Social Interactions and Optimal Consumption Under Conditional Cash Transfer Programs

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Abstract

The principal assumption of Conditional Cash Transfers (CCTs) is that poor families undervalue the education of their children (relevance), and as a consequence the recommended policy is that the optimal transfers should be close to the opportunity cost to send their children to the job market in order to incentivize them to accumulate human capital (effectiveness) and avoid consumption distortions (optimality). This paper evaluates the relevance, effectiveness, and optimality of the Conditional Cash Transfer programs. A model is developed using dynamic optimization to understand the family optimal decisions of accumulating human capital. The model takes into account social interactions and the uncertainty to drop out of the program. Using panel data from Oportunidades in urban areas (2002-2004), I estimate the parameters of the theoretical model. I find that: First, the assumption that poor families undervalue their childrens education is not generalizable, it was found only in 35% families. Second, the level of transfers is not effective with the families that undervalue the education of their children: 72% of these families have an opportunity cost bigger than the level of transfers. Finally, optimal consumption is distorted by the uncertainty to drop out of the program and by the social interactions effect.

JEL Classification: D1; I21; I38; O12

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1 Introduction.

The implementation of Progresa-Oportunidades in Mexico was one of the first social programs to have a positive impact on the accumulation of human capital and created the opportunity for many families to get out of poverty. According to many studies, the success of the program was due to the system of giving transfers conditional on accumulating human capital, more commonly known as Conditional Cash Transfers (CCTs). Specifically, families were required to send their children to school and go to health services in order to receive the cash transfers. This mechanism was implemented in more than 29 countries and the evaluations of these programs reported that the CCTs worked as a good incentive for the accumulation of human capital.

Though Oportunidades is by and large considered a successful program, there were concerns about the potential effectiveness of the program prior to its implementation. From a theoretical standpoint, Oportunidades violated the Carte Blanche principle which states that consumers are always better off receiving an unconstrained cash transfer than a conditional cash transfer of equal money (Pfouts, 1977). From an implementation standpoint, there were concerns about three aspects related to the transfers. The first concern was relevance: do families actually undervalue the education of their children? The use of conditional cash transfers is necessary if this is the case. The second concern was effectiveness, in essence, what level of transfers was necessary to incentivize the families to send their children to school. The third concern was optimality: what level of transfers does not affect the intertemporal consumption of the families? In relation to relevance, the argument in favor of Conditional Cash Tranfers was that poor families have persistent incorrect beliefs about the returns to education for their children (Jensen, 2010) and thus it was necessary to condition the transfers in order to increase the demand for schooling. With respect to effectiveness and optimality, the argument was that the level of transfers should be set close to the opportunity cost of the families to send their children to the job market in order to avoid consumption distortions (Levy, 2005).

In the end, empirical evaluations showed that the program Oportunidades had important impacts on education, health and nutrition (Behrman, 2006). And, at the time, this put to rest the concerns about Oportunidades and showed that the condition on transfers worked as an incentive for improving human capital accumulation.

However, new empirical results put CCTs under new scrutiny. In terms of relevance, the CCTs do not work as well in urban areas (Boullion, 2007). In terms of effectiveness, the level of transfers do not seem to matter (Benhassine, 2012), and furthermore unconditional cash transfers also have positive effects on education (Edmonds, 2009). Finally, in relation to optimality, there is a lack of evidence about effects on the intertemporal consumption decisions.

This paper asks three questions. First, what factors determine whether poor families value or undervalue the education of their children (relevance problem)? Second, is the mechanism to fix transfers to be equal to the opportunity cost (measured as the possible salary in the market for the children) an effective incentive? And finally, does the level of transfers have any effect on the intertemporal consumption decisions of the families (optimality problem)?

In order to answer these questions, we need to control for two aspects that can affect the family decisions: social interactions and operational factors related to the program. In terms of social interactions, Martinelli (2007) shows a trend that families underreport durable goods inside their homes and overreport goods linked with social status. This finding opens the hypothesis that families' decisions take into account the interactions with other members of the community. In relation to the operational aspect, the population that the program should attend to is poor people but the condition of poverty can change over time. In this sense, the program uses a process called recertification which applies a non-monetary proxy of poverty to identify whether a family remains poor and should continue participating in the program. This proxy of poverty is based principally on socioeconomic and geographical factors, but also possession of durable goods (fridge, television, etc.). Recertification creates the potential incentive that families under-accumulate durable goods in order to avoid losing transfers from the program.

To analyze the relevance, effectiveness and optimality of CCTs, I solve a dynamic optimization model that incorporates the following characteristics. First, in every period, families compare their opportunity cost to the level of transfers and decide whether to continue participating or not. In addition, families maximize their utility function differentiating between durable and non-durable consumption goods. This utility function takes into account the consumption of durable and nondurable goods of other members of their community (i.e. families care about their social status). Finally, uncertainty is incorporated and measured as the probability of dropping out of the program conditional on the accumulation of durable goods (process of recertification). After solving the model, I estimate the parameters of the model, particularly those related with social interactions and the parameters of the utility function. In order to do this, I use panel data from the CCT Oportunidades in Mexico from 2002-2004 in urban areas.

The rest of the paper is organized as follows. In Section 2, I present the basic environment of the model and the equilibrium results. In Section 3, the data, empirical strategy and results are presented and Section 4 concludes.

2 The Model

I now introduce the environment of the model and the intertemporal consumption decision problem faced by the families.

2.1 The environment

Families live four periods. In the first 3 periods, families analyze the transfers offered by the government and they decide on their participation.[1] The families can decide when to drop out of the program; however, once they decide to drop out, they are not able to enter again. In the last period (4th period), the program is not offered and the families do not face the trade off between the opportunity cost and the level of transfers.

There are two types of goods in the economy that generate utility to the families: Non durable consumption goods ($\hat{c_t}$) and durable consumption goods ($\hat{k_t}$). The non durable consumption goods only generates utility in one period. Durable goods can generate utility for many periods, but depreciate at rate δ. The families produce some goods inside the house ($\bar{c_t}^h$) (the technology is explained below) but these goods do not give utility though they are necessary for the existence of the family. Finally, the families take into account the mean consumption of non durable and durable goods for the other families $\left(\bar{c_t}, \bar{k_t}\right)$. Families gain utility if their own consumptions are above the mean consumption of their community. The utility function is separable and is as follows (Abel, 2003):

$$U\left(\bar{c_t}, \hat{c_t}, \bar{k_t}, \hat{k_t}\right) = \left[\frac{1}{1-\alpha}\left(\frac{\hat{c_t}}{\bar{c_t}^n}\right)^{(1-\alpha)} + \frac{\phi}{1-\alpha}\left(\frac{\hat{k_t}}{\bar{k_t}^n}\right)^{(1-\alpha)}\right] \quad ;\alpha \geq 0; \phi \geq 0; 0 \leq n \leq 1$$

The family has two endowments of labor (which are fixed): Adult labor ($\bar{N}^A$), and child labor ($\bar{N}^c$). Adult labor can be used in the market (L_t^m) or in the house (L_t^h). Child labor can be used only in the market (l_t^c). Thus, families choose either to send their children to work or to school. In relation to assets, the household can buy two kinds of assets: capital ($\bar{k_t}^h$) which only serves to produce $\bar{c_t}^h$ (basic goods inside the house) and does not give utility directly, as well as savings (s_t) which generate an interest rate (r_t).

There are 5 prices given in the economy: price of non durable goods ($p_t{}^c$), price of durable goods ($p_t{}^k$), price of capital goods ($P_t{}^k$), interest rate of savings (r_t), and adult's salaries (w_t^A). The agents know with probability one the prices for goods and capital from period t to t+1 [2].

[1] In Mexico, basic education is normally divided in three stages: primary school (primaria), comprising grades 1-6; junior high school (secundaria), comprising grades 7-9; and high school (preparatoria), comprising grades 10-12. We can think of the 3 periods of the model as the completion of each step. However, the principal results are not altered by the number of periods.

[2] This avoids introducing uncertainty due to prices and allows me to focus on the uncertainty related to the probability of exiting the program.

Table 1: Estimates of children's salary

t=1	t=2	t=3	t=4	
$\underline{w}$	$\underline{w}$	$\underline{w}$	$\underline{\text{w}}$	No participate
	$(1+r)\underline{w}$	$(1+r)\underline{w}$	$(1+r)\underline{w}$	Participate in the first period
		$(1+r)^2\underline{w}$	$(1+r)^2\underline{w}$	Participate two periods
			$(1+r)^3\underline{w}$	Participate 3 periods

Finally, the salaries for adults are fixed in the 4 periods: $w_t^A = \bar{w} \ \ \forall t$.

Every year the families determine the expected returns to their childrens' education (r), according to the following possibilities (see table 1). If families decide not to participate in the program, they will get a salary for their children of $\underline{w}$ for the 4 periods. If they decide to participate in period t and drop out in the next period, the payments for their children are zero until period t, and (1+r)$^t\underline{w}$ in the next periods. Note that r is a parameter that is only known by the families.

The families face an opportunity cost for the labor of their children (w_t^c). The opportunity cost is determined as a function of the expected return to education. For example, a family that takes a decision in the first period of sending their children today to the job market will get an income of $4\underline{w}$ and will lose the benefit of $(1+r)^3\underline{w}$ for being in the program until period three. So, the opportunity cost is $\underline{w}$(4-(1+r)^3). Notice that if 4>(1+r)^3, the family has a positive opportunity cost and has incentive to send their children to the labor market today. However, if 4<(1+r)^3, the family has a negative opportunity cost and this family has no incentives to send their children to the labor market.

Regarding technology, the $\bar{c_t}^h$ (consumption inside house) is produced by a traditional Cobb-Douglass function, that is: $\bar{c_t}^h \leq f\left(\bar{k_t}^h, L_t^h\right)$. This technology observes decreasing returns to scale, and capital depreciates completely every period. Furthermore, if the families produce more goods than necessary ($\bar{c_t}^h$), they can sell them to the market and get a profit π_t. Otherwise, if they produce less than necessary, they need to pay the difference using market income resources.

Finally, there is a Conditional Cash Transfer program that works for 3 periods. Households will receive a transfer (T_t) if and only if $l_t^c = 0$ (i.e. it is assumed that households send their children to school and they do not work in the house) and if they are poor ($\underline{P}$). The government decides to remove families from the program (recertification process) if the government determines that they are no longer poor, $\underline{P}$. Families do not know the level of $\underline{P}$, but they know that the government can see their accumulation of durable goods and that these are taken into account to determine $\underline{P}$. As a consequence, the probability of dropping out of the program (not receive anymore the transfers) is a conditional probability based on the observed level of durable goods ($\hat{k_t}$). I assume this distribution is uniform (the government assigns the same probability to each family being analyzed) and conditional (the families can affect the probability to be detected by the government), such that:

$$\hat{k}_t \in \left[0, \bar{\bar{k}}\right];$$
$$Pr\left(T_t = 0 \mid \hat{k}_t\right) = \frac{\hat{k}_t}{\bar{\bar{k}}};$$
$$\frac{\partial Pr\left(T_t = 0 \mid k_t\right)}{\partial \hat{k}_t} = \frac{1}{\bar{\bar{k}}};$$
$$where\ \ \bar{\bar{k}}\ \ is\ \ the\ \ maximum\ \ level\ \ of\ \ durable\ \ goods.$$

2.2 The dynamic problem

Under this environment, we are able to define the dynamic problem that families face:

Definition 1. An equilibrium for the households in this economy is a sequence of households decisions involving allocations $\left\{\hat{c}_t, \hat{k}_t, L_t^m, l_t^c, s_t\right\}_{t=1}^4$, decisions to participate in the program $\{\alpha_t\}_{t=1}^3$, production decisions $\left\{\bar{c}_t{}^h, L_t^h, \bar{k}_t{}^h\right\}_{t=1}^4$, government decisitions $\{T_t, \underline{P}\}_{t=1}^3$, a system of prices and opportunity cost $\left\{p_t^c, p_t^k, P_t^k, w_t^A, w_t^c, r_t\right\}_{t=1}^4$ and the mean of the consumption for nondurable and durable goods for the community $\left\{\bar{c}_t, \bar{k}_t\right\}_{t=1}^4$, such that, once the prices p_t^c, w_t^A and P_t^k are revealed, the families decide how much to produce inside the household solving:

$$\begin{aligned} \pi_t = \max \quad & p_t^c \bar{c}_t{}^h - w_t^A L_t^h - P_t^k \bar{k}_t{}^h \\ \text{s.t. } \bar{c}_t{}^h \quad \leq \quad & f\left(\bar{k}_t{}^h, L_t^h\right) \\ \bar{c}_t{}^h \quad > \quad & 0. \end{aligned}$$

Then, families solve the following utility maximization problem:

$$\max \sum_{i=0}^{4} \beta^t \log U\left(\bar{c_t}, \bar{k_t}\hat{c_t}, \hat{k_t}\right)$$

subject to:

$$p_t^c \hat{c_t} + p_t^k[\hat{k_t} - (1-\delta)\hat{k_{t-1}}] + s_t \leq w_t^A L_t^m + (1-\alpha_t) w_t^c L_t^c + (1+r_t)s_{t-1} + \alpha_t T_t + \pi_t$$

$$\hat{k_1} = \hat{k^0}$$

$$s_0 = \underline{s}$$

$$s_4 = 0$$

$$\alpha_t = \begin{cases} 1 & \text{if } w_t^c \leq T_t \;\; \textit{and} \;\; Pr(T_t > 0 \mid \hat{k_t}) < \underline{P}; \\ 0 & \text{if } w_t^c > T_t \;\; \textit{or} \;\; Pr(T_t = 0 \mid \hat{k_t}) \geq \underline{P} \end{cases}.$$

And finally, household resources clear:

$$L_t^m + L_t^h = \bar{N}_A \quad \forall t$$

$$\bar{k_t}^h = s_{t-1} \quad \forall t.$$

2.3 Key theoretical results.

Once I solve the dynamic problem, the first result is associated with the question of relevance: CCTs work in environments where the families undervalue the education of their children. However, *Result 1* points out that it happens when the expected returns to education are relatively low.

Result 1: Relevance (see Appendix 1 for derivation). The opportunity cost is positive (i.e. families undervalue the education of their children) when the returns associated to education are close to zero. The assumption of CCTs (the opportunity cost equals the actual salary for the children in the market) is only satisfied when the rate of return to education is equal to zero.

I now turn to the key result of this paper. It characterizes the intertemporal consumption decisions once we control for social interactions and the probability of dropping out of the program. Furthermore, this results is a mechanism for calculating the opportunity cost of the families using information on prices, transfers, and consumption of durable and non durable goods. Finally, using this result, it is possible to evaluate the effectiveness of the actual mechanism for setting up transfers in Oportunidades.

Result 2: Effectiveness (see Appendix 2 for derivation). The intertemporal consumption decision of durable goods ($\hat{k_t}$) is inversely affected by the level of transfers (T_t) and also is determined by the ratio of the social interactions effect $\left(\frac{\bar{k_t}}{\bar{c_t}}\right)^n$, and is given by:

$$\hat{k_t} = \left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}} + \frac{\partial Pr(T_t=0|k_t)}{\partial k_t}(T_t - w_t^c)} \right]^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n} \hat{c}_t; \quad for \;\; t < 4 \quad (2.1.)$$

Notice that under this environment families face two kind of distortions: the social interactions that work as an externality and the probability of dropping out of the program which works as a tax. The next result is promising in the sense that it show us that under some circumstances it is possible to recover the competitive equilibrium (i.e. the optimal intertemporal consumption without distortions). Unfortunately this solution is not unique.

Result 3: Optimality (see Appendix 3 for derivation). Under the presence of social interactions and the probability of dropping out of the program, there is a combination of prices and transfers which is equivalent to the prices and transfers without distortions, and this condition is given by:

$$\left[\frac{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}} - \frac{\partial Pr(T_t=0|k_t)}{\partial k_t}(w_t^c - T_t)}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}}} \right]^{1/\alpha} = \left[\frac{\bar{k_t}}{\bar{c_t}} \right]^n \qquad (2.2.)$$

Finally, the following result give us an analytical solution for the demand of durable, nondurable goods and for the structure of savings.

Result 4. (see Appendix 4 for derivation). There exists an analytical solution for $\hat{k_t}$ and $\hat{c}_t$. Furthermore, the savings are determined as a linear function of past savings.

2.4 Relevance, effectiveness and optimality without Social Interactions.

Using results 1-4, we are able to analyze the relevance, effectiveness and optimality of the CCTs. We can see these graphically (see figure 1). First, using equation (2.2) from result 3, the left part of this equation (the relation of prices, transfers and opportunity cost) is set up on the vertical axe and the right side of the equation (social interactions) is set up on the horizontal axe. When they are equal, from Result 3, we know that the result is similar to that without distortions. This is represented with a 45 degree line called "optimality". Also, notice that upward and to the left of this line the families underaccumulate durable goods, and downward and to the right the families overaccumulate durable goods. Using this graph, we are also able to represent the level of transfers. This level is equal to the salary of sending their children to the job market ($T_t = \underline{w}$), which is the mechanism used by Oportunidades. This is represented by the line “Transfers”. We know that the CCTs satisfy relevance when the families undervalue the education of their children ($w_t^c > 0$), this is represented by the horizontal line called “relevance”. Finally, I assume that there are not social interactions (n=0) and it is represented by the vertical line called “Social interactions”.

The first aspect to notice is that when the families determine the opportunity cost equal to the salary of sending the children to the job market (it happens when the expected return to education is zero), fixing the transfers equal to this opportunity cost is relevant, efficient and optimal. This is the environment of CCTs and it is represented at point A (see figure 1). It is relevant because it attends the families that undervalue the education of their children, it is effective because it works as an incentive to discourage the families to send their children to the market, and finally, it is optimal because the distortion due to the process of recertification is eliminated.

However, that is a particular case. Point B (see figure 1) shows a family with positive opportunity cost but less than the salary of sending their children to the market. In this case, the transfers are relevant, effective, but not optimal. This is a consequence of the process of recertification, in effect, it works as a “tax” increasing the relative price of durable goods.

In the case of the families with negative opportunity cost (point D, figure 1), the transfers are effective, but not relevant nor optimal. The transfers are effective because the families will choose to participate because the transfers are bigger than the opportunity cost. However, they are not relevant, because these families do not undervalue the education of their children. Also, the value of the transfers could be zero and they will still send their children to the school. Furthermore, the transfers are not optimal. Notice that these families under accumulate durable goods, because they pay a bigger “tax” to drop out of the program as a consequence of the process of recertification.

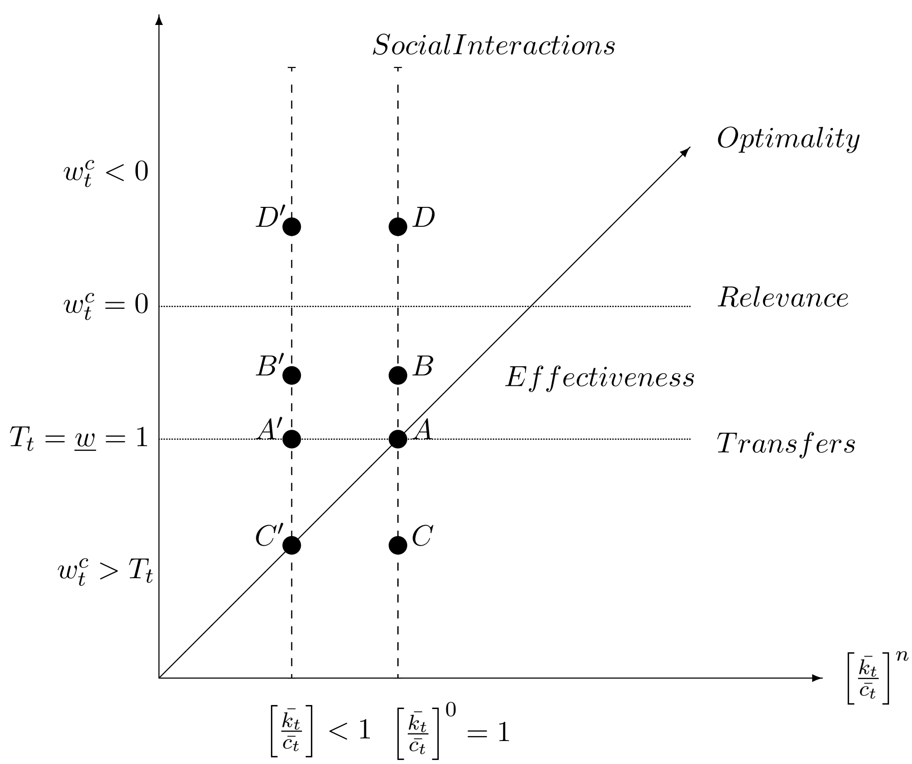
Finally, consider the case of a family that decides to participate in the program but the opportunity cost is greater than the level of transfers (point C). In this case, these families look for a compensation and they overaccumulate durable goods. In the next period it is possible that this families will drop out because they consume more durable goods and the probability of dropping out of the program increases.

To sum up, if the assumptions of CCTs are satisfied (i.e. there is no social interactions and the families calculate the opportunity cost as the present salary for sending the children to the job market), then fixing the transfers equal to this salary is relevant, efficient and optimal (point A). However, if the opportunity cost of the families is less than the value of the present salary (point B and D), families underaccumulate durable goods and this is reinforced as much as the families value the education of their children. Finally, for the families with opportunity costs bigger than the value of the present salary (which are part of the group of families that the program wants to attend), the probability of dropping out of the program increases as a result of the overaccumulation of durable goods.

Notice that these results are generated by the process of recertification. Once this process is eliminated, the distortions in the relative prices are also eliminated and the families (independent of the value of their opportunity cost) will converge to the optimal point (point A). However, the problems of relevance (incentives for people with negative opportunity cost to participate in the program) and effectiveness (families with a higher opportunity cost than the level of transfers) persist. I summarize this in Finding 1.

Finding 1. When there are no social interactions (n=0), eliminating the process of recertification, reestablishes the optimality in the consumption decisions of the families, independent of their opportunity cost. However, problems of relevance and effectiveness still persists.

Figure 1. Relevance, effectiveness and optimality of CCTs.



2.5 Relevance, effectiveness and optimality with Social Interactions

The introduction of social interactions has two negative consequences in relation to our previous section. First, when the opportunity cost of the families is equal to the present salary of sending their children to work, fixing transfers equal to this salary is no longer optimal. Furthermore, the elimination of the process of recertification improves the accumulation of non durable goods, but this is not enough to return the families to the optimal trend. I will explain these results below.

Under the absence of social interactions, the value of the elasticity to social interactions was equal to zero (n=0); however, under the presence of social interactions it can be non zero. To simplify the analysis, suppose that it is equal to one. Then assume that, in the case of poor families, the number of durable goods is less than the number of nondurable goods, which implies that $\left[\frac{\bar{k}_t}{\bar{c}_t}\right] < 1$. This is drawn in figure 1.

When families determine the opportunity cost equal to the salary of sending their children to the job market, fixing the transfers equal to this opportunity cost is relevant, efficient, but is no longer optimal. This is the environment of CCTs and it is represented in point A' (see figure 1). This result is because the families compare the ratio of their consumption of durable goods and non durable goods to the mean ratio of other poor families. In this sense their "aspirations" to accumulate durable goods is lower.

Furthermore, notice that under the process of recertification, the families with opportunity cost less than the salary of their children (B' and D') still continue underaccumulating durable goods, and additionally this underaccumulation is now reinforced by the process of social interactions. Once we eliminate the process of recertification, it is possible to improve the welfare of these families (they will increase their consumption of durable goods); however, the optimal equilibrium is not recovered. This is summarized in finding 2.

Finding 2. When there are social interactions and fixing the transfers equal to the salary of sending their children to the job market, eliminating the process of recertification increases the consumption of durable goods, but does not reestablish the optimality in the consumption decisions of the families.

However, there is a possibility to recover optimality using result 3. Notice that this result gives a combination of prices and transfers such that, given social interactions, we can return the families to the optimal intertemporal consumption. Another important aspect to notice is that the level of transfers can be altered by the government under the recertification process and this will affect the intertemporal consumption decisions. If a family over accumulates durable goods, the government can reduce their consumption of durable goods by increasing the level of transfers. This is because families value the transfers more, and they will try to avoid dropping out of the program. On the other hand, if families under accumulate durable goods, the government can increase their consumption of durable goods, reducing the level of transfers. Unfortunately, notice that in some cases, to recover optimality, we require the use of negative transfers which limits the use of this mechanism. This is summarized in finding 3.

Finding 3. Under the presence of social interactions and the recertification process, it is possible to return the families to the optimal intertemporal consumption decisions. When the families are over accumulating durable goods the best response should be, surprisingly, to increase the level of transfers. On the other hand, if the families are under accumulating durable goods, the best response is to reduce the level of transfers.

3 Empirical results.

3.1 Data and empirical strategy.

To analyze relevance, effectiveness and optimality, I need to have a measure of the opportunity cost. The opportunity cost can be estimated using equation (2.1.) from result 2, and it is given by:

$$w_t^c = \left[\bar{\bar{k}}\left(p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}} - z\right) + T_t\right] \qquad (3.1.)$$

$$where\ \ z\ \ is : z = p_t^c\left[\frac{\hat{c}_t}{\hat{k}_t}\frac{\bar{k_t}^n}{\bar{c_t}^n}\phi^{\frac{1}{\alpha}}\right]^{\alpha}$$

For estimating this equation I have information about the transfers, interest rate and depreciation[3]. However, I need information on prices for durable goods p_t^k and non durable goods p_t^c, an index for durable goods $\hat{k}_t$ and nondurable goods $\hat{c}_t$, and the parameters α, ϕ, and n.

To build prices for durable p_t^k and non durable goods p_t^c and an index for durable goods $\hat{k}_t$ and nondurable goods $\hat{c}_t$, I use the Panel Data 2002 -2004 from Oportunidades in urban areas. It consists of 3 rounds: 2002 was the baseline, and two post-program rounds (one in 2003 and the other in 2004). In addition to the treatment and control group, the database has a group that was eligible but decided not to participate in the program. So, the database has information of 4,651 families in the treatment group, 2,556 families that were eligible but decided not to participate and 10,834 families that serve as a control group.

I utilize the fact that this panel contains information for more than 30 non durable goods and 10 durable goods and their prices. Based on this information, I use Principal Component Analysis, which is a technique that reduces information exploiting the variability of the data, and which is appropriate in this context to generate the indexes needed. The indexes for durable and non durable goods were built per family and the prices per year. The estimation is explained in Appendix 5 and the results are presented in table 2 [4]. The index for non durable goods goes from 0 to 30 and

[3] I use a depreciation rate of .05 and the interest rate used was the intrahouseholds interest rate reported by Banco de Mexico: 8.21 in 2002, 7.02 in 2003 and 7.44 in 2004.

[4] These results are for the full sample.

the index of durable goods goes from 0 to 10 [5]. I observe the following trends. First, a reduction in the index price for durable goods, from 4,170 in 2002 to 4,085 in 2003 and ending in 4,024 in 2004. Second, an increase in the index of consumption of durable goods; the average increase from 3.09 in 2002 to 3.60 in 2003 and finally 3.80 in 2004. Third, a permanent increase in the index of price of non durable goods: 14.54 in 2002, 14.89 in 2003 and 15.65 in 2004. And lastly, the average of the index of consumption of non durable goods increased from 2002 to 2003 (17.67 to 18.07). However, I observe a decrease from 2003 to 2004 (18.07 to 17.76).

Table 2: Main results based on Principal Component Analysis

Variable	**N**	**mean**	**sd**	**min**	**max**
Nondurable goods 2002	17201	17.67	5.14	0.00	30.00
Durable goods 2002	17201	3.09	1.94	0.00	10.00
Price non durable goods 2002	17201	14.54	0.00	14.54	14.54
Price durable goods 2002	17201	4170.59	0.00	4170.59	4170.59
Nondurable goods 2003	16148	18.07	5.19	0.00	30.00
Durable goods 2003	16149	3.60	1.75	0.00	10.00
Price non durable goods 2003	18041	14.89	0.00	14.89	14.89
Price durable goods 2003	18041	4085.32	0.00	4085.32	4085.32
Nondurable goods 2004	15030	17.76	5.09	0.00	30.00
Durable goods 2004	15028	3.80	1.77	0.00	10.00
Price non durable goods 2004	17023	15.65	0.00	15.65	15.65
Price durable 2004	17023	4024.66	0.00	4024.66	4024.66

I then calculate the parameters α, ϕ, and n. These parameters are structural (preferences and social interactions), so I am able to calculate them using the data from the control group, which hypothetically has the same preferences as those families in the treatment group. Another advantage is that the families in the control group did not face the process of recertification and it facilitates the estimation of the parameters. So the equation of interest is:

$$\hat{k_t} = \left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}}} \right]^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n} \hat{c}_t; \qquad (3.2.)$$

Also, notice that we have information for prices of durable goods p_t^k and non durable goods p_t^c as well as indexes for durable goods $\hat{k_t}$ and nondurable goods $\hat{c_t}$ which were estimated using Principal Component Analysis. Furthermore, taking logs we can estimate this as a linear function:

[5] Then I will add 2 durable goods per family and we can think of them as the original durable goods of the families.

$$In\hat{k_t} - In\hat{c_t} = \frac{1}{\alpha} In \left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}}} \right] + In\phi^{\frac{1}{\alpha}} + nIn\frac{\bar{k_t}}{\bar{c_t}}; \qquad (3.3.)$$

To estimate the parameters of this model, I run a Pooled OLS, a Fixed Effect model and Random Effect model. The results are presented in table 3. When I compare FE vs RE using a Hausman test, it supports the use of FE (Prob>Chi2=0.0191). Then, I used a F-test comparing the Pooled OLS results with that of Fixed Effects, we did not reject the null hypothesis, so fixed effects are not present. This implies that we can use Pooled. Furthermore, the parameters estimated under Pooled are according to our theoretical model (the constant term did not vary for individuals as FE assumes). Finally, using the results for Pooled, I recover the structural parameters of the model which are reported in table 4.

Table 3: Estimation of the model parameters

	POOLED	FE	RE
log prices	0.108	0.097	0.101
	(0.033)	(0.033)	(0.033)
log ratio soc. int.	1.082	0.788	1.075
	(0.051)	(0.209)	(0.051)
constant	0.463	0.093	0.434
	(0.132)	(0.254)	(0.131)
N. of cases	8798	8798	8798

p - values in parentheses

Table 4: Structural parameters

$\alpha =$	9.25	Elasticity of utility
$\phi =$	72.43	Additional utility for consumption of durable goods
$n =$	1	Benchmark with respect consumption of community

3.2 Results.

To estimate the opportunity cost, I use the 2003 database. I find that 4,651 families reported receiving some transfers from Oportunidades; however, only 2,881 mentioned having children in the school which were the families that I decided to analyze. The main descriptive statistics are shown in Table 5. It is observed that the mean of non durable goods are 19 units and the mean of durable goods are 5.43. In relation to the ratio of durable- non durable goods the mean is 0.32. In relation to the transfers, the mean is around 604 pesos.

Table 5: Descriptive Statistics for families that receive transfer from Oportunidades in 2003

Variable	**N**	**mean**	**sd**	**min**	**max**
Non durable	2881	19.07	4.18	0.81	30.00
Durable	2881	5.43	1.46	2.00	11.48
Transfers	2881	604.05	302.36	300.00	1795.00
Ratio	2881	0.32	0.02	0.28	0.39

Then, I calculate the opportunity cost using equation (3.1.). Notice that now we have information for all the variables: prices for durable p_t^k and non durable goods p_t^c, an index for durable goods $\hat{k}_t$ and nondurable goods $\hat{c}_t$ and the parameters α, ϕ, and n. I normalize a 12 month period of transfers, which cancels with the value of the conditional probability (1/12 durable goods), and the equation is given by:

$$w_t^c = \left[p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}} - z + T_t\right] \qquad (3.4.)$$
$$where \;\; z \;\; is : z = p_t^c \left[\frac{\hat{c}_t}{\hat{k}_t}\frac{\bar{k_t}^n}{\bar{c_t}^n}\phi^{\frac{1}{\alpha}}\right]^{\alpha}$$

Now, I identify the families with positive and negative opportunity cost using equation (3.4). The results are reported in Table 6. According to these results, a considerable percentage of the families enrolled in Oportunidades, do not satisfy relevance: The majority of the families (64.39%) have a negative opportunity cost. This goes against the idea that the poor families undervalue the education of their children, at least in urban areas. This implies that for these families the transfer could be zero and they will still send their children to school.

The next question is: How effective is Oportunidades with the people that have a positive opportunity cost? The answer is: not much. There are 35.61% families that have a positive opportunity cost. However, in this population, we observe that the transfers only cover the opportunity cost from 28.07% of the families, so 71.93% are not covered by the transfers. As a consequence, with the actual level of transfers, the program is in reality not so effective with their target population (see Table 6).

Finally, I analyze optimality. Notice that our results support the presence of social interactions (n=1). The consumption of durable goods is calculated under social interactions and the presence of the process of recertification. Then I simulate what would be the consumption of durable goods once the process of recertification is eliminated. And finally, I calculate the optimal value of consumption of durable goods (once we eliminate the effects of the process of recertification and the

Table 6: Families by Opportunity Cost

Variable	Freq.	Percent	Cum.
Opportunity Cost negative	1,855	64.39	64.39
Opportunity Cost positive	1,026	35.61	100.00
- Opportunity Cost positive: Transfers are effective	288	28.07	28.07
- Opportunity Cost positive : Transfers are not effective	738	71.93	100.00

effects of social interactions). The results are presented in table 7.

The first aspect to notice is that with the actual scheme (the transfers equal to the possible salary of the children in the job market) the families that are more affected are those that value more the education of their children. The mean of durable goods for the families with negative opportunity cost is 4.86. The mean of the families with positive opportunity cost and that the transfers cover it is 6.19. Finally, in the case of the families that the transfer is less than their opportunity cost, the mean is 6.55.

Then, I calculate what happens when the process of recertification is eliminated. In this case the most benefited families are those that most value the education of their children. Their consumption of durable goods increase from 4.86 to 7.05. In the case of the families that have an opportunity cost and are covered by transfers, I find that their consumption of durable goods increases from 6.19 to 6.46. Finally, for the families whose opportunity cost is bigger than the level of transfers, I observe a reduction in their consumption of durable goods from 6.55 to 5.32. This result is strongly related with the predictions of our theoretical model: The families that more value the education of their children invest less in the accumulation of durable goods in order to avoid being dropped out of the program. Once the process of recertification is eliminated, they are the most benefited.

Finally, we should notice that eliminating the mechanism of recertification is not able to return the families to their level of optimal consumption of durable goods. Once the effects of social interactions is eliminated the consumption of durable goods should be around 22 durable goods for families with opportunity cost negative and 20 for families with positive opportunity cost (see table 7).

To sum up, when there are social interactions and transfers are fixed to equal to the salary of sending their children to the job market, eliminating the process of recertification increases the consumption of durable goods, but it does not reestablish the optimality in the consumption decisions of the families. Indeed, this is the exact prediction of the theoretical model.

Table 7: Analysis of Optimality

Variable	N	mean	sd	min	max
Families with Opportunity Cost negative					
Dur. Goods: Optimal	1855	22.06	3.73	8.50	31.77
Dur Goods: After Eliminate Recertification	1855	7.05	1.19	2.72	10.16
Dur Goods: Actual	1855	4.86	1.25	2.00	8.47
Families with positive Opportunity Cost less than the transfers					
Dur. Goods: Optimal	738	16.64	4.26	0.87	32.24
Dur Goods: After Eliminate Recertification	738	5.32	1.36	0.27	10.31
Dur Goods: Actual	738	6.55	1.28	2.00	11.48
Families with negative Opportunity Cost and the transfers cover it					
Dur. Goods: Optimal	288	20.21	3.43	9.70	30.52
Dur Goods: After Eliminate Recertification	288	6.46	1.09	3.10	9.76
Dur Goods: Actual	288	6.19	1.06	2.96	9.61

4 Conclusions.

The theoretical model develop in this paper shows the following. First, in relation to relevance, it is possible that families under value the education of their children. However, this can happen when the expected return to education is close to zero or negative. If the return on education is bigger than 1, families face a negative opportunity cost of sending their children to work. Therefore, these families value the education of their children. Second, in relation to the effectiveness, when the families face a negative opportunity cost of sending their children to work, transfers are not needed because they still will send their children to school. Third, in relation to the optimality, the process of recertification generates an under accumulation of durable goods, which affects mostly the families that more value the education of their children. The process of under accumulation of durable goods is also reinforced as a consequence of social interactions. And fourth, the model shows that it is possible to return the families to the optimal intertemporal consumption decisions. When families over accumulate durable goods the best response should be, surprisingly, to increase the level of transfers. On the other hand, if the families under accumulate durable goods, the best response is to reduce the level of transfers. However, this mechanism implies for some cases the use of negative transfers which is an aspect that limits their use as a mechanism to recover the optimality consumption decisions.

Moreover, the empirical results strongly support the theoretical conclusions. First, in terms of relevance, I find that the assumption that the poor families undervalue their children's education is not generalizable: 65% have a negative opportunity cost. Second, in relation to the effectiveness, the level of transfers is not so effective with the families that have positive opportunity cost: 72% of these families have an opportunity cost bigger than the level of transfers. Finally, in relation to optimality, I simulated the elimination of the process of recertification and found that the families with negative opportunity cost will increase their consumption from 4.86 to 7.05 units of durable goods. In the case of the families with positive opportunity cost, their consumption of durable goods will increase from 6.19 to 6.46. However, the effect of social interactions puts them significantly far from the potential level of accumulation of durable goods which is around 20 units.

Finally, these results have consequence in terms of public policy:

a) CCTs appear to work well in rural areas but not in urban areas (Boullion, 2007). This aspect is related to how the families determine their opportunity cost. It could be possible that the families in rural areas undervalue the education of their children, but it appears that this is not the case for the majority in urban areas. Under this environment, CCTs are not an appropiate policy.

b) In relation to the fact that the level of transfers appears not to be effective (Benhassine, et.al, 2012), the families that value the education of their children have a negative opportunity cost which implies that the transfers could be equal to zero and they will still send their children to school. In this sense, I explain why the level of transfers may not be effective.

c) Regarding optimality, the presence of the process of recertification generates distortions in the intertemporal consumption between durable and non durable goods. It could be necessary to discuss the possibility of eliminating this process. By doing this, it is possible to increase the consumption of durable goods; however, under the presence of social interactions, it is not possible to recover the optimal equilibrium.

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Appendix 1.

Result 1. Notice that, salaries for children are fixed in the first period and the families calculate the wage of their children's opportunity cost using the value they assign to returns of education (r) and their decisition to participate in the program (α_t), according to this rule:

$$w_t^c = \begin{cases} w_1^c = \underline{w}\left[4 - \left(1+r\right)^3\right)\right] \\ w_2^c = \underline{w}\left(1+r\right)\left[3 - \left(1+r\right)^2\right)\right] \\ w_3^c = \underline{w}\left(1+r\right)^2\left[2 - \left(1+r\right)\right)\right] \\ \end{cases}$$

In order that $w_1^c \geq 0$ (i.e. the families have a positive opportunity cost), it is necessary that $r \leq 0.58$ for period 1. In period 2, the rate of return in order that they have a positive opportunity cost should be $r \leq 0.73$, and finally, in period 3, it should be $r \leq 1$. These results shows that the possibility that the families undervalue the education of their children is when the rate of return on education is very low in the period of analysis. Also notice that in the case of CCTs the assumption is that $r = 0$, i.e. the case when the opportunity cost is positive and equal to the salary of the children in the market.

Appendix 2. *Result 2.* From A.2., if $\bar{c_t}^h = \bar{k_t}^{h^a}\bar{L_t}^{h^b}$ where a+b<1 we get:

$$\bar{L}_t^h = \frac{P_t a}{\bar{w}}\bar{c_t}^h$$

$$\bar{k}_t^h = \frac{P_t b}{P_t^k}\bar{c_t}^h$$

$$\bar{c}_t^h = \left(\frac{P_t a}{\bar{w}}\right)^{\frac{a}{1-a-b}}\left(\frac{P_t b}{P_t^k}\right)^{\frac{b}{1-a-b}}$$

Define $\Pi_t = p_t^c\left[\bar{c_t}^h - \bar{c}\right] - w_t^A L_t^h - P_t^k\bar{k_t}^h$, we can rewritte the utility maximization problem as:

$$\max \sum_{i=0}^{4} \beta^t \left[\frac{1}{1-\alpha} \left(\frac{\hat{c_t}}{\bar{c_t}^n} \right)^{(1-\alpha)} + \frac{\phi}{1-\alpha} \left(\frac{\hat{k_t}}{\bar{k_t}^n} \right)^{(1-\alpha)} \right]$$

subject to:

$$P_t^c \hat{c}_t + P_t^k [\hat{k_t} - (1-\delta)\hat{k_{t-1}}] + s_t \leq Pr\left(T_t = 0 \mid k_t\right)[\bar{w}L_t^m + w_t^c L_t^c + (1+r_t)s_{t-1} + \Pi_t] +$$
$$Pr\left(T_t > 0 \mid k_t\right)[\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t]\,; for \quad t = 1, 2, 3.$$
$$P_4^c \hat{c}_4 + P_4^k [\hat{k_4} - (1-\delta)\hat{k_3}] \leq \bar{w}L_4^m + w_4^c L_4^c + (1+r_4)s_3 + \Pi_4; for \quad t = 4.$$
$$\hat{k_1} = \hat{k^0}$$
$$s_0 = \underline{s}$$
$$s_4 = 0$$

Define λ_t as the lagrange multiplier for the four budget set restrictions, we have:

First Order Conditions:

$[\hat{c_t}] : \beta^t \left(\frac{\hat{c_t}}{\bar{c_t}^n} \right)^{-\alpha} - \lambda^t p_t^c = 0; for \quad t = 1, 2, 3, 4.$

Notice that:

$$\begin{aligned}
&Pr\left(T_t = 0 \mid k_t\right)[\bar{w}L_t^m + w_t^c L_t^c + (1+r_t)s_{t-1} + \Pi_t] + Pr\left(T_t > 0 \mid k_t\right)[\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t] \\
&= Pr\left(T_t = 0 \mid k_t\right)[\bar{w}L_t^m + w_t^c L_t^c + (1+r_t)s_{t-1} + \Pi_t] + [\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t] \\
&- Pr\left(T_t = 0 \mid k_t\right)[\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t] \\
&= [\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t] + Pr\left(T_t = 0 \mid k_t\right)[w_t^c L_t^c - T_t]
\end{aligned}$$

This implies:

$$\begin{aligned}
&\frac{d}{dk_t} Pr\left(T_t = 0 \mid k_t\right)[\bar{w}L_t^m + w_t^c L_t^c + (1+r_t)s_{t-1} + \Pi_t] + \frac{d}{dk_t} Pr\left(T_t > 0 \mid k_t\right)[\bar{w}L_t^m + T_t + (1+r_t)s_{t-1} + \Pi_t] \\
&= \frac{d}{dk_t} Pr\left(T_t = 0 \mid k_t\right)[w_t^c L_t^c - T_t]
\end{aligned}$$

Using this result we get:

$\left[\hat{k_t}\right] : \beta^t \left(\phi \frac{\hat{k_t}}{\bar{k_t}^n} \frac{1}{\bar{k_t}^n} \right)^{-\alpha} - \lambda^t \left[p_t^k - \frac{dPr(T_t=0|k_t)}{dK_t} \left(w_t^c l_t^c - T_t \right) \right] + (1-\delta)\,\lambda^{t+1} p_{t+1}^k$ for t=1,2,3.

$\left[\hat{k_4}\right] : \beta^4 \left(\phi \frac{\hat{k_4}}{\bar{k_4}^n} \frac{1}{\bar{k_4}^n} \right)^{-\alpha} - \lambda^4 p_4^k = 0; for \quad t = 4.$

$[\hat{s_t}] : -\lambda^t + \lambda^{t+1}\left(1 + r_{t+1}\right) = 0$

Finally notice that:

$$\hat{k_4} = \left(\frac{p_4^c}{p_4^k}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_4}^n}{\bar{c_4}^n} \hat{c_4}; for \quad t = 4.$$

And:

$$\hat{k_t} = \left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}} - \frac{\partial Pr(T_t=0|k_t)}{\partial k_t}(w_t^c - T_t)}\right]^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n} \hat{c_t}; for \quad t < 4.$$

Q.E.D.

Appendix 3

The Result 3 is obtained when we compare the intertemporal decision consumptions with distortions and that without distortions.

$$\left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}} - \frac{\partial Pr(T_t=0|k_t)}{\partial k_t}(w_t^c - T_t)}\right]^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n} \hat{c_t} = \left[\frac{p_t^c}{p_t^k - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}}}\right]^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \hat{c_t}$$

Appendix 4

Result 4.

Using *Result1* and the budget constraint we solve for $\hat{k_t}$ and $\hat{c_t}$:

For t=4:

$$\hat{k_4}\left(\hat{k_3}, s_3\right) = \frac{\left(\frac{p_4^c}{p_4^k}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_4}^n}{\bar{c_4}^n}}{p_4^c + p_4^k \left(\frac{p_4^c}{p_4^k}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_4}^n}{\bar{c_4}^n}} \left[\bar{w} L_4^m + w_4^c l_4^c + (1+r_4) s_3 + \pi_4 + p_4^k (1-\delta) \hat{k_3}\right]$$

$$\hat{c_4}\left(\hat{k_3}, s_3\right) = \frac{\bar{w} L_4^m + w_4^c l_4^c + (1+r_4) s_3 + \pi_4 + p_4^k (1-\delta) \hat{k_3}}{p_4^c + p_4^k \left(\frac{p_4^c}{p_4^k}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_4}^n}{\bar{c_4}^n}}$$

For $t \leq 3$:

$$\hat{k_t}\left(\hat{k_{t-1}}, s_{t-1}, s_t\right) = \frac{\left(\frac{p_t^c}{p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}}(w_t^c - T_t)}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n} \left[\bar{w}L_t^m + T_t + (1+r_t)\, s_{t-1} + \pi_t + p_t^k (1-\delta)\, \hat{k_{t-1}} - s_t\right]}{p_t^c + \left(\frac{p_t^c}{p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}}(w_t^c - T_t)}\right)^{\frac{1}{\alpha}} \left[p_t^k - \frac{1}{\bar{\bar{k}}}\left(w_t^c l_t^c - T_t\right)\right] \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n}}$$

$$\hat{c_t}\left(\hat{k_{t-1}}, s_{t-1}, s_t\right) = \frac{\bar{w}L_t^m + T_t + (1+r_t)\, s_{t-1} + \pi_t + p_t^k (1-\delta)\, \hat{k_{t-1}} - s_t}{p_t^c + \left(\frac{p_t^c}{p_t^k - (1-\delta)\frac{{P_{t+1}}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}}(w_t^c - T_t)}\right)^{\frac{1}{\alpha}} \left[p_t^k - \frac{1}{\bar{\bar{k}}}\left(w_t^c l_t^c - T_t\right)\right] \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n}}$$

Notice that in order to find the sequences of values for for $\hat{k_t}$ and $\hat{c_t}$ we need to solve for the values of s_t, before using the FOC for solving the intertemporal decisions on savings define:

$$P^c_{(t,t+1)} = p^c_t + \left(\frac{p^c_t}{p^k_t - (1-\delta)\frac{P_{t+1}{}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}}\left(w^c_t - T_t\right)} \right)^{\frac{1}{\alpha}} \left[p^k_t - \frac{1}{\bar{\bar{k}}}\left(w^c_t l^c_t - T_t\right)\right] \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n}; for \;\; t<4.$$

$$P^c_{(4)} = p^c_4 + p^k_4 \left(\frac{p^c_4}{p^k_4}\right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_4}^n}{\bar{c_4}^n}$$

$$\hat{\beta} = \beta^{\frac{1}{\alpha}}$$

$$(1+\hat{r_t}) = (1+r_t)\frac{\bar{c_t}^{n(\alpha-1)}}{\bar{c_{t-1}}^{n(\alpha-1)}} \left(\frac{p^c_{t-1}}{p^c_t}\right)^{\frac{1}{\alpha}} \left(\frac{p^c_{(t,t+1)}}{p^c_{(t-1,t)}}\right); for \;\; t<4.$$

$$(1+\hat{r_4}) = (1+r_4)\frac{\bar{c_4}^{n(\alpha-1)}}{\bar{c_3}^{n(\alpha-1)}} \left(\frac{p^c_3}{p^c_4}\right)^{\frac{1}{\alpha}} \left(\frac{p^c_{(4)}}{p^c_{(3)}}\right)$$

So, using the FOC on savings, the buget set and Result1 we get:

For s=1:

$$\hat{\beta}\left(1+\hat{r_2}\right) = \frac{\bar{w}L^m_2 + T_2 + (1+r_2)\,s_1 + \pi_2 + p^k_2(1-\delta)\,\hat{k_1} - s_2}{\bar{w}L^m_1 + T_1 + (1+r_1)\,s_0 + \pi_1 + p^k_1(1-\delta)\,\hat{k_0} - s_1} \quad (1)$$

For s=2:

$$\hat{\beta}\left(1+\hat{r_3}\right) = \frac{\bar{w}L^m_3 + T_3 + (1+r_3)\,s_2 + \pi_3 + p^k_3(1-\delta)\,\hat{k_2} - s_3}{\bar{w}L^m_2 + T_2 + (1+r_2)\,s_0 + \pi_2 + p^k_2(1-\delta)\,\hat{k_1} - s_2} \quad (2)$$

For s=3:

$$\hat{\beta}\left(1+\hat{r_4}\right) = \frac{\bar{w}L^m_4 + w^c_4 l^c_4 + (1+r_4)\,s_3 + \pi_4 + p^k_4(1-\delta)\,\hat{k_3}}{\bar{w}L^m_3 + T_3 + (1+r_3)\,s_2 + \pi_3 + p^k_3(1-\delta)\,\hat{k_2} - s_3} \quad (3)$$

Define:

$$z_t = \bar{w} L_t^m + w_t^c l_t^c + \pi_t$$

$$z_t^T = \bar{w} L_t^m + T_t + \pi_t$$

$$P_t = \frac{\left(\frac{p_t^c}{p_t^k - (1-\delta) \frac{{P_{t+1}}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}} \left(w_t^c - T_t \right)} \right)^{\frac{1}{\alpha}} \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n}}{p_t^c + \left(\frac{p_t^c}{p_t^k - (1-\delta) \frac{{P_{t+1}}^k}{1+r_{t+1}} - \frac{1}{\bar{\bar{k}}} \left(w_t^c - T_t \right)} \right)^{\frac{1}{\alpha}} \left[p_t^k - \frac{1}{\bar{\bar{k}}} \left(w_t^c l_t^c - T_t \right) \right] \phi^{\frac{1}{\alpha}} \frac{\bar{k_t}^n}{\bar{c_t}^n}}$$

$$P_{(t+1,t)} = \frac{p_{t+1}^k (1-\delta)}{P_t}$$

We start to calculate s_3, from (3):

$$z_4 + (1 + r_4)\, s_3 + p_4^k (1 - \delta)\, \hat{k_3} = \beta (1 + r_4) \left[z_3^T + (1 + r_3)\, s_2 + \right] + p_3^k (1 - \delta)\, \hat{k_2} - s_3$$

$$z_4 - \beta (1 + r_4)\, z_3^T = -(1 + \beta)(1 + r_4)\, s_3 + \beta (1 + r_4)(1 + r_3)\, s_2 - p_4^k (1 - \delta)\, \hat{k_3} + \beta (1 + r_4)\, p_3^k (1 - \delta)\, \hat{k_2}$$

Subst. k_3:

$$z_4 - \beta (1 + r_4)\, z_3^T = -\left[(1 + \beta)(1 + r_4) - P_{(4,3)} \right] s_3 + \left[\beta (1 + r_4)(1 + r_3) - P_{(4,3)} (1 + r_3) \right] s_2$$
$$+ \left[\beta (1 + r_4) - P_{(4,3)} \right] p_3^k (1 - \delta)\, \hat{k_2}$$

Subst. k_2:

$$z_4 - \left[\beta (1 + r_4) - P_{(4,3)} \right] z_3^T + \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} z_2^T = -\left[(1 + \beta)(1 + r_4) - P_{(4,3)} \right] s_3$$
$$+ \left(\left[\beta (1 + r_4)(1 + r_3) - P_{(4,3)} (1 + r_2) \right] - \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} \right) s_2$$
$$+ \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} (1 + r_2)\, s_1$$
$$+ \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} p_2^k (1 - \delta)\, \hat{k_1}$$

Subst. k_1:

$$z_4 - \left[\beta (1 + r_4) - P_{(4,3)} \right] z_3^T + \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} z_2^T - \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} P_{(2,1)} z_1^T =$$
$$- \left[(1 + \beta)(1 + r_4) - P_{(4,3)} \right] s_3$$
$$+ \left(\left[\beta (1 + r_4)(1 + r_3) - P_{(4,3)} (1 + r_2) \right] - \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} \right) s_2$$
$$+ \left(\left[\beta (1 + r_4)(1 + r_3) - P_{(4,3)} (1 + r_2) \right] P_{(3,2)} - \left[\beta (1 + r_4) - P_{(4,3)} \right] P_{(3,2)} P_{(2,1)} \right) s_1$$

$+\left[\beta\left(1+r_4\right)-P_{(4,3)}\right]\left(1+r_1\right)s_0$
$+\left[\beta\left(1+r_4\right)-P_{(4,3)}\right]P_{(3,2)}P_{(2,1)}p_1^k\left(1-\delta\right)\hat{k_0}$

We can restate the last expresion as:

$$A_3=\gamma_3^3 s_3+\gamma_3^2 s_2+\gamma_3^1 s_1+\gamma_3^0 s_0+\gamma_3^{k_0}\hat{k_0}$$

So:

$$s_3=-\frac{A_3}{\gamma_3^3}+\frac{\gamma_3^2}{\gamma_3^3}s_2+\frac{\gamma_3^1}{\gamma_3^3}s_1+\frac{\gamma_3^0}{\gamma_3^3}s_0+\frac{\gamma_3^{k_0}}{\gamma_3^3}s_{k_0} \qquad (3.1.)$$

Now, we calculate s_2 from (2):

$$z_3^T+\left(1+r_3\right)s_2+p_3^k\left(1-\delta\right)\hat{k_2}=\beta\left(1+r_3\right)\left[z_2^T+\left(1+r_2\right)s_1+p_2^k\left(1-\delta\right)\hat{k_1}-s_2\right]+s_3$$

$z_3^T-\beta\left(1+r_3\right)z_2^T=-\left(1+\beta\right)\left(1+r_3\right)s_2+\beta\left(1+r_3\right)\left(1+r_2\right)s_1-p_3^k\left(1-\delta\right)\hat{k_2}+\beta\left(1+r_3\right)p_2^k\left(1-\delta\right)\hat{k_1}+$
s_3

Subst. k_2:

$z_3^T-\left[\beta\left(1+r_3\right)-\left(1-\delta\right)P_{(3,2)}\right]z_2^T=-\left[\left(1+\beta\right)\left(1+r_3\right)-P_{(3,2)}\right]s_2+\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]\left(1+r_2\right)s_1$
$+\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]p_2^k\left(1-\delta\right)\hat{k_1}+s_3$

Subst. k_1:

$z_3^T-\left[\beta\left(1+r_3\right)-\left(1-\delta\right)P_{(3,2)}\right]z_2^T+\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]P_{(2,1)}z_1^T=$
$-\left[\left(1+\beta\right)\left(1+r_3\right)-P_{(3,2)}\right]s_2$
$+\left(\left[\beta\left(1+r_3\right)\left(1+r_2\right)-P_{(3,2)}\left(1+r_2\right)\right]-\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]P_{(2,1)}\right)s_1$
$+\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]P_{(2,1)}\left(1+r_1\right)s_0$
$+\left[\beta\left(1+r_3\right)-P_{(3,2)}\right]P_{(2,1)}P_{(2,1)}p_1^k\left(1-\delta\right)\hat{k_0}$

We can restate the last expresion as:

$$A_2=\gamma_2^2 s_2+\gamma_2^1 s_1+\gamma_2^0 s_0+\gamma_2^{k_0}\hat{k_0}+s_3$$

Subst. s_3 and rearranging terms, we get:

$$s_2 = \frac{A_2+\frac{A_3}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} - \frac{\gamma_2^1+\frac{\gamma_3^1}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} s_1 - \frac{\gamma_2^0+\frac{\gamma_3^0}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} s_0 - \frac{\gamma_2^{k_0}+\frac{\gamma_3^{k_0}}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} k_0 \quad (2.1.)$$

Finally, we calculate s_1 from (1):

$$z_2^T + (1+r_2)\, s_1 + p_2^k (1-\delta)\, \hat{k_1} = \beta (1+r_2) \left[z_1^T + (1+r_1)\, s_0 + p_1^k (1-\delta)\, \hat{k_0} - s_1 \right] + s_2$$

$$z_2^T - \beta (1+r_2)\, z_1^T = -(1+\beta)(1+r_2)\, s_1 + \beta (1+r_2)(1+r_1)\, s_0 - p_2^k (1-\delta)\, \hat{k_1} + \beta (1+r_2)\, p_1^k (1-\delta)\, \hat{k_0} + s_2$$

Subst. k_1:

$$\begin{aligned} & z_2^T - \beta (1+r_2)\, z_1^T + P_{(2,1)} z_1^T = \\ & - \left[(1+\beta)(1+r_2) - P_{(2,1)} \right] s_1 \\ & + \left[\beta (1+r_2) - P_{(2,1)} \right] (1+r_1)\, s_0 \\ & + \left[\beta (1+r_2) - P_{(2,1)} \right] p_1^k (1-\delta)\, \hat{k_0} + s_2 \end{aligned}$$

We can restate the last expresion as:

$$A_1 = \gamma_1^1 s_1 + \gamma_1^0 s_0 + \gamma_1^{k_0} \hat{k_0} + s_2$$

Subst. s_2 and rearranging terms, we get:

$$s_2 = \frac{\left(A_1 - \frac{A_2+\frac{A_3}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)}{\left(\gamma_1^1 - \frac{\gamma_2^1+\frac{\gamma_3^1}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)} s_1 - \frac{\left(\gamma_1^0 - \frac{\gamma_2^0+\frac{\gamma_3^0}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)}{\left(\gamma_1^1 - \frac{\gamma_2^1+\frac{\gamma_3^1}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)} s_0 + \frac{\left(\gamma_1^{k_0} - \frac{\gamma_2^{k_0}+\frac{\gamma_3^{k_0}}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)}{\left(\gamma_1^1 - \frac{\gamma_2^1+\frac{\gamma_3^1}{\gamma_3^3}}{\gamma_2^2+\frac{\gamma_3^2}{\gamma_3^3}} \right)} k_0 \quad (1.1.)$$

Q.E.D.

Appendix 5

Estimation of the Indexes of durable, non durable goods and prices (data and descriptive statistics)

An Index of nondurable goods is estimated using the data for 2002. I used 30 non durable goods where in general we have information (consumption of tomatoes, tortilla, etc.), which the families report if they have consumed or not in the previous week. The descriptive statistics are presented in Table 8.

Using this information, we apply Principal Component Analysis and the results are reported in Table 9. The first component explains around 15% of all the variation, and the rest does not have a lot of variation, so we only use the first component to estimate the index. The values of the first component are also reported in Table 10. Using these coefficients, the Index is estimated and then standardized so that the maximum level of goods is again 30. It is necessary to mention that these coefficients will be used to estimate the index for nondurable goods for each family for 2003 and 2004.

A similar strategy is used to estimate an Index for durable goods. I used 10 durable goods (fridge, television, etc.), which the families reported having or not in the year of the survey. The descriptive statistics are presented in Table 10. Using this information, the Principal Component Analysis is applied and the results are reported in Table 11. The first component explains around 27% of all the variation, and it is used to estimate the Index. Finally, I standarized in order to recover the original level of goods, which was 10, and furthermore, I assumed an original accumulation for all the families of 2 durable goods, so the maximum level of standardized durable goods is 12.

Then, I use the principal component analysis to determine the price of consumption of goods in 2002 and then I normalized the prices (mean 0 and standard deviation 1). The first component explains around 60% of all the variation, so I only use this first component to estimate the price of nondurable goods (See table 12). The values of the first component are also reported in table 12. I normalized these coefficients to sum one and then I applied the coefficents over the mean prices reported by the families to get the final price.

Finally, the price of durable goods is calculated using Principal Components Analysis. To calculate it, I normalized the prices (mean 0 and standard deviation 1). The results are reported in Table 13. The first component explain 62% of the variance , so I only used this component to estimate the price of non durable goods. I normalized these coefficientes to sum one and then we applied them over the mean prices reported by the families to get our final price.

Table 8: Summary Statistics Non Durable Goods

Variable	**N**	**Mean**	**Sd**	**Min**	**Max**
Tomatoes	15584.00	0.93	0.26	0.00	1.00
Onions	15574.00	0.90	0.29	0.00	1.00
Potato	15572.00	0.67	0.47	0.00	1.00
Chilies	15572.00	0.75	0.43	0.00	1.00
Carrots	15563.00	0.37	0.48	0.00	1.00
Pumpkins	15560.00	0.35	0.48	0.00	1.00
Banana	15562.00	0.60	0.49	0.00	1.00
Apples	15560.00	0.35	0.48	0.00	1.00
Oranges	15562.00	0.33	0.47	0.00	1.00
Tortilla	15570.00	0.84	0.37	0.00	1.00
White Bread	15554.00	0.48	0.50	0.00	1.00
Sweete bread	15549.00	0.42	0.49	0.00	1.00
Pasta soup	15566.00	0.75	0.43	0.00	1.00
Beans	15568.00	0.87	0.34	0.00	1.00
Rice	15560.00	0.76	0.42	0.00	1.00
Pastries	15554.00	0.06	0.24	0.00	1.00
Beef	15559.00	0.48	0.50	0.00	1.00
Chicken	15561.00	0.71	0.45	0.00	1.00
Pork	15550.00	0.23	0.42	0.00	1.00
Tuna	15546.00	0.21	0.41	0.00	1.00
Fish	15545.00	0.17	0.37	0.00	1.00
Egg	15561.00	0.89	0.31	0.00	1.00
Milk	15551.00	0.59	0.49	0.00	1.00
Cheese	15538.00	0.37	0.48	0.00	1.00
Soda	15552.00	0.40	0.49	0.00	1.00
Sugar	15540.00	0.88	0.33	0.00	1.00
Concentrates	15543.00	0.34	0.47	0.00	1.00
Coffe	15550.00	0.61	0.49	0.00	1.00
Oil	15547.00	0.83	0.38	0.00	1.00
Chips	15516.00	0.06	0.24	0.00	1.00

Table 9: Principal Component Analysis Quantity Non Durable Goods

Component	**Eigenvalue**	**Proportion**	**Good**	**Comp 1**
comp1	4.64	0.15	Tomatoes	0.2263
comp2	1.96	0.06	Onions	0.2415
comp3	1.59	0.05	Potatoes	0.2221
comp4	1.27	0.04	Chilies	0.1976
comp5	1.10	0.03	Carrots	0.2103
comp6	1.08	0.03	Pumpkins	0.2020
comp7	1.03	0.03	Banana	0.2391
comp8	0.98	0.03	Apples	0.2078
comp9	0.92	0.03	Oranges	0.1819
comp12	0.91	0.03	Tortilla	0.1432
comp13	0.89	0.02	White bread	0.1781
comp14	0.88	0.02	Sweet bread	0.1636
comp15	0.85	0.02	Pasta soup	0.2183
comp16	0.84	0.02	Beans	0.2184
comp17	0.81	0.02	Rice	0.2299
comp18	0.80	0.02	Pastries	0.0834
comp20	0.76	0.02	Beef	0.1730
comp21	0.75	0.02	Chicken	0.2018
comp22	0.75	0.02	Pork	0.1220
comp23	0.73	0.02	Tuna	0.1335
comp24	0.72	0.02	Fish	0.1004
comp25	0.72	0.02	Egg	0.1943
comp26	0.71	0.02	Milk	0.1936
comp27	0.67	0.02	Cheese	0.1699
comp30	0.65	0.02	Soda	0.1175
comp31	0.63	0.02	Sugar	0.2054
comp32	0.62	0.02	Concentrates	0.1312
comp34	0.59	0.02	Coffe	0.1300
comp35	0.54	0.01	Oil	0.1895
comp36	0.46	0.01	Chips	0.0764

Table 10: Descriptive Statistics Durable Goods

variable	**N**	**mean**	**sd**	**min**	**max**
Car	17201.00	0.03	0.17	0.00	1.00
Van	17201.00	0.02	0.12	0.00	1.00
Television	17201.00	0.75	0.43	0.00	1.00
Videocassetera	17201.00	0.11	0.31	0.00	1.00
Radio	17201.00	0.62	0.49	0.00	1.00
Fridge	17201.00	0.34	0.47	0.00	1.00
Stove	17201.00	0.70	0.46	0.00	1.00
Washing machine	17201.00	0.13	0.34	0.00	1.00
Water heating	17201.00	0.04	0.20	0.00	1.00
Tinaco	17201.00	0.08	0.26	0.00	1.00

Table 11: Principal Component Analysis Durable Goods

Component	**Eigenvalue**	**Proportion**	**Variable**	**Comp1**
comp1	2.75	0.27	Car	0.2577
comp2	1.49	0.14	Van	0.1611
comp3	0.96	0.09	Television	0.3700
comp4	0.93	0.09	Videocassetera	0.2993
comp5	0.79	0.07	Radio	0.3006
comp6	0.79	0.07	Fridge	0.3699
comp7	0.69	0.06	Stove	0.3505
comp8	0.65	0.06	Washington Machine	0.3218
comp9	0.48	0.04	Water heating	0.3299
comp10	0.42	0.04	Tinaco	0.3446

Table 12: Principal Component Analysis Prices Non Durable Goods

Component	**Eigenvalue**	**Proportion**	**Good**	**Comp 1**
comp1	18.10	0.60	Tomatoes	0.2136
comp2	5.36	0.17	Onions	0.2165
comp3	3.48	0.11	Potatoes	0.2218
comp4	1.62	0.05	Chilies	0.2000
comp5	1.42	0.04	Carrots	0.2213
comp6	0.00	0.00	Pumpkins	0.2008
comp7	0.00	0.00	Banana	0.2270
comp8	0.00	0.00	Apples	0.1677
comp9	0.00	0.00	Oranges	0.1719
comp12	0.00	0.00	Tortillas	0.0289
comp13	0.00	0.00	White bread	0.2216
comp14	0.00	0.00	Sweet bread	0.1172
comp15	0.00	0.00	Pasta soup	0.2140
comp16	0.00	0.00	Beans	0.1899
comp17	0.00	0.00	Rice	0.2179
comp18	0.00	0.00	Pastries	0.2134
comp20	0.00	0.00	Beef	0.1179
comp21	0.00	0.00	Chicken	0.1191
comp22	0.00	0.00	Pork	0.1531
comp23	0.00	0.00	Tuna	0.2258
comp24	0.00	0.00	Fish	0.0902
comp25	0.00	0.00	Egg	0.1558
comp26	0.00	0.00	Milk	0.0062
comp27	0.00	0.00	Cheese	0.1834
comp30	0.00	0.00	Soda	0.2140
comp31	0.00	0.00	Sugar	0.1617
comp32	0.00	0.00	Concentrates	0.1724
comp34	0.00	0.00	Coffe	0.1971
comp35	0.00	0.00	Oil	0.2175
comp36	0.00	0.00	Chips	0.1579

Table 13: Principal Component Analysis Prices Durable Goods

Component	**Eigenvalue**	**Proportion**	**Variable**	**Comp1**
comp1	6.26	0.62	Car	0.0603
comp2	1.76	0.17	Van	0.3409
comp3	1.25	0.12	Television	0.2955
comp4	0.72	0.07	Videocassetera	0.3656
comp5	0.00	0.00	Radio	0.2372
comp6	0.00	0.00	Fridge	0.3471
comp7	0.00	0.00	Stove	0.3869
comp8	0.00	0.00	Washing machine	0.2911
comp9	0.00	0.00	Water heating	0.3576
comp10	0.00	0.00	Tinaco	0.3435