent and the child work in the labor market. In period 30, the 66-year-old parent dies and he leaves an endogenous bequest to his 36-year-old child.[7] At the beginning of the next period, the child becomes a new parent, since at this period a 6-year-old child is born. The new parent and the newborn child start a new household and thus continue the immortal dynasty.

A household has instantaneous utility represented by $u(c_t, l_{p,t}, l_{k,t})$. It is defined over household consumption (c_t), parent's time spent working $(l_{p,t})$ and child's time spent working $(l_{k,t})$. Utility is additively separable between consumption and time spent working $u(c_t, l_{p,t}, l_{k,t}) = u_1(c_t) + u_2(l_{p,t}) + u_3(l_{k,t})$. In this economy the parent decides optimally every period over consumption (c_t), saving (a_{t+1}), hours of work $(l_{p,t}, l_{k,t})$ and, during the first 17 periods, schooling. There is also a bequest decision that is taken at period 30.

I assume that a household at time zero (or at the beginning of period 1 when the household is born) sorts its random streams of consumption and hours of work according to the lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_{p,t}, l_{k,t}) \tag{1}$$

The parameter β is the subjective discount factor. In our model β has two interpretations. It measures time preference within the lifetime of a generation. It also measures the intergenerational altruism of a given generation; a generation leaves a bequest for the future generation in a given dynasty and β may affect the discounted value of a future generation's preferences. The following utility function is considered:

$$u(c, l_p, l_k) = \frac{c^{1-\sigma}}{1-\sigma} - B_p \frac{l_p^{1+1/\psi}}{1+1/\psi} - B_k \frac{l_k^{1+1/\psi}}{1+1/\psi} \tag{2}$$

[6]The timing of the schooling decision of the model attempts to capture the education system of Mexico. Primary education in Mexico lasts for 6 years ('Educacion Primaria'). Secondary education lasts for 6 years; it comprises two levels: lower-secondary ('Educacion Secundaria') for 3 years and upper-secondary ('Educacion Media Superior') for 3 years. Finally, tertiary education lasts for 5 years ('Educación Superior').

[7]The assumption that the child leaves her parent's house at age 36 may not affect the policy experiment. From the point of view of our policy evaluation, what matters is both the age at which the schooling decision is made and the length of time over which each individual accumulates human capital. In our model, each agent may keep studying for at most 17 years, and after these schooling periods, he accumulates human capital during his lifetime. Both parent and child accumulate human capital while they work.

where ψ represents the Frisch elasticity of labor supply, $B_p > 0$ $(B_k > 0)$ represents the preference parameter related to the parent's (child's) disutility of hours of work.

Both parent (p) and child (k) face an idiosyncratic productivity shock that is realized at the beginning of each period before any decision is taken. I assume that the parent's and child's idiosyncratic productivity shocks are correlated. This correlation is measured by the correlation coefficient ρ_{pk}. I denote the parent's (child's) productivity shock by $e_{p,t}$ $(e_{k,t})$. Idiosyncratic productivity shocks follow a VAR(1) process: $\ln(e_{j,t}) = \varphi_j \ln(e_{j,t-1}) + \upsilon_{j,t},\ j = p,k$; with the shocks υ_p and υ_k following a bivariate normal distribution:

$$\begin{bmatrix} \upsilon_p \\ \upsilon_k \end{bmatrix} \sim N \left\{ \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{\upsilon_p} & \sigma_{\upsilon_{pk}} \\ \sigma_{\upsilon_{kp}} & \sigma^2_{\upsilon_k} \end{bmatrix} \right\}$$

and

$$\rho_{pk} = \frac{\sigma_{\upsilon_{pk}}}{\sigma_{\upsilon_p} \sigma_{\upsilon_k}}$$

.

where σ_{υ_p} and σ_{υ_k} are the standard deviations of the parent's and child's productivity shock, and $\sigma_{\upsilon_{pk}}$ is the covariance between the parent's and child's productivity shocks.

Households are allowed to save and there is only one asset available for this purpose. Savings is denoted by $a' \in A$, where A is a compact set that represents the savings state space. Households are borrowing constrained $(a' \geq \underline{a})$ and they can finance expenses only with labor income, savings and government transfers. In this environment the market is incomplete, since there is only one asset that can be used by the household to insure against the idiosyncratic productivity shocks that affect the working family members.

The government taxes the household's total income at a constant rate (τ), and the collected tax revenues are used by the government to finance monetary transfers to households. There are two types of transfers: a lump-sum transfer (tr) that is given by the government to each household and a conditional cash transfer (ctr) that represents the government's anti-poverty policy. The government provides ctr only to those households that qualify as beneficiaries of the anti-poverty program. Two conditions must be filled in order to qualify as a beneficiary of the program: the household must be in poverty and the child must be attending primary or secondary school. I assume that a household is in poverty if its disposable income is below a threshold (poverty line) denoted by $\underline{line}$. Since the government may not be able to reach 100% of the eligible beneficiaries, I consider that the government provides cash transfers to a proportion η of the potential beneficiaries of the program.

Education is costly, and the education cost depends on the child's level of education. If the child attends primary school, the parent pays a cost denoted by $cost_{pr}$; similarly, the secondary education cost is denoted by $cost_{se}$ and the tertiary education cost by $cost_{te}$. Since education in developing economies is mainly public, this education cost represents the household's education expenses in order to keep the child enrolled in school. Households with a child attending school face a utility cost that represents the psychological cost of sending a child to school. The utility cost differs according to the level of education: ζ_{pr}, ζ_{se} and ζ_{te} denote the utility cost of pursuing primary, secondary or tertiary education, respectively.

Workers are paid a wage by efficiency units of labor denoted by w. The pre-tax labor income of a parent is represented by $wh_pl_pe_p$,[8] where h_p stands for the human capital stock, l_p stands for hours of work and e_p stands for the parent's idiosyncratic productivity shock. The parent's and child's human capital evolve according to a Mincer-type production function $h_p = f(i, s_p, x_p)$, where i stands for parent ability, s_p stands for parent schooling level, and x_p denotes parent labor market experience. The human capital production function has the following functional form:

$$f(i, s_p, x_p) = \exp(\phi_{01} + \phi_{0i}1_{[i>1]} + \phi_{11}s_p + \phi_{1i}1_{[i>1]}s_p + \overline{\phi_1}\overline{S} + \phi_2 x_p + \phi_3 x_p^2) \tag{3}$$

where $1_{[i>1]}$ is an indicator function that takes the value of one if the ability type is higher than one. The child's human capital has a similar representation: $h_k = f(i, s_k, x_k) = \exp(\phi_{01} + \phi_{0i}1_{[i>1]} + \phi_{11}s_k + \phi_{1i}1_{[i>1]}s_k + \overline{\phi_1}\overline{S} + \phi_2 x_k + \phi_3 x_k^2)$. Note that we differentiate the human capital production function by ability types; high-ability agents have higher private return to education compared with low-ability agents $(\phi_{1i+1} + \phi_{11} > \phi_{1i} + \phi_{11})$. Similarly, high-ability agents have a higher initial level of human capital $(\phi_{0i+1} + \phi_{01} > \phi_{0i} + \phi_{01})$.

In this economy there is a positive externality generated by the average years of schooling of the population. The government has an incentive to promote children's schooling attendance, since higher years of education increase workers' productivity.[9] The term $\overline{\phi_1}\overline{S}$ captures the externality induced by the average years of education. I include the schooling externality in the human capital production function in order to justify the government's policy intervention: the government may want to induce a higher schooling level of the population through conditional cash transfers, since every agent in the economy will be positively affected by this policy through the externality. Note that under our formulation in equilibrium, when $\overline{S}$ equals the average years of education of the whole economy, the social return to an additional year of education $(\phi_{11} + \phi_{1i} + \overline{\phi_1})$ is higher than the private return $(\phi_{11} + \phi_{1i})$ for each ability type.

Production takes place in a competitive market, which implies that a factor's price (wages or the interest rate) is equal to its marginal productivity. Output is produced according to a Cobb-Douglas production function that uses capital and two types of labor as production factors. Two skill levels are considered: skilled and unskilled. I relate skills to the schooling level of the agents; the unskilled workers have either primary or secondary education and the skilled workers are those with tertiary education. Finally, I assume that the labor inputs of different skill levels are not perfect substitutes.

[8]Similarly, the pre-tax child labor income is denoted by $wh_kl_ke_k$.

[9]The use of a human capital externality at an aggregate level was introduced by Lucas (1998) and Mankiw et al. (1992).

I model the schooling externality by using the Mincerian approach of human capital production. Our approach is similar to that in Rauch (1993), Acemoglu and Angrist (2000), and Ciccone and Giovanni (2002).

2.2 Recursive representation

I describe the recursive representation of the household's problem. In this section I also describe the representative firm's problem.

2.2.1 Household's problem

The life-cycle feature of the model allows us to separate the recursive representation of the household's problem according to household age. I index the household's age by t; since a household lives for 30 years, t takes discrete values from 1 to 30. Note that t helps to keep track of both the parent's and the child's ages; a child's age at t is $t+6$ and the parent's age at the same period is $t+36$.

I denote by $V_{i,t}(a, e_p, s_p, e_k, s_k)$ the lifetime value of a t-year-old household with ability type i. In general terms, the state space is represented by the household's asset position a, the parent's and child's schooling levels (s_p, s_k) and the parent's and child's idiosyncratic productivity shocks (e_p, e_k). I denote the state by $\Theta = \{\Theta_p, e_k, s_k\}$, where $\Theta_p = (a, e_p, s_p)$ and $\Theta'_p = (a', e'_p, s_p)$. At the beginning of period 1 the child begins his life with zero years of schooling and he accumulates one year of schooling if he attends school. The government cash transfer policy is represented by ctr. Since I consider that the government can reach only a fraction η of the potential beneficiaries, ctr is a state variable for the first 12 periods (when a child is attending primary and secondary school). I consider that ctr follows a two-state iid process: $ctr > 0$ for those who get transfers and $ctr = 0$ for those potential beneficiaries who cannot be reached by the government policy.

$\Theta = (a, e_p, s_p, i_p, e_k, s_k, i_k, ctr, j)$

$$V(\Theta) = \max_{\{c \geq 0, a' \geq \underline{a}, l_p, l_k\}} \left\{ u(c, l_p, l_k) - \zeta + \tilde{\beta} E \tilde{V}(\Theta') \right\} \tag{4}$$

S.t.

$$c + a' + \cos t \leq (1-\tau) \left\{ w_{i_p} h_p l_p e_p + w_{i_k} h_k l_k e_k \right\} + (1 + (1-\tau) r) a + tr + \psi ctr$$

Household's problem for periods 1 through 5. The household's problem has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k, ctr) = \max_{\{c \geq 0, a' \geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{pr} + \\ +\beta E V_{i,t+1}(\Theta_p, e'_k = 0, s_k + 1, ctr') \end{array} \right\} \tag{5}$$

S.t.

$$c + a' + \cos t_{pr} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr + \psi ctr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

During these periods the child is studying, and he does not face any idiosyncratic productivity shock; we denote this event by $e_k = 0$. The CCT policy is represented by the indicator function ψ, which is a function of the disposable income and it takes two values according to the household's poverty status: $\psi = 1$ if the household is in poverty or when $(1-\tau)(w_i h_p l_p e_p + ra) < \underline{line}$ and 0 otherwise. The definition of ψ is similar when the child is attending primary or secondary school.

Household's problem at period 6. At period 6 the household's problem is similar to the problem faced during the previous 5 periods; however, the continuation value of period 6 changes to reflect the child's secondary schooling at the beginning of period 7. The household's problem now has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k, ctr) = \max_{\{c \geq 0, a' \geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{pr} + \\ \beta EMax \left[\begin{array}{c} V_{i,t+1}(\Theta'_p, e'_k = 0, s_k + 1, ctr'); \\ V_{i,t+1}(\Theta'_p, e'_k, s_k) \end{array} \right] \end{array} \right\} \tag{6}$$

S.t:

$$c + a' + \cos t_{pr} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr + \psi ctr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

where $V_{i,t+1}(\Theta'_p, e'_k = 0, s_k + 1, ctr)$ denotes the value function of the household at the beginning of period 7 when the child attends secondary school. Similarly, $V_{i,t+1}(\Theta'_p, e'_k, s_k)$ denotes the value function when the child does not go to secondary school. Note that in the latter case the child faces an idiosyncratic productivity shock e'_k. The decision rule to attend secondary education is denoted by $DR(.)$; specifically, $DR(.) = s_k + 1$ if sending the child to secondary school produces a higher value for the household than a working child $[V_{i,t+1}(\Theta'_p, e'_k = 0, s_k + 1, ctr') \geq V_{i,t+1}(\Theta'_p, e'_k, s_k)]$. On the other hand, $DR(.) = s_k$ if the household with a working child is greater than the value of sending him for secondary education $[V_{i,t+1}(\Theta'_p, e'_k = 0, s_k + 1, ctr') < V_{i,t+1}(\Theta'_p, e'_k, s_k)]$.

Household's problem for periods 7 through 11. In these periods there are two types of households according to the child's secondary school attendance.

The problem of a household with a child attending secondary school has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k, ctr) = \max_{\{c \geq 0, a' \geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{se} + \\ +\beta EV_{i,t+1}(\Theta_p, e_k = 0, s_k + 1, ctr')) \end{array} \right\} \tag{7}$$

S.t:

$$c + a' + \cos t_{se} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr + \psi ctr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

The problem of a household with a working child has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k, s_k) = \max_{\{c\geq 0, a'\geq \underline{a}, l_p, l_k\}} \left\{ u(c, l_p, l_k) + \beta E V_{i,t+1}({\Theta_p}', e'_k, s_k) \right\} \tag{8}$$

S.t:

$$c + a' \leq (1-\tau) w_i h_p l_p e_p + (1-\tau) w_i h_k l_k e_k + (1 + (1-\tau) r) a + tr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

$$h_k = f(i, s_k, t + 6 - s_k - 6)$$

Since employment is an absorbing state (a working child cannot return to school), the problem of a household with a working child will have the same recursive representation in the remaining periods.

Household's problem at period 12. At period 12 the household faces a problem similar to the previous period's problem; however, at the beginning of period 13, the parent will decide whether the child will attend college. In order to decide on college attendance, the parent compares the value of sending the child to college, $V_{i,t+1}(\Theta'_p, e_k = 0, s_k + 1)$, with the value of sending him into the labor market, $V_{i,t+1}(\Theta'_p, e'_k, s_k)$. Note that in the latter case, the child's idiosyncratic productivity shock is realized before his schooling decision.

The problem of a household with a child attending secondary school has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k, ctr) = \max_{\{c\geq 0, a'\geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{se} + \\ \beta E \max \left[\begin{array}{c} V_{i,t+1}(\Theta'_p, e_k = 0, s_k + 1); \\ V_{i,t+1}(\Theta'_p, e'_k, s_k) \end{array} \right] \end{array} \right\} \tag{9}$$

S.t:

$$c + a' + \cos t_{se} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr + \psi ctr$$

$$h_p = f(i, s_p, t - s_p - 6)$$

Household's problem for periods 13 through 16. The problem of a household with a child attending college (tertiary education) has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k) = \max_{\{c\geq 0, a'\geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{te} + \\ +\beta E V_{i,t+1}(\Theta_p', e_k = 0, s_k + 1) \end{array} \right\} \tag{10}$$

S.t:

$$c + a' + \text{cost}_{te} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr$$

$$h_p = f(i, s_p, t - s_p - 6)$$

Household's problem at period 17. At the end of this period the studying child will finish his tertiary education, and at the beginning of the next period, he will start working according to some idiosyncratic productivity shock (e_k').

The problem of a household with a child pursuing tertiary education has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k = 0, s_k) = \max_{\{c\geq 0, a'\geq \underline{a}, l_p\}} \left\{ \begin{array}{c} u(c, l_p, 0) - \zeta_{te} + \\ +\beta E V_{i,t+1}(\Theta_p', e_k', s_k + 1) \end{array} \right\} \tag{11}$$

S.t:

$$c + a' + \text{cost}_{te} \leq (1-\tau) w_i h_p l_p e_p + (1 + (1-\tau) r) a + tr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

Household's problem for periods 18 through 29. During these periods all household members are working and the household's problem has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k, s_k) = \max_{\{c\geq 0, a'\geq \underline{a}, l_p, l_k\}} \left\{ u(c, l_p, l_k) + \beta E V_{i,t+1}(\Theta_p', e_k', s_k) \right\} \tag{12}$$

S.t.

$$c + a' \leq (1-\tau) w_i h_p l_p e_p + (1-\tau) w_i h_k l_k e_k + (1 + (1-\tau) r) a + tr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

$$h_k = f(i, s_k, t + 6 - s_k - 6)$$

Household's problem at period 30. At period 30 the household decides bequests for future generations in its dynasty. For the previous 29 periods, I denote the household's saving decision by a'; however, at the end of period 30, the parent dies and I let a' denote the household's bequest decision. Note also that at this period the parent values the child's future value function due to his altruistic concern for the future of his child. The household's problem has the following recursive representation:

$$V_{i,t}(\Theta_p, e_k, s_k) = \max_{\{c \geq 0, a' \geq \underline{a}, l_p, l_k\}} \left\{ u(c, l_p, l_k) + \beta E V_{i,1}(a', e'_k, s_k, 0, 0, ctr') \right\} \tag{13}$$

S.t.

$$c + a' \leq (1-\tau) w_i h_p l_p e_p + (1-\tau) w_i h_k l_k e_k + (1 + (1-\tau) r) a + tr$$

$$h_p = f(i, s_p, t + 36 - s_p - 6)$$

$$h_k = f(i, s_k, t + 6 - s_k - 6)$$

The policy functions that solve the household problem are those determining household consumption, savings, bequest, hours worked by the parent, hours worked by the child, and the secondary and tertiary schooling attendance decision. The optimal policies depend on the state space, and for easy notation I denote them by: $c(\Theta; i, t)$; $a'(\Theta; i, t)$; $l_p(\Theta; i, t)$; $l_k(\Theta; i, t)$; and $DR(\Theta; i, t)$.

Firm's problem. The representative firm produces in a competitive market according to a Cobb-Douglas production function.

$$Y = F(K, L) = z K^{\theta} L^{1-\theta}$$

where K and L are the aggregate capital and labor inputs, respectively. Y is output, z is the economy-wide productivity and θ represents the capital share parameter. Since the labor inputs of different schooling levels are not perfect substitutes for each other, aggregate labor is calculated by adding up the efficiency units of labor of each skill level (L_j) by using the following CES function

$$L = \left\{ \sum_{j=1}^{2} \chi_j L_j^{\gamma} \right\}^{1/\gamma}$$

where the agent's skill is indexed by j. Since I consider two schooling levels, $j = 1$ denotes the primary or secondary education level, while $j = 2$ denotes the tertiary education level. χ_j represents the share, or the relative productivity, of the individuals with schooling level j, and $\frac{1}{1-\gamma}$ denotes the elasticity of substitution between labor inputs of different skill levels.

The marginal productivity of labor equals $mpl_j = F_{L_j}(K, L) = (1-\theta)\frac{Y}{L}(\frac{L}{L_j})^{1-\gamma}\chi_j$ and the marginal productivity of capital equals $mpk = F_k(K, L) = \theta \frac{Y}{K}$.

2.3 Definition of equilibrium

Definition: A stationary recursive competitive equilibrium consists of a set of policy rules for the households regarding consumption, saving, bequest, hours of work and schooling decision ($c(\Theta;i,t)$, $a\prime(\Theta;i,t)$, $l_p(\Theta;i,t)$, $l_k(\Theta;i,t), DR(\Theta;i,t)$; a stationary probability measure of households ($\mu_i' = \mu_i(\Theta)$); aggregate factors, output and prices $(K, L, \{L_i\}_{i=1}^{N}, Y, r, \{w_j\}_{j=1}^{2})$; tax revenues (Tax); aggregate transfers (TR) and household value functions $(V_{i,t}(\Theta))$ such that the following conditions hold:

i) Aggregate capital (K), labor (L), transfers (TR) and tax revenues (Tax) are calculated from individual policies by using the following formulas:

$$K = \sum_{i=1}^{N} \alpha_i \left\{ \int a'(\Theta;i,t) d\mu_i \right\} \tag{14}$$

$$L_j = \sum_{i=1}^{N} \alpha_i \left\{ \int [h_p l_p(\Theta;i,t) e_p 1_{[j]} + h_k l_k(\Theta;i,t) e_k 1_{[j]}] d\mu_i \right\}^{10} \tag{15}$$

$$Tax = \tau \sum_{j=1}^{2} w_j L_j + \tau r \sum_{i=1}^{N} \alpha_i \left\{ \int a d\mu_i \right\} \tag{16}$$

$$TR = tr + \sum_{i=1}^{N} \alpha_i Pov(i) ctr(i) \tag{17}$$

where $Pov(i)$ represents the measure of households of ability type i that are beneficiaries of the anti-poverty program.

ii) Given r and $\{w_j\}_{j=1}^{2}$, decision rules $\{c(.); a'(.); l_p(.); l_k(.), DR(.)\}$ solve the household's problem (2) through (10)

iii) The goods market clears.

$$F(K,H) + (1-\delta_k)K = \sum_{i=1}^{N} \alpha_i \left\{ \int c(\Theta;i,t) + a'(\Theta;i,t) + E\cos t(t,e_k)] d\mu_i \right\}^{11} \tag{18}$$

iv) Firms maximize profits in a competitive market.

$$r + \delta_k = mpk \tag{19}$$

$$w_j = mpl_j \tag{20}$$

[10] $1_{[j]}$ denotes an indicator function that is one when the schooling level is j.

[11] I use Ecost(t) to denote the education cost at period t of those households with a child attending school. Ecost(t) has the following functional form:

$$Ecost(t,e_k) = \left\{ \begin{array}{cc} \cos t_{pr}; & t = 1,2,...,6 \\ \cos t_{se}; & t = 7,8,...,12; e_k = 0 \\ \cos t_{te}; & t = 13,...,17; e_k = 0 \\ 0; & Otherwise \end{array} \right\}$$

v) The government balances its budget constraint.

$$Tax = TR \tag{21}$$

vi) The aggregate schooling level is consistent with individual schooling decisions.

$$\bar{S} = \sum_{i=1}^{N} \alpha_i \left\{ \int \frac{1}{2}(s_p + s_k) d\mu_i \right\}$$

vii) The law of motion of distribution of households is stationary.

$$\mu_i' = \mu_i \tag{22}$$

3 Calibration

In this section, I solve the model for a representative developing economy in which the CCT program was implemented. I consider Mexico as the natural choice, since its program was first introduced in 1997. Additionally, there is an abundance in empirical literature based on the Mexican experience that will guide the calibration process.

I perform a counterfactual experiment in order to measure the economic effects of the CCT program. The counterfactual economy includes the CCT policy, which was fully described in the previous section. The baseline model represents an economy without conditional cash transfers, a situation in which the anti-poverty policy is based on transfers that are independent of school attendance. I call this solution the unconditional cash transfers model (UCT). Note that the baseline economy results after relaxing some assumptions of the CCT model as I will explain carefully later.

The Baseline Model

The baseline equilibrium represents the Mexican economy in 1996, one year before the Mexican government introduced the conditional cash transfers program. The parameters of the baseline model (Table 1) are chosen such that the model generates a group of moments that are close to their corresponding observed moments in Mexico.

The moments shown in Table 2 are correlated among each other, which in fact implies that I cannot perfectly target a particular moment by using a specific parameter without affecting the value of the remaining moments. I address this issue by iterating over the whole set of parameters such that the competitive equilibrium supported by them represents a reasonable approximation of the Mexican economy. In this section I discuss the rationale behind the values of the parameters of the baseline model.

Each person's ability level is identified by using the Raven test. This test is part of the Mexican Family Life Survey (MxFLS), and it is reported as an index and measures the cognitive ability of each person based on a set of questions designed for this purpose. The ability index is discretized in order to have a feasible number of states. I consider two ability levels ($N = 2$): high ability and low ability. I consider that 50% of the population has high ability ($\alpha_1 = \alpha_2 = 0.5$).[12]

The risk-aversion parameter is fixed at $\sigma = 1.4$, consistent with the common usage in the neoclassical literature. The available time of each family member is set to one and the values of the parameters, ψ, B_p, B_k, are chosen such that in equilibrium the average hours of work are around 0.35. The Frisch elasticity of labor supply (ψ) is set at 0.30 and $B_k/B_p = 50/30$. Note that when $B_k/B_p = 50/30$[13] we have a smooth transition of the child's hours of work when he becomes a parent; this is the life-cycle profile of hours of work.

The parameters of the production function take standard values: $\theta = 0.33$, $z = 1$. The annual physical capital depreciation rate is set at $\delta_k = 6.5\%$. The parameters of the human capital production function cannot be estimated directly since human capital is not observable; however, it is easy to see that these parameters are closely related to the parameters of the Mincer equation, which relates hourly labor income to schooling and experience. Under our strategy, the parameters of the human capital production function are estimated by the indirect inference method, and they are chosen such that the Mincer equation estimated by using model-simulated data is similar to the empirical Mincer equation estimated by using household survey data, MxFLS(2002, 2005). Appendix B describes the Mincer equation estimation.

Table 6 and Table 8 show the OLS estimators of the parameters of the Mincer equation by using both the model-generated data and real data. The estimated return to education is around 7%, which is consistent with the empirical evidence. We also report a positive ability premium of the return to education: a high-ability agent's return to education is 20% higher than that of a low-ability agent. I normalize the intercept of the human capital production function in order to have a feasible number of grid points for the saving policy function.[14] Since I have two ability levels, each ability type intercept is normalized such that the difference of the intercepts of the Mincer equation according to ability type is similar in both the model and the data.

The parameter that identifies the externality of education, $\overline{\phi_1} = 0.0035$, is chosen such that the social return to education is around 0.35% above the private return. This value was reported as a lower bound for the US (Moretti, 2002), and I use this value as a proxy for the social return to education in Mexico.[15]

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[12]The standardized ability index goes from 0 to 1 and the median ability (0.45) is the threshold that identifies each ability type.

[13]From the FOC of the household problem when both the parent and the child are working, it is easy to show that the parent-child hours of work ratio is affected by the B_p/B_k ratio:

$$\frac{l_k}{l_p} = \left\{ \frac{B_p}{B_k} \frac{h_k E_k}{h_p E_p} \right\}^{\psi}$$

[14]The normalization of the ability parameter will affect only the model's units. Note that the efficiency units of time of a parent are represented by the following expression: $l\exp(\phi_{01} + \phi_{0i} + \phi_{11}s_p + \phi_{1i}s_p + \phi_2 x_p + \phi_3 x_p^2 + \ln e_p)$. After some arrangement I express this term by $l\exp(\phi_{01} + \phi_{0i})\exp(\phi_{11}s_p + \phi_{1i}s_p + \phi_2 x_p + \phi_3 x_p^2 + \ln e_p$. From the last expression, the term $\exp(\phi_{01} + \phi_{0i})$ may be normalized without loss of generality.

[15]Moretti (2002) reports that the social return to education in the US ranges from $0.6\% - 1.2\%$, above and beyond the private return to education. Since the private return to education was around 10%, the externality represents between 6% and 12% of the private return to education.

I assume the social return to education in Mexico is at the lower bound of the corresponding value for the US. Since the estimated private return to education in Mexico is around 7%, the value of the externality parameter is set at

I consider two levels of education. The first level comprises primary and secondary education and the second level includes tertiary education. The degree of substitution between these two schooling levels is measured by the elasticity of substitution $\frac{1}{1-\gamma} = 2$. This value is consistent with the estimated degree of substitution between these two schooling levels; however, in order to evaluate the robustness of this assumption I will perform, later, a sensitivity analysis considering different values of the elasticity of substitution.

The autoregressive coefficient and the standard deviation of the idiosyncratic productivity shock are similar for both parents and children, $\varphi = \varphi_p = \varphi_k = 0.65$ and $\sigma_\upsilon = \sigma_{\upsilon_p} = \sigma_{\upsilon_k} = 0.75$. These parameters are estimated from the residual of the Mincer regression (see Appendix B for details). Each of the idiosyncratic productivity processes is discretized to a 4-state discrete shock using an extension of the procedure described in Tauchen (1986) for multivariate processes. I set the correlation of the parent and child productivity shock, $\rho_{pk} = 0.685$, such that the intergenerational correlation of labor income (correlation of log-income of two consecutive generations) is around 0.5.[16]

The income tax rate is fixed at 7% so that the income tax revenue is around 5% of GDP. The education cost structure is chosen so that private spending on education is equivalent to 4% of household consumption (ENIG 1996). I consider the following education cost structure: $\cos t_p = 0.005$; $\cos t_s = 0.006$; $\cos t_{te} = 0.498$. This set of cost parameters, together with the utility cost of pursuing education ($\xi_{pr} = \xi_{se} = 0, \xi_{te} = 0.27$), helps us match the schooling levels of the Mexican adult population. I consider the education distribution of the adult population (25 years or older) reported by the Mexican Statistical Institute (INEGI) for 2000: 27% have completed primary education, 57.6% have some level of secondary education and 15.4% have some level of tertiary education.

I use the labor share parameters χ_1, χ_2 and the poverty line ($line$) to target both the inequality of household consumption and the poverty rate. The joint values of $\chi_1 = 0.25513$, $\chi_2 = 0.74487$ and $line = 0.101$ match the poverty rate (23%) and the inequality of household consumption (Gini=0.53) for 1996 (ENIG 1996).[17] Note that the value of the poverty line is consistent with the monetary value of the poverty line ($2 a day) that is used in Mexico to measure the poverty rate.[18]

In the baseline UCT model the anti-poverty policy is independent of school attendance; then, the previously described recursive representation of the model is modified in order to reflect this feature.[19] I denote

$\overline{\phi}_1 = 0.0035$ such that the social return to education is around 6% higher than the corresponding private return.

[16]We do not have an estimator for the intergenerational correlation of earnings in Mexico; however, there is a considerable literature that has measured this indicator for the US. According to Solon (2002), Aiyagari et al. (2001), and Restuccia and Urrutia (2002) the father's and son's earnings correlation in the US is somewhere between 0.4 and 0.65. I assume that in Mexico the intergenerational correlation between parent and child is around 0.5, close to the value estimated for the US.

[17]ENIG stands for the Mexican Household Survey of Income and Expenses (*Encuesta Nacional de Ingresos y Gastos)*

[18]The annualized value of the poverty line is around 730 US\$, which represents around 25% of per capita GDP of Mexico for the period 1990-1995. The value of the poverty line used in the model $(line = 0.101)$ represents around 30% of per capita GDP.

[19]In the UCT model the anti-poverty transfer, tr_{poor}, goes to the poor households' budget constraint either when the

Table 1: **Parameters of Baseline Solution**

Description	Parameter	Value
Preferences	β	0.916450
	σ	1.4
	B_p	30
	B_k	55
	ψ	0.30
Technology	z	1
Capital share	θ	0.33
Ph. capital depreciation	δ_k	0.065
Low skill labor share	χ_1	0.25513
Elasticity of substitution	$\frac{1}{1-\gamma}$	2.0
Productivity shock	$\rho_p = \rho_k$	0.65
	$\sigma_p = \sigma_k$	0.75
	ρ_{pk}	0.685
Human capital externality	ϕ_0^*	0.0037
	ϕ_{01}	$log(0.9/4)$
	ϕ_{02}	$log(1/4)$-$log(0.9/4)$
	ϕ_{11}	0.074
	ϕ_{12}	0.0118
	ϕ_2	0.022
	ϕ_3	-0.00027
Tax rate	τ	0.07
Number of types	N	2
Education expenses	$cost_{pr}$	0.005
	$cost_{se}$	0.006
	$cost_te$	0.498
Poverty line	$\underline{line}$	0.101

the unconditional transfer by tr_{poor}. I set tr_{poor} such that the government spends around 0.1% of GDP as part of its anti-poverty policy. Since the unconditional transfers are stochastic, similar to the CCT model, I set $tr_{poor} = 0.01$ if the household receives the unconditional transfer and $tr_{poor} = 0$ if the household does not. Each potential beneficiary of the unconditional program receives a positive transfer with 0.6 probability $(\eta = 0.6)$. The rationale of this choice will be explained below when we discuss the CCT calibration.

The discount factor, $\beta = 0.91645$, is consistent with a capital-output ratio equal to 3. Finally, we iterate over interest rate, wages, lump-sum transfer and average years of education in order to find the competitive equilibrium. This is supported by the following: $r = 4\%$, $w_1 = 0.2170$, $w_2 = 1.0292$, $tr = 0.0354$, and $\overline{S} = 9.96$. The lump-sum transfer, tr, helps to balance the government budget and the value of $\overline{S}$[20] is chosen

child is working or when he is studying. Note that this model still considers that tr_{poor} is stochastic, similar to the CCT model.

[20]The model does not consider illiteracy and incomplete primary education. The average years of education in 2002 for the whole population was 6.02 years (MxFLS 2002); however, excluding illiteracy and those individuals who do

such that the aggregate and individual years of education are consistent.

I summarize the moments generated by the model as well as the empirical moments in Table 2. The capital-output ratio, the consumption-output ratio and the taxes-output ratio represent the traditional moments that characterize the aggregate features of Mexico. I also show another set of indicators, such as consumption inequality and the poverty rate. From this table we can conclude that the baseline economy is a reasonable approximation of Mexico's economy.

Table 2: **Comparison of Baseline Model and Data Moments**

Moments	Data	Model
Capital / Output	3.00	3.14
Consumption / Output	0.80	0.80
Taxes / Output	5.0%	5.6%
Hours of work	0.40	0.39
Poverty rate	23%	24.1%
Gini (Consumption)	0.53	0.49
Education spending / Consumption	4.0%	3.1%
Correlation of parent-child income	0.50	0.485
Years of education	9.5	9.96
Education of adults		
Primary	27.0%	31.1%
Secondary	57.6%	53.9%
Tertiary	15.4%	15.1%

The CCT Model

I compute the CCT competitive equilibrium by using the parameters of the UCT solution. As stated before, the main difference between these two models is the anti-poverty transfers. In this section I discuss the calibration of the parameters that characterize the CCT model.

In the CCT model the anti-poverty transfer is represented by ctr. I set $ctr > 0$ for those who effectively receive the monetary transfer and $crt = 0$ for those who don't receive the transfer. I include two additional features of the Mexican program in order to make the CCT model more realistic. First, the Mexican CCT program differentiates between the amounts transferred according to the child's education level; those beneficiaries with a child in secondary education receive more transfers than those beneficiaries with a child attending primary school. I include this feature in the model by providing $ctr = tr_p$ for the former and $ctr = tr_s$ for the latter $(tr_s > tr_p)$. Second, the CCT program in Mexico does not provide transfers during the first two years of primary education. In the model, I set to zero the cash transfers during the first two years of primary education.

Three parameters need to be determined in the CCT model: tr_p, tr_s and η. The percentage of potential beneficiaries that receive cash transfers, η, is chosen such that the number of beneficiaries of the program

not complete a primary education, the average years of education was 9.5 years. The former is close to the model estimated average years of education: 9.96 years.

is around 5 million households (5% of Mexican households were covered by the CCT program in 2007, World-Bank (2009). With a value of $\eta = 0.6$ the CCT program covers around 8.0% of households nationwide.[21]

Meanwhile, with $tr_s = 0.043$ and $tr_p = 0.0172$ the model matches the aggregate amount that the government spent on this program, which is around 0.5% of GDP (World-Bank, 2009). Note that, consistent with the program in Mexico, the amount transferred to those beneficiaries with a child attending primary school is around 40% of the amount transferred for those beneficiaries with a child in secondary school. Table 3 summarizes the general equilibrium prices, transfers and other outcomes in both models.

The CCT competitive equilibrium is computed by iterating over prices, tax rate and average years of education. Contrary to the UCT model, in the CCT model we iterate over the tax rate in order to balance the government budget. Our assumption is that the CCT anti-poverty policy is mainly supported by tax revenues. Table 3 shows the CCT equilibrium.

4 Quantitative Results

4.1 Long-run effects

I measure the long-term effects of the CCT program by comparing the outcomes of both solutions. We consider that these effects are observable only when the policy is implemented continuously for several years. This suggests that there is a transition period before the full effects of the policy are observed as I will explain later when I describe the competitive transition.

First, the main channel by which the conditional cash transfers policy affects the economic outcomes in the long-run is through human capital accumulation. The human capital induced by the higher school attendance increases workers' productivity; as a result, the CCT model delivers more efficiency units of labor, compared with the UCT model, that act as a positive labor supply shock. In aggregate terms, this abundance of human capital causes a 6.8% increase in labor (in efficiency units), a 6.0% increase in physical capital and a 6.5% increase in output.

In terms of average years of education, it increases 1.1 years due to the CCT program. I find this amount higher than the values reported by the literature. Todd and Wolpin (2006), for example, report that, in the long-run, the conditional cash transfer program in Mexico may generate an increase of 0.54 years of the children's mean years of completed education at age 16. McKee and Todd (2009) simulate the long-term effects of a $0.6-$year increase in schooling attainment of the Mexican CCT program. Table 3 presents the main indicators that capture the long-term effects of the CCT program; I briefly discuss some indicators.

Poverty. CCT has stronger effects on poverty. The poverty rate decreases by 21.6% due to the effects of the CCT program. The driving force behind the reduction in poverty is the higher human capital induced by conditional transfers. Poor families are able to support their children at school by using the resources provided by the program. The children who participate in the program will accumulate more schooling, and

[21] The empirical value of the participation rate (η) is around 0.55. This value was used by Freije et al. (2006).

they will be more productive workers in the future. In the CCT model, the high productivity workers will have more labor income and they will be able to support more consumption, which in fact will reduce the poverty rate.

Inequality. The consumption Gini decreases 3.0%, from 0.485 to 0.470, due to the CCT program. The increase in low-income workers' productivity reduces income inequality. Similarly, both the skilled wage reduction and the unskilled wage increase also contribute to the reduction in income inequality. Note that the tax rate and interest rate changes may not be responsible for the reduction in inequality, since they affect the whole population equally. The modest reduction in the inequality induced by a CCT program in the long-run was also mentioned by McKee and Todd (2009).

Hours of work. The model predicts that people will work fewer hours due to the anti-poverty transfers. The results are consistent with some empirical evidence about the change in the allocation of time within the household induced by CCT. I find a small change in the parents' hours of work due to CCT (Table 3); however, I also find that the CCT program may cause a significant reduction in children's hours of work. The empirical counterparts of these results are consistent with our findings.

4.2 General equilibrium effects

I measure the general equilibrium effects as prices change due to the CCT program. Going from the UCT equilibrium to the CCT equilibrium, the interest rate increases 1.2%, the wage of unskilled agents increases 0.2% and the wage of skilled agents decreases 0.6%. Since these changes seem to be small, they may support the current view that states that the general equilibrium effects of the CCT program are small. However, these effects are in the long-run when the total effects of the program are observed. We can see from the estimated competitive transition[22] that the long-run effects of the program will be fully observed in two generations, with most of its effects happening during the lifetime of one generation, that is, 60 years after the introduction of the CCT program.

As I mentioned before, the current literature has pointed out that the general equilibrium effects of the Mexican type CCT program may not be significant enough, and a partial equilibrium analysis may be good enough to measure most of its economic effects (Todd and Wolpin (2006), McKee and Todd (2009)). Unfortunately, it is not supported by the model predictions.

Our model allows us to extend the study of the general equilibrium effects of the CCT program along the competitive transition. We may want to ask if there are differences among the short-term effects, the middle-term effects and the long-term effects of the CCT program. In this direction, I provide additional insights about the dynamics of the general equilibrium effects of the anti-poverty program along the competitive transition between the pre-program period and the final period in which the effects of the program are fully observed. From Figure 1 we can see that the change in prices along the transition are not monotonic, and the dynamics of prices are also not negligible, since we observe a lot of action during the following 60-70 years after implementation of the program.

[22] Appendix A describes the details of the computational procedure that I follow to find the competitive transition.

Table 3: **Long-term Effects of CCT**

	UCT	CCT	% Change
Human capital	0.748	0.798	6.7
Consumption	0.520	0.552	6.2
Hours parents	0.386	0.386	-0.02
Hours child	0.192	0.178	-7.3
Secondary enrollment rate	0.69	0.89	29.4
College enrollment rate	0.22	0.20	-7.4
Years of education	9.96	11.1	10.9
Education of adults	100.0%	100.0%	
Primary	31.1%	10.8%	-65.1
Secondary	53.9%	71.1%	32.0
Tertiary	15.1 %	18.0%	19.8
Poverty rate	24.1%	18.9%	-21.6
Gini	0.485	0.470	-3.0
CEV			0.85
Output	0.65	0.70	6.5
Capital	2.05	2.18	6.0
Labor	0.37	0.40	6.8
Prices			
Interest rate	0.0400	0.0405	1.2
Wage (Unskilled)	0.2170	0.2174	0.2
Wage (Skilled)	1.0292	1.0235	-0.6
Aggregate transfers			
Lump-sum transfer	0.0354	0.0354	
Anti-poverty transfer	0.0010	0.0035	
Tax rate	7.00%	7.46%	
Tax revenues	0.0364	0.0388	

CCT: Conditional on both poverty and schooling attendance.
UCT: Conditional on poverty only.

From Figure 3 I divide the transition of prices into three stages: short-term, mid-term and long-term. The first stage comprises the first 5 – 6 years. During this period, the wage of unskilled agents increases and the wage of skilled agents decreases. This price change is driven by the initial labor supply effects of the program; given that the program promotes attending school and reduces child labor, the relative scarcity of an unskilled labor force (child labor) in efficiency units pushes for an increase in the unskilled wage. This scarcity effect lasts only through the 5 initial years following the introduction of the program. Note that the wage of skilled and unskilled agents moves in opposite directions due to the imperfect substitution between these labor inputs.

The second stage is characterized by a wage reduction of poorly educated agents (reduction of wages between the 5th year and the 60th year) and a persistent increase in the average human capital that lasts for around 55 years. During this stage, the new generation of workers will gradually replace the previous generation; this may last for around 55 years, the length of time in which the current generation of workers will be fully replaced by the new generation of more educated workers. The third stage is mainly that of convergence to the new equilibrium; this period lasts for around 60 years.

The demographic feature of the model allows us to support the claim that the effects of the program will be fully absorbed during the lifetime of two generations after the introduction of the anti-poverty program. Since most of the increase in the population's schooling happens during the first 60 years after the introduction of the program, we may be able to observe most of the effects of the program in one generation. The direct implication of this finding from the policy perspective is that the CCT program may not deliver its main results in the short-run; even though the documented short-run effects of this program are extremely optimistic, its long-run effects may be even stronger.

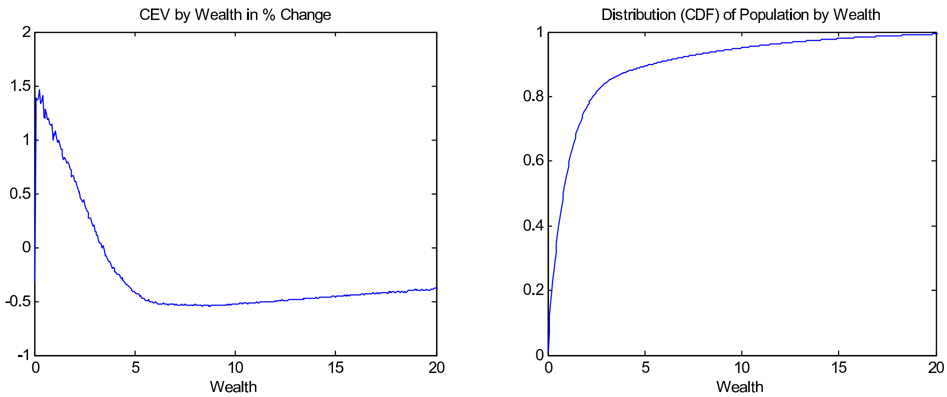
One interesting feature to mention is the evolution of the poverty rate along the competitive transition. Figure 3(i) shows that the poverty rate dynamic is not monotonic. It may increase a bit during the early periods right after the introduction of the conditional cash transfer program.[23] The driving force of this result is the increase in the tax rate (overshooting) that happens mainly during the early periods of the program. In our model the tax rate affects the whole population in the same proportion; some non-poor households may suffer a reduction in consumption due to the tax increase and eventually they may be poor. There is also a group of non-poor households that will become poor due to the tax rate increase; these agents may be characterized as being poor since their consumption levels are close to the poverty line threshold.

4.3 The welfare effects

Our approach follows the procedure for welfare analysis in models with heterogeneous agents implemented by Flodén (2001) and Heathcote (2005). I measure the welfare effects of the CCT program by the consumption equivalence variation (CEV), which is defined as the proportional change in consumption at each date and in each event needed to make a household indifferent between the stationary equilibria of two economies: the baseline stationary equilibrium in which there is no conditional cash transfers policy and the stationary equilibrium after the introduction of the conditional cash transfers program. The latter equilibrium is computed along the competitive transition between the two models. Figure 3 shows the competitive transition of some important variables of the model.

[23]This feature of the model may not be supported by empirical evidence since the poverty rate should decrease monotonically. The reason is that in our model CCT is supported by resources collected from a constant income tax rate that affects the whole economy in the same proportion.

Figure 1: **Consumption Equivalent Variation by Wealth (%)**



I estimate a CEV of 0.85%, which implies that on average households will be better off, in welfare terms, after the implementation of the CCT program. The main feature of the CEV is that there is significant heterogeneity in terms of the welfare effects of this program (Figure 1).

In general terms, there are two groups of households in terms of CEV. The first group is represented by those agents who may strongly support the implementation of the anti-poverty program; they report a positive CEV and they are characterized as low-income households (low wealth). We can also mention that they are the winners from this policy reform, since they will gain in welfare terms due to the introduction of the program. The welfare gain of this group of agents is driven by the general equilibrium effects induced by the anti-poverty program. Note that the forces that promote welfare gain are stronger than the ones that promote welfare loss. The driving forces that promote welfare gains are the following: the conditional transfer by itself may promote welfare gain by increasing the family's disposable income; the wage increase (unskilled wage increases right after the introduction of the program); the higher schooling level (externality) and the higher interest rate. On the other hand, the higher tax rate that supports the anti-poverty transfers may adversely affect some of the low-income agents. Note that the previous claim is true even for those low-income agents who are not direct beneficiaries of the program.

The second group of agents are those who will not support the implementation of the program; they report a negative CEV and they are the wealthiest households. These households are not allowed to participate directly in the anti-poverty program, since they do not qualify as beneficiaries; however, they are the most affected by the indirect general equilibrium effects induced by the CCT program (wage reduction, tax rate increase and interest rate increase). In net terms, the welfare gain induced by the interest rate increase is not strong enough to compensate for the welfare loss induced by the changes in wages and taxes. This feature of the welfare effects of the CCT program holds after controlling for the age of the household's child. From Figure 2 we see that the shape of the CEV is similar when the child is at the primary, secondary or tertiary level of education.

Can the government implement the CCT program with the support of the population? This is a political economy issue, since the introduction of the reform should have the support of the population in order to be successfully implemented. To deal with this question I estimate the percentage of persons who report a positive CEV. It is a measure of the number of agents who may vote in favor of the implementation of the CCT program if they are asked to vote on it. The model predicts that around 80% of the population faces a positive CEV; this means that under a democratic election, in which each individual has a vote, a policy reform that attempts to introduce a CCT program will be supported by majority rule. An interesting implication of this result is that the CCT program will have strong support among the population in the long-run, since our calculation is based on the competitive transition.

The computed welfare effect of the anti-poverty program is consistent with some results provided by the related literature. Coady and Lee-Harris (2001) and Coady and Lee-Harris (2004) show that after the implementation of the CCT program in Mexico, welfare increased by around 9%. Even though their welfare measure[24] is not strictly the same as the one used in this study, our reported welfare gains are qualitatively similar; however, our welfare change seems to be significantly smaller.

4.4 The intergenerational persistence of poverty: the poverty trap

In this section we deal with the question of whether children inherit poverty from their parents. More specifically, I study the degree to which the intergenerational persistence of poverty is affected by the anti-poverty CCT program.

Our claim is that the conditional cash transfers program reduces the intergenerational transmission of poverty by permanently breaking down the correlation between parent and child education in low-income households. I provide two indicators that support this claim. First, I compute the correlation of parent and child labor income (in logs). This correlation decreases 3%, from 0.485 to 0.470, due to the anti-poverty CCT policy (Table 4).

Table 4: **Intergenerational Transmission of Poverty: Correlation of Parent and Child Labor Income**

	UCT	CCT	% Change
$Corr[log(Inco_p), log(Inco_k)]$	0.485	0.470	-3.0%

Second, I compute the dynamic of poverty along the competitive transition for a simulated panel of households.[25] This simulation allows identifying the dynamic of poverty between consecutive generations. Results are provided in Table 5. We see that the poverty rate decreases 14% during the lifetime of the

[24] Following Deaton (1997), Coady and Lee-Harris (2004) use a welfare index ($\breve{W}$) as being the product of the mean level of consumption, $\breve{\mu}$, and the Atkinson measure of inequality $\breve{I}$: $\breve{W} = \breve{\mu}(1 - \breve{I})$.

[25] I simulate a panel of households of measure one. This panel is represented by the households of the baseline solution. I simulate the behavior of each of those agents along the competitive transition (200 years). In each period, we identify the poverty situation and the education level of each household member by using the previously estimated policy rules. Recall that the policy rules of the households along the transition are known, since they were previously estimated when I computed the competitive transition.

first generation (from 23.3% to 20%), and during the lifetime of the second generation, it will decrease an additional 6%. In terms of the transition of poverty status, the anti-poverty program promotes a significant reduction in the persistence of the poverty rate. Around 76% of descendants of those agents who were poor in the baseline equilibrium will leave poverty after four generations; a remarkable 94% of this poverty reduction occurs after one generation. Poorly educated parents tend to have educated children under the CCT model, as Table 9 shows; see how the distribution of adult education between consecutive generations changes when parents have access to the resources provided by the CCT program. Parents with a primary education will have children whose education level will be concentrated at the secondary and tertiary levels; better educated children will eventually escape from the poverty trap, which was previously induced by the low education level of their parents.

One interesting finding from the simulation is that the effects of the CCT program will be observed mainly during the first 60 years after the implementation of this policy, that is, during the lifetime of one generation. This result is consistent with this program feature. Recall that this program promotes the education of children, and we expect to observe its outcomes when these children become adults. This is when those educated children will become parents and when they will completely replace the old generation of workers. In Figure 3 I provide some evidence that shows how this substitution of workers between generations may work over time. During the first 60 years after the introduction of the policy, the average years of education increases monotonically, Figure 3(d); during this period the labor market is replacing those uneducated workers with the new generation of educated workers, who will gradually enter the labor market. After this policy has been implemented during the lifetime of one generation, this substitution is almost complete and the average years of education is almost stable around its new stationary equilibrium.

Table 5: **Distribution of Population According to Poverty Situation** (in % of Population)

	Baseline	2nd Generation		3th Generation		4th Generation	
	All	Poor	No-Poor	Poor	No-Poor	Poor	No-Poor
Poor	23.3	6.5	16.8	5.8	17.5	5.5	17.8
No-Poor	76.7	13.5	63.2	13.0	63.7	12.6	64.1
All	100.0	20.0	80.0	18.8	81.2	18.1	81.9

The baseline distribution represents the poverty status at period zero.
The 2nd generation represents the poverty status of the panel of individuals at period 60.
Similarly, the 3th and 4th generations correspond to periods 120 and 180, respectively.
/* Results correspond to a simulated panel of individuals along the competitive transition.

5 Summary

Conditional cash transfer programs are currently among the most popular anti-poverty policies in developing economies. In this paper, I use an extended version of the neoclassical growth model with heterogeneous agents to evaluate the economic effects of the Mexican-type CCT program in a general equilibrium framework. Our formulation captures the effectiveness of the program in some dimensions that were not previously documented. I evaluate the long-run effects of CCT in terms of poverty, income inequality, human capital and output. I also study the welfare implications of this program as well as its effects on the intergenerational transmission of poverty.

Our results reinforce the well-known positive outcomes of the Mexican-type conditional cash transfer program. The general equilibrium effects of this program are significant enough such that, in the long-run, the program delivers a remarkable increase in output (6.5%), human capital (6.7%), and years of education (10.9%), and a reduction in poverty (21.6%) and income inequality (3.0%). However, I also find that most of these effects may not be observable during the lifetime of the current generation, which implies that the long-term effects of this program are stronger than its short-term effects. This result is due to the demographic feature of the CCT program. The current generation of children, who will get more education as a result of the program, will fully replace the current generation of workers only after all of them die.

Regarding the welfare implications of this program, I find that the aggregate welfare effect is small (0.85%); however, the majority of households will gain in welfare terms after the implementation of the CCT program. Finally, poor parents are able to educate their children by using the resources provided by the CCT program. As a result, the intergenerational correlation of poverty decreases and the program will deliver a noticeable reduction in the poverty trap.

Summing up, the economy-wide effects of a CCT program are significant enough to encourage a long-term implementation of the program in developing economies in which the poverty rate is high.

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A Computing the Steady-State Solution and the Competitive Transition

Steps to compute the stationary competitive solution

- Choose an initial guess of the value function in period 30. Initialize parameters of the model: consider an initial set of prices (wage and interest rate), initial average years of education and an initial value of the lump-sum transfer.
- Solve the household's problem for the remaining periods by backward recursion. At period 29, for example, the value function of period 30 is given by the initial guess. In this step I use the first-order conditions of the household's problem to solve for hours of work. I use value function iteration with local search in order to solve for the household's optimal decision rules. The optimal policy rules are saving, consumption, parent hours of work, child hours of work and child's schooling decision.
- For the given set of prices, parameters and policy rules, solve for the stationary distribution. The stationary distribution is computed by the transition matrix method.
- Compute aggregate indicators (capital, labor), compute the marginal productivity conditions (marginal productivity of labor and capital) and the average years of education. Compare them with the initial prices and average years of education considered to solve the model (initial values).
- Iterate for a different set of prices, lump-sum transfers and average years of education until convergence, that is, when the competitive prices are equal to the corresponding marginal productivity conditions. I also iterate over the lump-sum transfer such that the government budget balances.

Steps to compute the competitive transition

- Compute both the baseline steady-state equilibrium (UCT model) and the final steady-state equilibrium (CCT model).
- Fix the length of the transition, say, T =200.
- Guess an initial path or sequence of the following: prices, tax rate and average years of education; denote them by: $\Phi^{old} = [r^{old}, w^{old}, tax^{old}, S^{old}]$.
- Given the final steady-state solution and the sequence of prices, tax rate and years of education, solve for the whole sequence of value functions and policy rules along the transition path by backward recursion.
- At $t = 0$ the stationary distribution corresponds to the baseline solution. Compute (update) the distribution at $t = 1$ by using the previously estimated policy rules and the baseline distribution. Following a similar updating procedure, estimate the distribution for each of the 200 periods.

- Given the distribution and policy rules for each period I calculate aggregate variables and the model-generated path of prices, tax rate and the average years of education. Denote them by: $\Phi^{new} = [r^{new}, w^{new}, tax^{mew}, S^{new}]$.

- Verify convergence criterion: stop if $\left|\Phi^{old} - \Phi^{new}\right| < \varepsilon$.

- If the convergence criterion does not hold, let $\Phi^{old} = 0.5(\Phi^{new} + \Phi^{old})$ and repeat the procedure from step 4 until the convergence criterion is reached.

B Estimation of Human Capital Production Equation

The human capital production function that we estimate is the standard Mincer[26] equation that relates the log of labor income per hour with schooling and experience $Log(H_t) = \phi_{01} + \phi_{02}Ab_t + \phi_{11}S_t + \phi_{12}S_tAb_t + \phi_2X_t + \phi_3X_t^2 + u_t$. I consider that this equation is different for high-ability and low-ability agents. Ab_t is a dummy variable that takes the value of one for high-ability agents and zero otherwise. Schooling denotes the years of education and experience denotes the individual's potential experience ($age - 6 - schooling$). I estimate the parameters of the Mincer equation by using the MxFLS household survey. This survey is a longitudinal survey with a panel structure available for 2002 and 2005. I use this survey since the panel structure allows estimating both the parameters of the Mincer equation and the parameters of the autoregressive process of the productivity shock. I proceed in two steps. First, I estimate the Mincer equation parameters by using standard OLS. Second, I use the estimated residuals of this first-step estimation in order to estimate the parameters of the autoregressive process. The first-step estimation is presented in Table 6.

The available information does not allow us to directly estimate the parameters of the autoregressive $AR(1)$ process. However, since we have information for two periods (2002, 2005) we may be able to estimate an auxiliary process, $AR(3)$, that will later be used to recover the parameters of the $AR(1)$ process. Our autoregressive process is the following $Log(\upsilon_t) = \varphi Log(\upsilon_{t-1}) + \varepsilon_t$, and the available data allow us to estimate the following process $Log(\upsilon_t) = \tilde{\varphi} Log(\upsilon_{t-3}) + \tilde{\varepsilon}_t$. From the latter equation I may recover our underlying parameters by using the following relationship between the two processes: $\varphi = \tilde{\varphi}^{1/3}$ and $\sigma_\varepsilon^2 = \frac{\sigma_{\tilde{\varepsilon}}^2}{1+\varphi^2+\varphi^4}$. Note that υ_t and υ_{t-3} are the residuals that were estimated from the first-step estimation of the Mincer equation. Table 7 shows the results of the second-step estimation (OLS).

[26] See Heckman et al. (2003) for an interesting review of the literature on the Mincer equation

Table 6: **Estimated Parameters of the Mincer Equation**

Log of labor income per hour		
$Log(H_t) = \tilde{\phi}_{01} + \tilde{\phi}_{02}Ab_t + \tilde{\phi}_{11}S_t + \tilde{\phi}_{12}S_tAb_t + \tilde{\phi}_2X_t + \tilde{\phi}_3X_t^2 + \upsilon_t$		
Constant	$\tilde{\phi}_{01}$	2.0921
		(0.0716)*
Ability	$\tilde{\phi}_{02}$	0.06179
		(0.06307)
Schooling	$\tilde{\phi}_{11}$	0.06970
		(0.00645)*
Schooling $*$ *Ability*	$\tilde{\phi}_{12}$	0.01457
		(0.00727)*
Experience	$\tilde{\phi}_2$	0.01602
		(0.00406)*
Experience^2	$\tilde{\phi}_3$	-0.00018
		(0.00008)*
Sample Size		4492
R^2		0.13

*/ Standard deviation in parenthesis.

OLS estimation from MxFLS 2002,2005.

Table 7: **Estimated Parameters of the Productivity Shock**

AR(3) Process	
$Log(\upsilon_t) = \tilde{\varphi}Log(\upsilon_{t-3}) + \tilde{\varepsilon}_t$	
$\tilde{\varphi}$	0.206
	(0.031)**
$\sigma^2_{\tilde{\varepsilon}}$	0.91
R^2	0.06

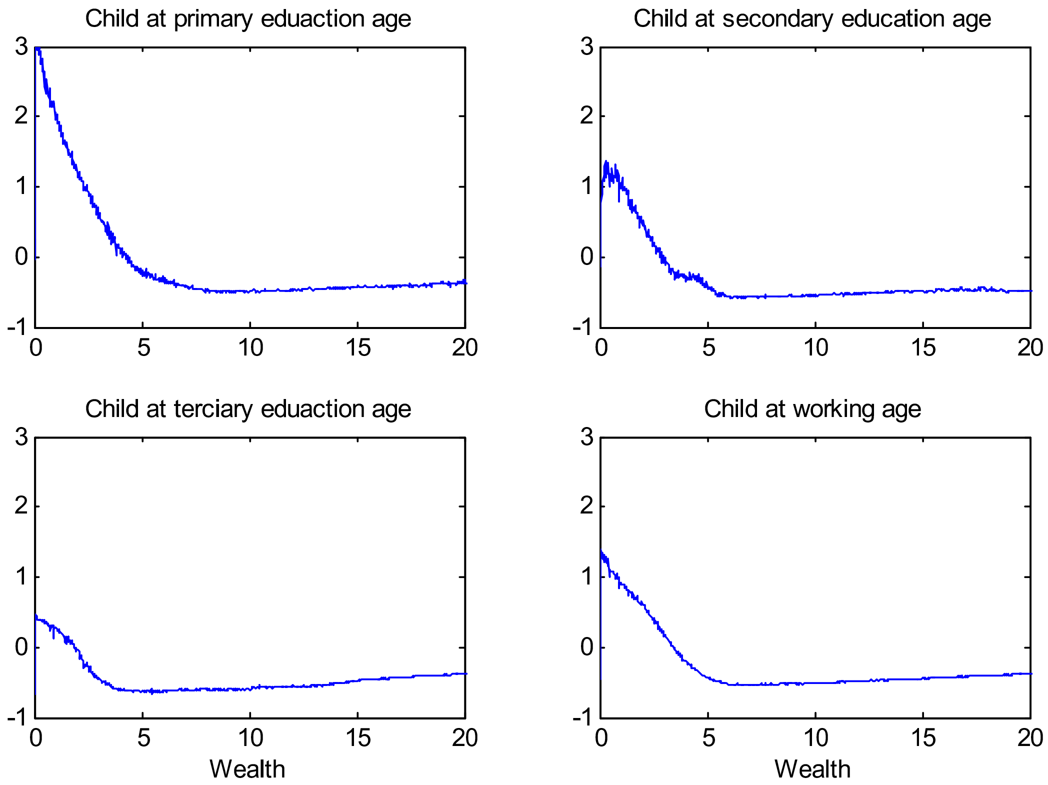
*/ Standard deviation in parenthesis.

Table 8: **Parameters of the Hourly Labor Income Mincer Equation**

Parameters	ϕ_{01}	ϕ_{02}	ϕ_{11}	ϕ_{12}	ϕ_2	ϕ_3
Model-generated values	-1.3630	0.0994	0.0693	0.0128	0.0150	-0.00016
Targeted values	-1.4917	0.0834	0.0697	0.0146	0.0162	-0.00018

C Welfare Effects of CCT: Consumption equivalence variation by wealth and age

Figure 2: **CEV in % Change by Child Age**



D The Competitive Transition Path

Figure 3: **Competitive Transition**

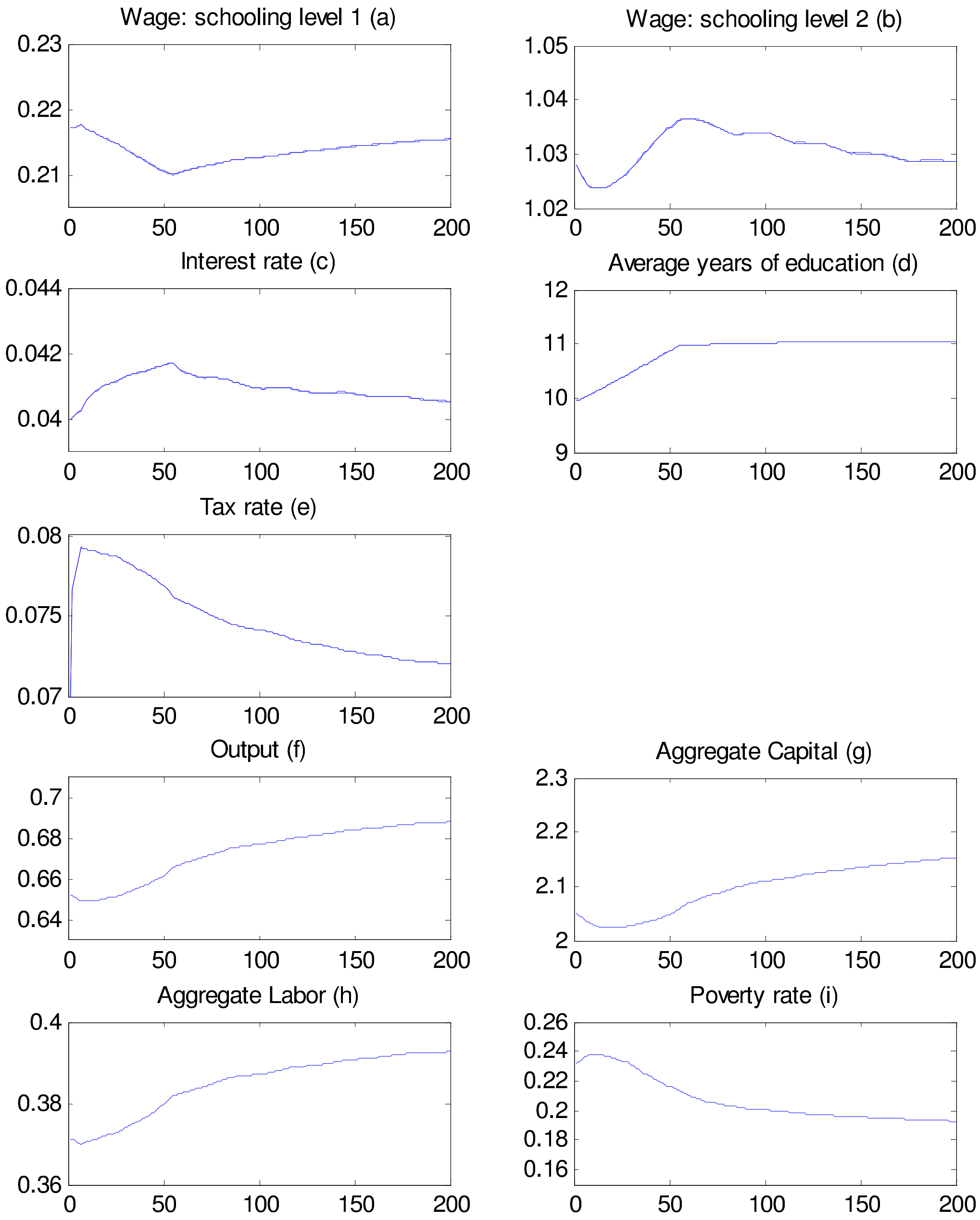


Table 9: **Distribution of Parents' Education According to Generations** (in % of Population)

	Baseline	2nd Generation			3th Generation			4th Generation		
Education	All	P	S	T	P	S	T	P	S	T
P	31.1	5.2	25.1	0.8	4.3	24.8	2.0	4.0	24.2	2.8
S	51.6	6.3	39.9	5.4	5.9	37.9	7.7	5.7	37.0	8.9
T	17.3	0.1	5.5	11.7	0.4	7.0	9.9	0.6	7.8	8.9
All	100.0	11.6	70.3	18.1	10.7	69.7	19.6	10.4	69.0	20.6

P: Primary education. S: Secondary education. T: tertiary education
The baseline distribution represents the distribution of parents' education at period zero.
The 2nd generation represents the education distribution of the panel of individuals at period 60.
Similarly, the 3th and 4th generations correspond to periods 120 and 180, respectively.
/* Results correspond to a simulated panel of individuals along the competitive transition.