Making Conditional Cash Transfer Programs More Efficient: Designing for Maximum Effect of the Conditionality

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Abstract

Conditional Cash Transfer (CCT) programs are now extensively used to induce poor parents to increase investment in the human capital of their children. These programs can be large and expensive, motivating the quest for greater efficiency in increasing the impact of the imposed condition on human capital formation. This requires designing the programs' targeting and calibration rules specifically to achieve this result. Using data from the Progresa randomized experiment in Mexico, we show that large efficiency gains can be achieved by taking into account how the probability of enrollment of a child is affected by a cash transfer. Calibration of the transfers relies on heterogeneity in responses due to child, household, and community characteristics. Rules for targeting and calibration can be made easily implementable by selecting indicators that are simple, observable and verifiable, and that cannot be manipulated by beneficiaries. In the case under study, results show that these efficiency gains can be achieved without rising inequality among the poor.

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I. Conditional cash transfer programs and the efficiency question

Conditional cash transfer (CCT) programs targeted at the poor have become widely used, in particular to induce beneficiary households to invest in the human capital of their children. The presumptions of the approach are that the supply side of social services for education and health is in place, and that stimulating demand via income effects is insufficient to induce major changes in human capital investment (Bourguignon, Ferreira, and Leite, 2002). Needed instead is a condition attached to the cash transfer that transforms the income effect into a price effect on the condition. In this case, receiving the transfer requires meeting school assistance and health practice requirements.

The approach has been hailed as a major innovation in how to organize poverty reduction programs. Well known examples include Progresa/Oportunidades in Mexico, Bolsa Escola/Bolsa Familia in Brazil, Red de Protección Social in Nicaragua, Programa de Asistencia Familiar in Honduras, the Program of Advancement Through Health and Education in Jamaica, Food-for-Education in Bangladesh, and Subsidio Unico Familiar in Chile (see Ravallion and Wodon, 2000; Skoufias, 2000; Morley and Coady, 2003; and Rawlings and Rubio, 2005). Some of these programs have become very large and expensive. In 2003, Oportunidades serviced 4 million families at the annual cost of US$2.2 billion. In 2001, Bolsa Escola covered 4.8 million families at the annual cost of $700 million. While rigorous evaluations of these programs are still few, positive impacts have been demonstrated for Progresa on education (Shultz, 2004) and health (Gertler, 2004). However, there has been almost no analysis of the effectiveness of alternative program designs in achieving these results, in spite of the large sums spent obtaining them. We address this issue here by analyzing whether better targeting of the qualifying poor and better calibration of the levels of cash transfers could help raise efficiency relative to current levels of achievement.

CCT have a double objective: immediate poverty reduction through the transfers, and longer term poverty reduction through investment in human capital. Meeting the first objective effectively requires accurate targeting of the transfers on the poor. While targeting cash transfers is always difficult to achieve (see, e.g., van de Walle, 1998; Alderman, 2001 and 2002; and Ravallion, 2003), we do not address this issue here. Meeting the second objective requires: (1) accurate selection among the poor to minimize the efficiency leakages that occur when payments are made to categories of children already highly likely of going to school without a transfer, as opposed to children who will only go to school because of the transfer; and (2) offering a level of transfer that will secure a high uptake because it is sufficient to meet the opportunity cost of the change in behavior, while minimizing project costs. Specifically, we are concerned with the definition of targeting and calibration rules for CCT programs that can be easily implemented, with low cost outlays, and high transparency. And we are concerned with potential trade-offs between efficiency gains through implementation of these rules and higher inequality in transfers among the poor.

We use Progresa as a case study in exploring these alterative program designs. Results show that efficiency gains in the 29% to 44% range can be achieved over the current scheme and that they are not obtained at the cost of rising inequality among the poor.

II. The efficiency issue in Progresa

2.1. Progresa as a human capital formation program targeted on the poor

In our interpretation, Progresa is a CCT program for human capital formation targeted at the children of the rural poor. It consists in three closely related components for education, health, and nutrition. For education, Progresa offers a monetary grant to each child under 18 years old, conditional on regular school attendance in grades between the third year of primary school and the third year of secondary school and on regular health visits. The health component provides basic health care for all members of the family. The nutritional component includes a monetary transfer conditional on regular visits to a health center, as well as nutritional supplements for children and women in need.

Progresa was introduced in 1997 and, by 2000, had achieved full coverage of marginal rural municipalities, reaching 2.6 million families. The overall budget for that year was 9 billion pesos (US$ 950 million), of which 4 billion (44%) was for educational transfers (Coady, 2000). These transfers benefited approximately 1.6 million children in primary school and 800,000 in secondary school.

The transfers that Progresa families receive result in a significant increase in their income, equal on average to 22%. The targeting of Progresa has explicitly been on poor households living in marginal rural areas of Mexico. Our purpose is not to question this targeting, which corresponds to Progresa's objective of transferring resources to poor families. Our purpose is to explore whether, for a given budget constraint, targeting and calibrating transfers among the poor can help raise efficiency in increasing school participation. We consequently only look at Progresa's educational component, and use it as a laboratory to explore alternative targeting and calibrating rules. The idea is to derive lessons from this richly informed experiment that can be applied to Progresa and to other CCT programs where the targeting issue is critical due to severely limited budgets.

To measure its impact, Progresa selected a sample of 506 marginal communities comprising 24,000 households and 17,000 children eligible for transfers, to which a survey was applied a year before the program started and subsequently every 6 months during three years. Information was collected on individual, household, and community characteristics. The sample design consists in the random selection of 320 treatment communities and 186 control communities from among these 506 communities. We restrict our analysis to the children that were in school in October 1997. Indeed, among eligible children, 12 percent had left school, some for several years, and, while the program has indeed helped bring some of them back to school, this one time effect at the onset of the program is not the focus of our analysis. For most of our analysis, we further restrict the sample to the 2,242 poor children that graduated from primary school in summer 1998 and were facing the decision of whether to continue in secondary school. We use this information to estimate a model of school enrollment that captures, in particular, the impact of Progresa transfers, paying particular attention to heterogeneity of conditions among children. We then simulate alternative targeting schemes and transfer formulas, and compare their efficiency.

2.2. Focusing on entry into secondary school

In this section, we make a simple analysis of the overall Progresa budget to suggest that an efficient scheme for school enrollment should strictly focus on the transition from primary to secondary school, a point already suggested in the IFPRI evaluations (Skoufias, 2000; Coady, 2000; Schultz, 2004).

We do not observe the effective transfers offered to each particular child, but can compute them based on the program rules. The educational transfers increase as children progress to higher grades, and are higher for girls than for boys in secondary school (Table 1). There is, however, a maximum amount to the transfer that each family can receive, set at 625 pesos/month in 1998 (including the 100 pesos granted for nutrition).[1] In the sample, 13.4% of eligible children are affected by the household transfer cap rule. Using the proportionality rule that Progresa applies, we calculate the effective transfer to which a child can pretend by scaling down by the same factor all the school subsidies in any household that would surpass the cap.[2] Among the children graduating from primary school, 28% are affected by the cap, and the transfer offered to them varies from $100 to the full $200/210, with an average value of $169. This provides the budget for educational transfers in the treatment villages from the sample as reported in Table 1, with its distribution by grade. Overall, the budgetary saving implied by the cap put on total household transfers represents 17% of the budget with no cap. Taking into account these caps on transfers, primary school accounts for 55.4% of the total educational budget and the first year of secondary school for almost 20% (Table 1).

Other studies have shown that Progresa transfers do increase continuation rates at all grades (Behrman et al., 2001; de Janvry et al., 2001; Shultz, 2004). However, as shown in Figure 1, school continuation rates are very high in primary school and again in secondary school. Because of these high continuation rates in primary and secondary school, the gain obtained from the transfers is only of around one percentage point in primary school grades, and one half of one percentage point in the 2nd and 3rd years of secondary school. This suggests that the current transfer system is unnecessarily expensive for primary school grades from an efficiency standpoint. Indeed, while the transfer to a primary school child is approximately $100/year (100 pesos per month over 10 months), 96 school-attending children are paid for each child that is retained in school by the transfer incentive, implying that the effective cost per additional child attending primary school is $9,600. Assisting the 3-4% of children that drop out of school at each grade would require a very different program that we cannot analyze on the basis of the functioning of the current program. Eliminating all transfers to primary school students would in itself save 55.4% of the educational grant budget, or $230 million out of the total budget of $950 million in 2000.

The critical problem in terms of educational achievement occurs at entry into lower secondary school. We, therefore, continue our analysis of the transfer program only for secondary school.

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[1] This cap was introduced so the program does not induce a fertility response.

[2] For households affected by the cap, all transfers are scaled down by a common factor so they add up to the cap. This prevents these household from keeping any child out of school without penalty.

2.3. The efficiency issue with Progresa school subsidies

There are two sources of inefficiency in the subsidy program that need to be optimally reduced:

The first is paying people for what they do anyway. As we have seen it, this is obvious in primary school. But the problem also arises in secondary school: 64% of the poor children that graduate from primary school would enter secondary school without a transfer. Reducing this efficiency leakage requires being able to anticipate who might not be going to school. Hence, we rely on the ability to predict the probability that a given type of child will enroll in school. Because such a prediction is necessarily noisy, there is no possibility of completely avoiding this inefficiency.[3] The question, however, is to reduce it by not targeting children most likely to go to school anyway.

The second source of inefficiency comes from offering incentives that are either too high or too low relative to the minimum amount needed to induce the conditional action. As we will see later, the simple difference estimation of the impact of Progresa indicates that the program has raised the enrollment rate from 93.6% to 76.6%. The subsidies offered were thus sufficient for the 13% that were attracted to enroll in secondary school and would not have done so otherwise. With them, could we have done as well with a smaller transfer? For the 23% that did not take up the transfer offered, the subsidy was not sufficient. Would they have taken the offer had it been at a higher level and, if so, should the transfer be increased if we can identify who they are?

If there were a clear opportunity cost to children's time in school, one could calibrate the subsidy to match this level. This is the underlying reasoning for the calculation of the Progresa transfer. It represents 40% of what children of comparative age earn when they work. However, children's opportunity cost of time at school is not easy to establish. Less than 30% of the children that quit at the end of primary school work during the subsequent 18 months (45% for boys and 10% for girls), increasing to 35% (55% for boys and 12% for girls) the following year. Among the reasons given for not continuing school, lack of money or need to work come first with 57% of the answers, but other important reasons are given such as the school is too far (13%) and the child does not like school or does not learn (23%). What

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[3] This inefficiency concept is analogous to the issue of fungibility with infra-marginal transfers, whereby beneficiaries substitute other consumption for those subsidized by the program, meaning that the program has no real effect on total consumption of the targeted commodity.

needs to be known is the response function of children to incentives in order to maximize the return to transfers. This is what the Progresa randomized experiment allows us to do. Since there was no design to observe the response to variable transfers, we exploit the particular feature of the cap on total transfer to a household to infer the marginal response to varying transfer amounts.

Dealing with these two sources of inefficiency requires an accurate predictive model of the probability of going to school as a function of the characteristics of the child, the household, and the community and of the amount offered. We concentrate our analysis on entry into secondary school since this is where the CCT can induce an important change in behavior resulting in efficiency gains.

We do not question transfers to children in 2d and 3rd grades of secondary school for two reasons. First, anticipation of these transfers is part of the expected benefits from entering secondary school, and the measured impact of the current Program thus includes their effect. Second, while we observed very high continuation rates in secondary school, these observations are made on the selected group of children that voluntarily entered secondary school without any subsidy. Other children that are induced to enter secondary school with a subsidy are very unlikely to continue at the same rate into the following grades if the subsidies were discontinued. We have no experimental design that allows us to study this particular continuation rate since Progresa always supported the first three grades of secondary school. The safe bet is that, whatever support is provided for the first grade needs to be provided for all three grades of secondary school, as it is currently. And while there are many less children in the second and third grades of secondary school than in the first grade among Progresa children in 1998, because it is the first year of the program, these numbers should even up after three years of program implementation. We will thus apply the results of our analysis for the first grade to all three grades of secondary school.

III. A model of optimal cash transfer

Denote by $P(X,T)$ the probability that a child with characteristics X and eligible for a transfer T will enroll in school. Eligibility is denoted by the index function $I \in [0,1]$. Children characteristics are distributed according to the density function $f(X)$.

The allocation problem consists in choosing the eligibility status $I(X)$ and, if eligible, the transfer $T(X)$ offered to each child X, to maximize the gain in enrollment over the population:

$$\max_{I(X),T(X)} \int [P(X,T) - P(X,0)] I \, f(X) dX \, , \tag{1}$$

subject to a budget constraint:

$$\int P(X,T) T \, I f(X) dX \leq B \, , \tag{2}$$

where B is the budget available for the program. The first order conditions for the optimal transfer is that, for any eligible child $(I = 1)$,

$$P_T - \lambda(P_T T + P) = 0 \, , \tag{3}$$

where $P_T = \dfrac{\partial P}{\partial T}$ and λ is the Lagrange multiplier associated with the budget constraint. This relationship states that the ratio of cost $(P_T T + P) dT$ to enrollment benefit $P_T dT$ of a marginal increase dT in the transfer offered is equal across children. Hence, the cost of the marginal child brought to school is equal across children types X. Note that the cost has two terms. The first term $P_T T dT$ is the transfer cost to the marginal children $P_T dT$ brought to school by the increase in transfer. The second term is the cost of giving the increase in transfer dT to all P children from the same type X, even though they went to school with the initial transfer T. This is the marginal equivalent of the decomposition of the cost of transfer:

$$P(X,T)T = [P(X,T) - P(X,0)]T + P(X,0)T \, ,$$

where the first term represents the cost of the transfer to the kids brought to school by the transfer, and the second term the cost to the kids of similar observable characteristics who would have gone to school anyway.

Given the optimal transfer conditional on eligibility, the optimal eligibility rule is defined by:

$$I = 1 \text{ if } (P(X,T) - P(X,0)) - \lambda P(X,T)T \geq 0 \text{ , 0 otherwise .} \tag{4}$$

The optimal allocation of a budget B is thus the solution to the system (3), (4), and (2).

In the particular case of a linear probability model that we consider in the following empirical work, the conditional expectation of the enrollment probability is written:

$$EP(X,T) = X\beta + \delta_0 I + X\delta T \, , \tag{5}$$

where $\delta_0 I + X\delta T$ measures the total impact of a transfer T, and $X\delta$, which includes a constant term, measures the marginal impact of the transfer *T*. The presence of an intercept $\delta_0 I$ is motivated by the fact that we only observe transfers in the range \$100 – \$210, and thus cannot impose the linearity of the transfer effect to extend below that range to a 0 transfer.

The optimal transfer and eligibility criteria defined in equations (3) and (4) are written:

$$T = \max\left(\frac{1}{2\lambda} - \frac{1}{2}\frac{X\beta + \delta_0}{X\delta}, 0\right), \tag{6}$$

where λ is solution to the budget constraint (2). This expression shows that both eligibility and the optimal transfer for any given child are function of the ratio $\frac{X\beta + \delta_0}{X\delta} = \frac{EP(X,0) + \delta_0}{EP_T}$. The first term in the numerator is the expected probability that children with characteristics *X* would go to school even without a transfer, and the denominator is the marginal effect of the transfer on the expected enrollment probability. Children will thus be eligible and receive high transfers if they have a low initial probability of enrollment and/or a high enrollment response to a transfer. This optimal transfer is function of all the characteristics *X* that predict enrollment, albeit in a very non-linear form. Whether any program can use such a complex formula to compute transfers is questionable. Yet, it is a useful benchmark, as it gives the maximum efficiency that could be reached with the observables *X*, and we will thus compute it in the empirical analysis that follows. We, however, turn next to the definition of the optimal scheme constrained to be linear and to use a restricted number of observable characteristics.

Implementable scheme

To be useful for program implementation, eligibility rules need to be simple and transparent. Indicators used to determine eligibility and the level of cash transfer must be few, easily observable and verifiable, and non-manipulatable. Simplicity and transparency may also be important to ensure the political acceptability of a transfer program (Schady, 2002). Progresa uses grade and gender to adjust transfers (Table 1). The objective is thus to reduce the complexity of the formula (6) established for the optimal transfer scheme to a linear index based on a few correlates. We, therefore, establish the optimal transfer scheme that is linear in a subset of characteristics *Z* of the children.

The allocation problem consists in choosing the eligibility status and, if eligible, the transfer T to offer to each child to maximize the gain in enrollment over the population (1), subject to a budget constraint (2), and using simple linear formulas for eligibility and transfer:

$$T = Z\alpha,$$

and $$I = 1\left[Z\gamma \geq \gamma_{\min}\right],$$

where Z is a subset of characteristics of the children, and α, γ, and $\gamma_{\min}$ are parameters to be determined. As in the model above, optimal eligibility is defined by the sign of the optimal transfer value:

$$I = 1 \quad \Leftrightarrow \quad T = \max(Z\alpha, 0) > 0. \tag{7}$$

The parameters α are solution of the maximization of a quadratic function:

$$\max_{\alpha} \sum_{i \in E} m_i Z_i \alpha - \lambda \left[B - \sum_{i \in E} \left(P_{0i} + \delta_0 + m_i Z_i \alpha \right) Z_i \alpha \right], \tag{8}$$

where E is the set of eligible children, $m_i = X_i \delta$ is the marginal effect of the transfer on child i school enrollment, $P_{0i} = X_i \beta$ is its enrollment probability without transfer, and λ is the Lagrange multiplier on the budget constraint. The transfer formula (7) is therefore a simple linear combination of a few observed characteristics Z. It is similar to the scoring system used in many welfare programs, whereby characteristics Z command scores α that add up to an aggregate score $Z\alpha$. In this case, $Z\alpha$ determines not only eligibility but also the transfer amount. An important empirical question is whether the use of this simple scoring scheme is sufficiently close to the optimal transfer scheme, and what type 1 and II errors are made in this implementation. We will return to this question after we establish these schemes.

IV. Predicting enrollment

We now proceed to build a predictive model of entry into secondary school. Although a probit and a logit perform better at the high and low probabilities, we use a linear model to avoid imposing heterogeneity on the impact of the transfer through the functional form, since this will be an important determinant of the targeting scheme.[4] We use the sample of children finishing primary school and eligible for a Progresa transfer (defined as poor using the Progresa welfare index) in both the control and treatment villages. Randomization in the selection of communities insures that being in a treated community is orthogonal to the characteristics of the children.[5] The average treatment effect can thus be obtained by simple comparison of the average enrollment of the children in the two types of village. The actual amount of transfer offered to a child is, however, not orthogonal to its characteristics. This is because, being subject to the cap rule and to the corresponding household scaling factor are both function of the children's age structure, which is likely correlated with household preferences that influence schooling decisions. The impact of the continuous treatment effect is thus estimated conditional on the potential transfer level.

The empirical equivalent of equation (5) is written:

$$S_i = \delta_0 I_v + \delta I_v T_i + \beta_0 T_i + u_i ,$$

or $S_i = \delta_0 I_v + \delta I_v T_i + \beta_0 T_i + X_i \beta + u_i$, with additional control variables X_i.

S_i is a binary variable indicating the enrollment status of child i, I_v indicates whether i lives in the program area, and T_i is the potential transfer that i would be eligible for under the program. The other control variables X are child, household, and community characteristics.

Table 2 reports the estimation results for different specifications, and Table 3 gives the corresponding marginal effects for given types of children. The result in column (1) gives the simple difference effect of the Progresa CCT on enrollment. Among qualifying poor, the impact of the program on the probability of continuation into secondary school is 13%. As expected, this is slightly higher than the 8-9 percentage points estimate of impact on enrollment conditional on completed primary school (i.e., including children who had dropped out of school prior to the onset of the program) obtained in other studies (e.g., Schultz, 2004).

Using, in column (2), the value of the cash transfer, which varies across children due to the cap on payments that affects 26% of the qualifying children, we see that the marginal effect of a dollar of transfer is high (1.42% per 10 dollars). Note that the imposed linear form gives a meaningful positive effect only

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[4] In the simulation exercises that follow, we will never encounter a problem of predicted negative probability (the majority of children have predicted probabilities above .40), but we do have some predictions above 1, even without transfers and more when applying transfers. For simulation purposes these will be set equal to 1.

[5] The quality of the randomization is verified and documented in Behrman and Todd (1999).

for transfers above \$100, which is not really restrictive as current transfers are much higher. Adding a large number of child, household, and community controls in column (3), indicates that the main correlates of a child's secondary school enrollment are age of the child (negative), mother's literacy and the household's maximum educational level (positive), the number of agricultural workers and self-employed in the household (negative), total expenditure (positive), and distance to school (negative). State effects are also important. Both models predict that the current US\$200 CCT increases the probability of enrollment by the same 14% (Table 3), which confirms that controls are orthogonal to the treatment.

We then proceed in columns (4) and (5) to explore heterogeneity of impact across categories of children without and with controls, respectively. We focus on aspects of heterogeneity that may be useable for targeting purposes. They are age of the child[6], father's ethnicity, and whether there is or not a secondary school in the village. Progresa recognizes gender differences, which we do not find to be important in explaining differential impacts of transfers on the decision to continue into secondary school.[7] We see from the results that age, ethnicity, and presence of a school in the village all make large differences on enrollment, both directly as controls, and in affecting the impact of the transfer. We use the results in column (5) as the predictive model to evaluate the impact of targeting.

Heterogeneity implies large differences in the impact of a transfer on enrollment across categories of children (Table 3). For a 12 years old male child, with a non-indigenous father, and a school in the village, the \$200 Progresa transfer only increases the probability of enrollment by 3–4%. If this child is two years behind normal progress, the transfer increases the probability of enrollment by 10–12%. When this child has an indigenous father or no secondary school in the village, the transfer increases enrollment by 9–11%. Combining the features of being a boy, 14 years old, with an indigenous father, and in a village with no secondary school, indicates that a \$200 transfer raises the probability of school enrollment by 23–24%. These large differences suggest that there can be efficiency gains in using some of these

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[6] The age is centered on 12 years old, where 12 is the median age for entry into secondary school, so that the coefficent on the direct variable is readily readable as the impact on a 12 years old.

[7] The lack of significance and very low point estimate (0.003 with standard error 0.002) are robust to many specifications, including either less or more interactions terms, and introduction of a number of control variables. We, therefore, drop the term from the estimation in column (5) that will serve for the simulations. The often reported difference between boys and girls comes from estimation of enrollment rather than continuation rates. Coady (2000) shows that most of that difference comes from the very high impact of Progresa on re-entry of girls into the school system the first year of the program.

dimensions of heterogeneity for the targeting of transfers, in the same way as Progresa used gender differences in setting transfer levels.

A potential concern is that identification of the impact of the transfer value derives from observation of children who receive less than the full transfer amount because of the cap on total household transfer. These children are, by definition, from households with a larger number of eligible children. To check that the enrollment model of these households does not differ in any significant way from that of smaller households, we compare our estimation with a model estimated for these children alone. The estimation is, as expected, more precise with the whole sample, but the parameters are neither individually nor globally significantly different in the two estimations (the p-values for the test of equality of the parameters on the transfer variables are 0.49 without heterogeneity and 0.16 with heterogeneity), which confirms that identification of the transfer parameter is correct. We also checked the orthogonality of the transfer to all other variables by estimating different models for children in the treatment and control villages, and verify that the parameters are neither individually nor globally significantly different in the two estimations. Hence, the model that we have estimated can be used for predicting behavior in absence of a transfer program.

V. Comparing alternative transfer schemes

We now proceed to analyze, in Table 4, three alternative targeting and calibration schemes with the purpose of seeing if they can help raise the efficiency of transfers in inducing school enrollment. The different schemes all add up to the same total budget spent in implementing the current Progresa transfers. This budget is computed by predicting for each sample child the expected uptake (predicted probability) $\hat{E}P$, and summing up expected transfers $\hat{E}P.T$ over the children. It amounts to a total annual outlay of \$322,000 for the 2,242 sample children.[8] In the upper panel, we report enrollment rates for all children, and then by category of children according to their "risk level", i.e., their predicted enrollment rates without

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[8] Another interesting exercise would be to define an efficient allocation of the total educational budget of the current Progresa program. It would thus consist in reallocating the primary school budget to secondary school, thus doubling the budget for secondary school. A simulation of this budget re-allocation shows that it would lead to almost universal secondary education with enrollment rates between 90.4% and 91.7% depending on the rule for transfer calibration.

any transfer, or their eligibility status in the program. In the lower panel, we report some aggregate targeting and cost outcomes for the different schemes.

5.1. Emulating Progresa: universal uniform transfers

The school participation rate without transfer is 63.2% (Table 4, col. (1)). Progresa's current universal transfers with a cap and with differential cash transfers for boys and girls, raise the participation rate to 75.7%, a gain of 12.5 percentage points. The universal uniform transfers without a cap and without gender differences that we use as a benchmark for the subsequent simulations raise participation to an identical 75.7% (col. (2)). Under this scheme, the transfer per child is \$194/year.[9] Because many children receive a transfer even though they would be going to school without it, the cost per additional child enrolled is \$1,151/year.

Figure 2 shows the enrollment probability with transfers according to the initial enrollment probability without a transfer program. The distance from the diagonal to the curve thus represents the gain in enrollment from the program. Gains are largest for children with a low probability of enrollment and they decline as the enrollment probability rises. Table 4 reports these gains, with enrollment probability rising from an average 27.8% to 47.2%, or 19.4 percentage points, for the children with probability of enrollment lower than 40%, while the gain is only 5.6 percentage points for those in the 80-100% category (Table 4, cols. (1) and (2)). Gains are hence progressive in terms of the initial likelihood of going to school, even with uniform transfers. This is the Progresa achievement that has been widely acclaimed in the literature. However, can we do better by redefining the targeting and the calibration of transfers?

5.2. Optimal variable transfers

The second scheme implements the optimal variable transfers established in the model, under the same budget constraint and taking into account heterogeneity in probability of enrollment and responses to transfers across children based on all controls and interactions with transfers used in Table 2 column 5. Both eligibility and optimal transfer value are simultaneously determined. This is done by offering the

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[9] The transfer level is determined to match the Progresa budget, taking into account the predicted uptake that it induces.

transfer defined in (5) to children of characteristics X, predicting their uptake, and finding by tâtonnement the shadow value λ of the budget constraint that balances the budget. Under this scheme, we should raise the cash transfers to children with a low probability of going to school, and target less the children with high probabilities of going to school because efficiency leakages are particularly high among them. Results in Table 4 (col. (3)) show that students eligible to receive a transfer have a probability of enrollment of 78.9%, compared to 55.8% had they not received a transfer. The non-eligible students have a probability of enrollment of 89%. Overall, the probability of school enrollment is now 81.1%, a gain in efficiency of 43.6% over universal uniform transfers. As can be seen in Figure 2, this optimal transfer scheme almost equalizes the enrollment rates among the children with initially very different enrollment rates to values close to 70%. The largest gains in probability of enrollment are thus captured by those with the lowest initial probabilities.

Figures 3 and 4 illustrate the transfer scheme by showing eligibility and transfer offer by initial enrollment probability. Figure 3a reports the distribution of the number children by initial probability, superimposing the distribution of those that are eligible in the optimal scheme (in black), and showing, by difference, the distribution of non-eligible (in grey). It clearly shows how eligibility is concentrated over the children with low initial probabilities, while the non-eligible all have initial probabilities above 0.70. Figure 4 shows that optimal calibration of transfers also favors those with low initial probabilities, trying to induce them to go to school with higher CCT. The transfers decline as the probability of going to school without a transfer rises. Note, however, on Figure 3 that there are relatively few children with predicted low probability. The majority of the children are concentrated in the 40-80% enrollment rate range.

Returning to Table 4, we see that 77.5% of the children are eligible for a transfer. The average transfer is \$237 compared to the universal uniform transfer of \$194, a 22% increase. The optimal scheme thus suggests raising transfers for the beneficiaries while reducing coverage over those with high likelihood of going to school without a transfer. Since there are still efficiency leakages among eligible children, the cost per additional child enrolled is \$802, down from \$1,151 under the universal uniform transfer. Cost saving per additional child enrolled is thus no less than 30%.

5.3. Implementable transfers

Having established the optimal transfer scheme as an efficiency benchmark, we now turn to the definition of simpler implementable transfer schemes, based on a linear combination of a few observable characteristics. Using expressions (7) and (8), we establish the optimal implementable transfer scheme by proceeding as follows. For a given set of explanatory variables, we solve the optimal transfer iteratively[10], and compute the resulting enrollment rate. We explore combinations of characteristics that correspond to the criteria of being easily observable, verifiable by others, and non-manipulatable by the household, selecting variables that increase the overall enrollment rate. In addition to these features, actual implementation of a program requires these criteria to be legally and politically acceptable. This is clearly an issue that every program would have to address in its own context. Currently, the Mexican law sets very strict rules of equal treatment among beneficiaries of program using federal funds. The simulation that we explore here should thus be seen as illustrative of the concept of an implementable transfer scheme, rather than a precise proposition. In our base model, we restrict the transfer scheme to only depend on gender and birth order of the child, presence of a secondary school in the village, distance to a secondary school if there is not one in the village, and state dummy variables. We later report a few alternative specifications. Note that age of the child is not used since an eligibility criterion based on age could give rise to perverse behavior of parents delaying their children's entry in secondary school to benefit from a larger cash transfer. The rank of the child in the family, which cannot be manipulated, turns out to capture part of this information. Every single one of these variables can be easily observed and verified. In fact, instead of secret eligibility formulas as currently used for poverty that give no room for recourse, self-registration is possible, with easy verification. The results are reported in the first panel in Table 5, column (1). The birth order parameter indicates that the transfer is highest for the older child and decreases by \$12 for each of the younger siblings. Girls would optimally receive a premium of \$25. The main source of variation in transfer is, however, related to distance to school, with a large premium given to children that need to travel to school and an additional transfer for each kilometer traveled. The scheme also exhibits some variation

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[10] Starting with general eligibility, we solve the optimization problem (8) for α as a function of λ and adjust λ to balance the budget. These parameters are used to compute transfers and define eligibility. We iterate this procedure until there is convergence, i.e., no change in eligibility between two consecutive iterations. This is always achieved in less than 5 iterations.

across states, with a difference of $87 between the extreme cases of Queretaro and Guerrero. Examples of eligibility and transfer amounts computed with this simple points system are reported in the lower panel of Table 5. Children with a school in their own village are not eligible; they represent 23% of the sample. Their enrollment rate without transfer is predicted at 80.5%, which is also the rate observed in control villages with a school. By contrast, all the children who do not have a school in their village are eligible for some transfer.[11] A boy, oldest child, and living 3kms away from a school (which is the mean value among those without a school in their village) would receive a transfer of $213, while the transfer to the third child would only be $190. If the oldest child is a girl, she receives $239. Cumulating all the disadvantages, a girl living 6kms away from school would receive the highest transfer at $266.

Implementation of this transfer scheme results in enrollment rates and efficiency levels reported in column (4) of Table 4. There is of course an efficiency loss relative to the optimal transfer scheme, the cost to be paid for simplicity and transparency. Although the number of eligible children is about the same as in the optimal transfer scheme (77.4%), the eligibility criterion is not the same. The implementable scheme includes 9% of the children not eligible under the optimal scheme (type II error) and exclude 9% of the children eligible under the optimal scheme (type I error). Enrollment of eligible children rises from 58.2% without a transfer to 79.1% with a transfer. Enrollment rate for the non-eligible is 80.5% and for the population of poor is 79.4% overall. This implies a 29.4% efficiency gain over the universal uniform CCT option. Cost per additional child enrolled is $889, still 23% cheaper than under the universal uniform CCT option, but 11% more expensive than under the optimal scheme.

While the average transfers under the implementable and optimal schemes are equal at $236, the distributions are quite different. This is shown in Figure 5 that reports their density functions. The distribution of transfers is very uniform between $150 and $350 in the optimal scheme, while transfers all concentrate between $200 and $270 in the implementable scheme.[12] This is due to the limited number of characteristics that could be used to define the implementable scheme, and is responsible for the observed loss in efficiency. In Figures 3 and 4, we see that the implementable program loses some sharpness in the

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[11] The average distance to school for the 77% of the children that do not have a school in their village is 3.1 kms, Enrollment rates are observed to decrease very sharply with distance to school in the control villages, reaching the low value of 43% for the 19% children living further away than 4kms.

[12] Actual transfers are $200 for boys and $210 for girls in the households that do not reach the maximum transfer, and vary from $100 to $200 children in households under the cap constraint.

targeting of the children with lower probability of enrolling (comparing Figures 3a and 3b) and allows little variation in transfer amount compared to the optimal scheme.

We explore alternative implementable schemes, varying the characteristics used to establish eligibility and transfer amount (Table 5). Adding mother and father illiteracy (column (2)), which are important predictors of school enrollment, raises the efficiency gain to 31% above the universal uniform transfer. While some people argue that such subsidies (here computed as \$26 and \$30 if the mother or the father are illiterate, respectively) may give the wrong signal and bias the return to education, one can also see them as a way of compensating for the handicap that children of uneducated parents have and of helping them catch-up. At the other extreme, one can ask how efficient would it be to define transfers at the community level (although only for the poor). This is reported in column (3) of Table 5, and shows an important efficiency gain of 28.5% over the uniform transfer. This geographical targeting scheme is interesting, as it shows that in this particular case of rural Mexico, an important efficiency gain could be obtained by redesigning the CCT as a school transportation subsidy. This simple transportation subsidy would capture 65% of the efficiency gain that the optimal CCT would garner. The question arises then of comparing this intervention with a supply-side policy that would bring schools close to where people live. This is beyond the scope of this paper, but Coady (2000) estimated that the cost of raising enrollment through a supply-side intervention increasing the number of rural schools would cost more than 7 times as much as the current Progresa program.

These specific implementable schemes are illustrations of the idea that designing a relatively simple transfer scheme, with a points system that is transparent and easily verifiable, is indeed feasible and could insure large efficiency gains.

5.4. Comparing direct costs and efficiency leakages under the three schemes

An important determinant of the relative efficiency of different targeting schemes is the importance of their efficiency leakages, namely the magnitude of the cash transfers that go to children that would go to school without the transfer. This is analyzed in a comparative fashion in Figure 6 where the total transfer cost for each category of children is divided into direct cost (transfers to children that would not otherwise have enrolled, represented in black) and leakage costs (transfers to children that would have enrolled anyway, represented with stripes). Differences among the figures are quite telling.

With the universal uniform transfer program (Figure 6a), leakages are particularly high, especially among children with a high probability of going to school without a transfer. Altogether, 83.2% of the total budget goes to efficiency leakages, leaving an effective direct cost of only 16.8%. The optimal variable transfer program reduces efficiency leakages by focusing eligibility among low probability children and increasing the magnitude of the cash transfers offered to them (Figure 6b). Efficiency leakages are reduced to 64.9%, implying an effective direct cost of 36.1%. Finally, the implementable transfer program has an efficiency leakage of 72.5% (Figure 6c). Because targeting is simplified and transparent, it is a compromise between the universal and the optimal transfer. The effective direct cost is 27.5%.

We conclude that the optimal variable scheme could offer a significant efficiency gain in school enrollment. It could be implemented through a secret formula as Progresa currently uses to target poverty. This may, however, be too complex to administer, and secrecy is not a desirable feature as it does not allow recourse. However, results show that the implementable variable transfer scheme also results in substantial efficiency gains relative to Progresa's current universal uniform transfers.

VI. Equity

Are these optimal and implementable schemes progressive or regressive among the poor? In other words, are efficiency gains in enrollment achieved at an equity cost? CCT driven by efficiency gains indeed raise the issue that maximally efficient schemes may be inequitable (Das, Do, and Özler, 2005). For this reason, eligibility is restricted to the poor. However, when there is further targeting among the poor, are the resulting transfers regressive among the poor?

Before looking at the distributive effect of this targeting among the poor, it is interesting to note that even the Progresa transfers themselves were not particularly efficient for reducing poverty or inequality. Indeed, when measuring poverty by consumption per capita, the transfers per capita were almost uniformly distributed across levels of consumption per capita (de Janvry and Sadoulet, 2003). In this paper, we discuss this issue of trade-off between efficiency and equity using the Progresa welfare index measured in 1997 rather than the income/consumption level, since this is what Progresa used as a reference.

We illustrate the results in Figure 7 with several indicators of the program design and effect on households ranked by the Progresa welfare index. Figure 7a shows that the individual transfer offered slightly declines with welfare level in both the optimal and implementable transfer schemes. Eligibility is, however, neutral to welfare levels and the uptake is slightly increasing. As a consequence, the effective transfer by class, which is the product of transfer by eligibility and uptake, slightly decrease across welfare levels in the optimal transfer scheme (from \$160 to \$140), and is uniform in the implementable transfer (Figure 7b). In contrast, the average effective transfer distributed by Progresa shows a clear upward trend and thus regressivity among the poor. This is due to the low uptake rate in low welfare classes. Efficiency gains in implementing variable transfers are thus not achieved at the cost of rising inequality among the poor.

VII. Conclusions

We raise in this paper the question of whether efficiency gains can be achieved in CCT programs by improved targeting among the poor and better calibration of transfers. The efficiency objective is to maximize impact over the population of the condition imposed on the transfer, in this case gains in school enrollment among the children of the poor. Using the data from the Progresa randomized experiment, we focused our analysis on the crucial educational decision for children in poor Mexican rural communities, namely whether to continue schooling at the secondary level or not.

Achieving efficiency gains through the targeting and calibration of conditional transfers requires focusing on children with a high probability of not going to school without a transfer and with a high response to the amount transferred, within the overall program budget constraint. Implementing this program requires predicting school enrollment as a function of the transfer offered and of the child, household, and community characteristics. Heterogeneity in responses shows that age, ethnicity, and presence of a school in the village make large differences on enrollment. We then compared three alternative targeting and calibration schemes: the current Progresa scheme of universal uniform transfers, an optimal scheme of variable transfers, and a scheme of implementable transfers where the criteria used for targeting and calibration are easily observable, verifiable by others, and non-manipulatable by the household. In setting up new programs, a pilot experiment would need to be used to estimate the enrollment probability model necessary to establish the targeting and calibration formulas.

Results show that the optimal scheme gives a 44% efficiency gain over the universal transfer scheme and the implementable scheme a 29% gain. The optimal scheme reduces efficiency leakages (receipt of transfers by children with a high probability of going to school without a transfer) from 83% to 65%, and the implementable scheme to 73%. We also show that these efficiency gains are not achieved at the cost of rising inequality among the poor for such a program.

The overall conclusion is thus that large efficiency gains could be achieved in implementing what are in many countries highly expensive CCT programs for human capital formation among the poor if better rules for the targeting and calibration of transfers were introduced. This requires estimating the predicted responsiveness of recipients' enrollment decisions to the transfers. We have shown that simple rules can be designed to implement such a scheme.

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Table 1. Budget for educational transfers, Progresa program in the sample villages, 1998

Grade that children could attend	Number of eligible children[1]	Transfers[2] (pesos/month)	Continuation rate (percent)	Budget for enrolled children[3] (pesos/month)	(% of total)
Primary 3	1909	70	98.2	114,229	11.8
Primary 4	1811	80	97.8	120,260	12.4
Primary 5	1613	100	97.1	135,626	14.0
Primary 6	1476	135	97.4	166,035	17.2
Secondary 1	1416	200/210	76.7	189,602	19.6
Secondary 2	752	210/235	96.1	134,884	14.0
Secondary 3	551	220/255	96.7	106,028	11.0
Total	9528			966,664	100

[1] Children enrolled in school in 1997 only.

[2] Transfers in secondary school are given separately for boys/girls.

[3] Taking into account the cap on total household transfers. With a schedule of 10 monthly transfers per school year and an exchange rate in October 1998 of 10 pesos per US$, all transfers can be read as either in pesos/month or in US$/year.

Table 2. Linear probability model of enrollment

		(1)	(2)	(3)	(4)	(5)
	Mean		Homogeneous impact		Heterogeneous impact	
Transfer dummy	0.718	0.130**	-0.146	-0.172	-0.091	-0.159
		(0.019)	(0.171)	(0.156)	(0.162)	(0.156)
Transfer (US$100)	1.215		0.142	0.156+	0.061	0.095
			(0.088)	(0.080)	(0.084)	(0.083)
Transfer*Male					0.003	
					(0.019)	
Transfer * (Age –12)	1.239				0.020**	0.016*
					(0.007)	(0.007)
Transfer * Father indigenous	0.419				0.037*	0.028
					(0.019)	(0.019)
Transfer * No sec. school in village	0.945				0.022	0.037+
					(0.022)	(0.021)
Child and household characteristics						
Potential transfer (US$ 100)	1.940		-0.015	-0.072	0.006	-0.063
			(0.069)	(0.069)	(0.065)	(0.069)
Male	0.507			0.057	0.073**	0.057
				(0.037)	(0.029)	(0.037)
Age	13.012			-0.090**	-0.130**	-0.110**
				(0.008)	(0.010)	(0.011)
Father is indigenous	0.354			0.027	0.059*	-0.006
				(0.040)	(0.029)	(0.045)
Birth order	2.014			0.016		0.014
				(0.015)		(0.015)
Head is male	0.930			-0.037		-0.033
				(0.044)		(0.044)
Has no father	0.114			-0.015		-0.011
				(0.045)		(0.045)
Father is literate	0.670			0.054+		0.053+
				(0.028)		(0.028)
Father's education	2.491			0.000		0.000
				(0.006)		(0.006)
Has no mother	0.050			0.058		0.057
				(0.075)		(0.074)
Mother is literate	0.621			0.055*		0.057*
				(0.027)		(0.027)
Mother's education	2.351			-0.002		-0.003
				(0.006)		(0.006)
Mother is indigenous	0.372			0.059		0.057
				(0.039)		(0.039)
Mother's age	36.192			0.001		0.001
				(0.001)		(0.001)
Number of children 0-10 years old	2.586			0.002		0.002
				(0.006)		(0.006)
Number of children 11-19 years old	2.781			-0.014		-0.014
				(0.012)		(0.012)
Number of agricultural workers	1.274			-0.031**		-0.030**
				(0.009)		(0.009)
Number of non-agricultural workers	0.314			-0.02		-0.019
				(0.014)		(0.014)
Number of self employed	0.194			-0.039*		-0.037*
				(0.018)		(0.018)
Household's maximum education	4.975			0.018**		0.017**
				(0.004)		(0.004)
Total expenditure (100 pesos/month)	8.055			0.004*		0.004*
				(0.002)		(0.002)
Dwelling has dirt floor	0.696			0.047*		0.043*
				(0.020)		(0.020)
Persons/room in dwelling	5.206			-0.003		-0.002
				(0.004)		(0.004)
Dwelling has water	0.327			0.056**		0.058**
				(0.020)		(0.020)
Rainfed land (ha)	2.059			0		0
				(0.002)		(0.002)
Irrigated land (ha)	0.066			-0.009		-0.007
				(0.015)		(0.015)
Herd size	0.878			-0.005		-0.005
				(0.006)		(0.006)
Community characteristics						
No secondary school in village	0.775			0.014	-0.221**	-0.031
				(0.045)	(0.033)	(0.051)
Distance to secondary school (ln of kms)	1.031			-0.130**		-0.129**
				(0.026)		(0.025)
No school in village x Girl	0.384			-0.028		-0.029
				(0.041)		(0.041)
Guerrero	0.174			-0.124**		-0.124**
				(0.044)		(0.044)
Michoacan	0.136			-0.168**		-0.166**
				(0.045)		(0.045)
Puebla	0.159			-0.137**		-0.140**
				(0.043)		(0.043)
Queretaro	0.050			-0.268**		-0.279**
				(0.054)		(0.054)
San Luis Potosi	0.133			-0.163**		-0.161**
				(0.045)		(0.045)
Veracruz	0.281			-0.103*		-0.103*
				(0.041)		(0.041)
Constant		0.636**	0.666**	2.009**	2.428**	2.301**
		(0.015)	(0.134)	(0.204)	(0.186)	(0.231)
Observations		2242	2242	2242	2242	2242
R-squared		0.02	0.02	0.23	0.17	0.23

Standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 3. Heterogeneity: Impact of CCT on the probability of school enrollment by type of child

	Homogenous impact			Heterogenous impact	
Type of child	Transfer (1)	Transfer amount (2)	Transfer amount w/controls (3)	Transfer amount (4)	Transfer amount w/controls (5)
Overall effect	0.130	0.140	0.140		
Boy, 12 years old, non-indigenous, with sec. school in the village (US$200)				0.035	0.031
Boy 14 years old				0.115	0.095
Boy with father indigenous				0.109	0.087
Boy with no secondary school in the village				0.089	0.105
Boy 14 years old, indigenous, with no school in the village				0.243	0.225

Source: Based on results from Table 2, with corresponding columns in parentheses.

Table 4. Enrollment rates under alternative targeting schemes

			No program (1)	Universal uniform transfers (2)	Optimal variable transfers (3)	Implementable transfers (4)
	Observations	(%)	Enrollment rates (%)			
All children	2242	100.0	63.2	75.7	81.1	79.4
By probability of enrollment without transfer						
0-40%	354	15.8	27.8	47.2	73.2	57.9
40-60%	583	26.0	50.9	66.1	76.8	71.4
60-70%	376	16.8	64.9	77.8	79.3	81.3
70-80%	392	17.5	74.6	85.8	82.0	87.6
80-100%	537	24.0	90.5	96.1	91.8	94.9
Eligible students						
Without transfer				63.2	55.8	58.2
With transfer				75.7	78.9	79.1
Non-eligible students				–	89.0	80.5
Eligibility (%)				100.0	77.5	77.4
Average transfer value (US$/year)				193.6	236.9	236.3
Cost per additional child enrolled (US$/year)				1151	802	889
Efficiency gain over universal transfers (%)				–	43.6	29.4

Table 5. Optimal implementable schemes

	Transfer (in US$/year)		
	Base model (1)	With illiteracy (2)	Geographical (3)
Transfer formula			
Birth order	-12	-11	
Male	-25	-25	
No secondary school in the village	476	502	447
Distance to secondary school (ln(1+kms))	50	49	48
Mother illiterate		26	
Father illiterate		30	
Guerrero	-295	-351	-295
Hidalgo	-278	-327	-283
Michoacan	-246	-288	-253
Puebla	-267	-317	-273
Queretaro	-208	-257	-214
San Luis Potosi	-260	-303	-260
Veracruz	-285	-333	-288
Examples of transfers (pesos/month) by children types (in State of Guerrero)			
School in the village	Not eligible	Not eligible	Not eligible
Oldest, male, with literate parents, and school at 3kms	213	184	218
3rd sibling, male, with literate parents, and school at 3kms	190	162	218
Oldest, male, with illiterate parents, and school at 3kms	213	240	218
Oldest, female, with illiterate parents, and school at 3kms	239	265	218
Oldest, female, with illiterate parents, and school at 6kms	266	292	245
Efficiency gain over universal uniform transfers (%)	29.4	31.0	28.5

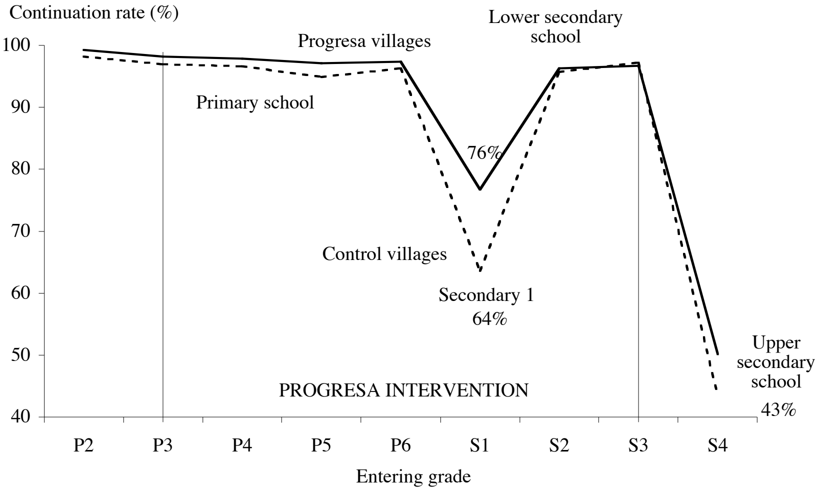


Figure 1. School continuation rates of poor children in sample villages

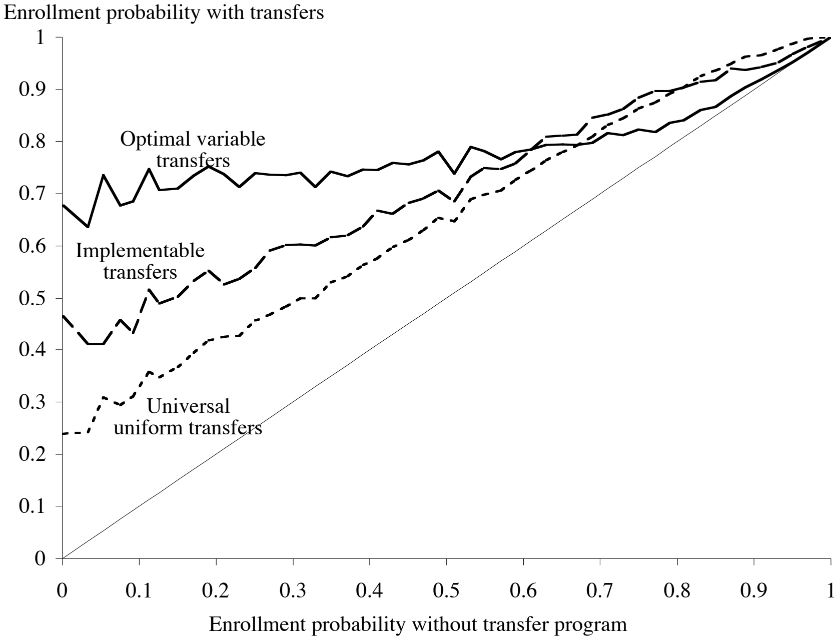


Figure 2. Impact of alternative transfer programs on enrollment rates

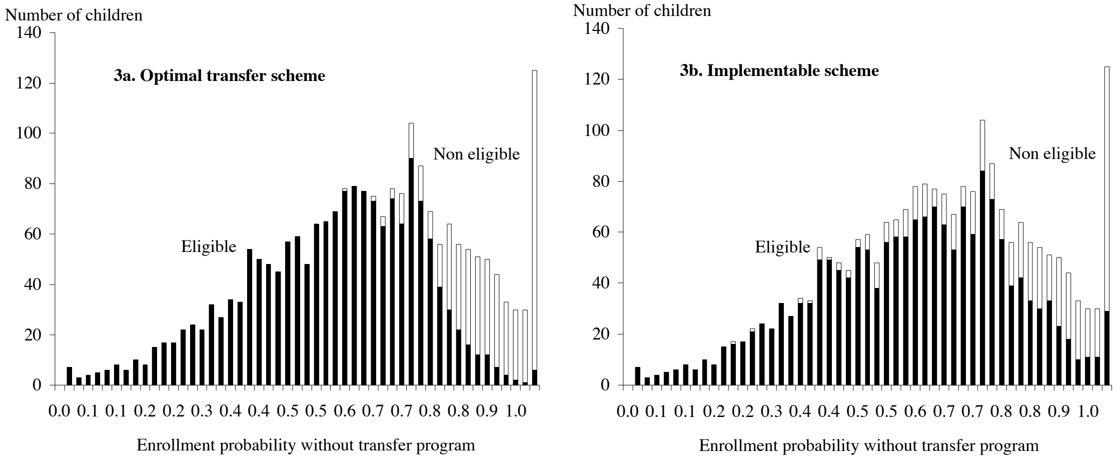


Figure 3. Eligibility in the optimal and implementable schemes

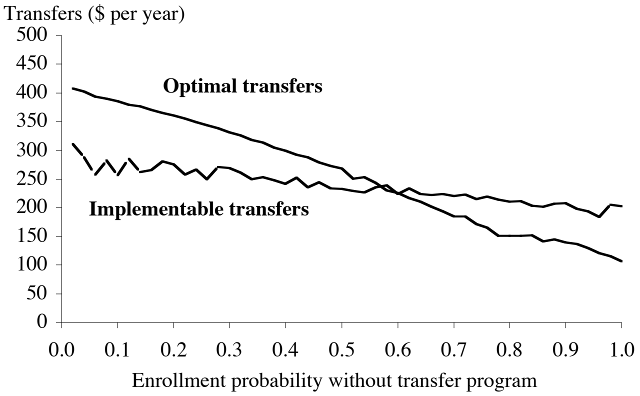


Figure 4. Average transfers in the optimal and implementable schemes

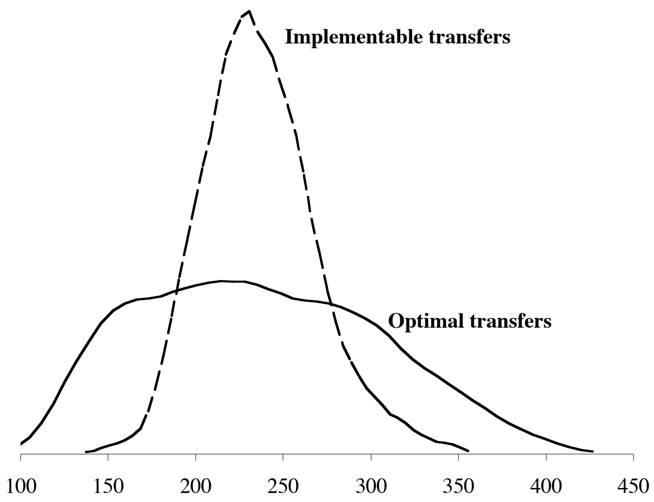
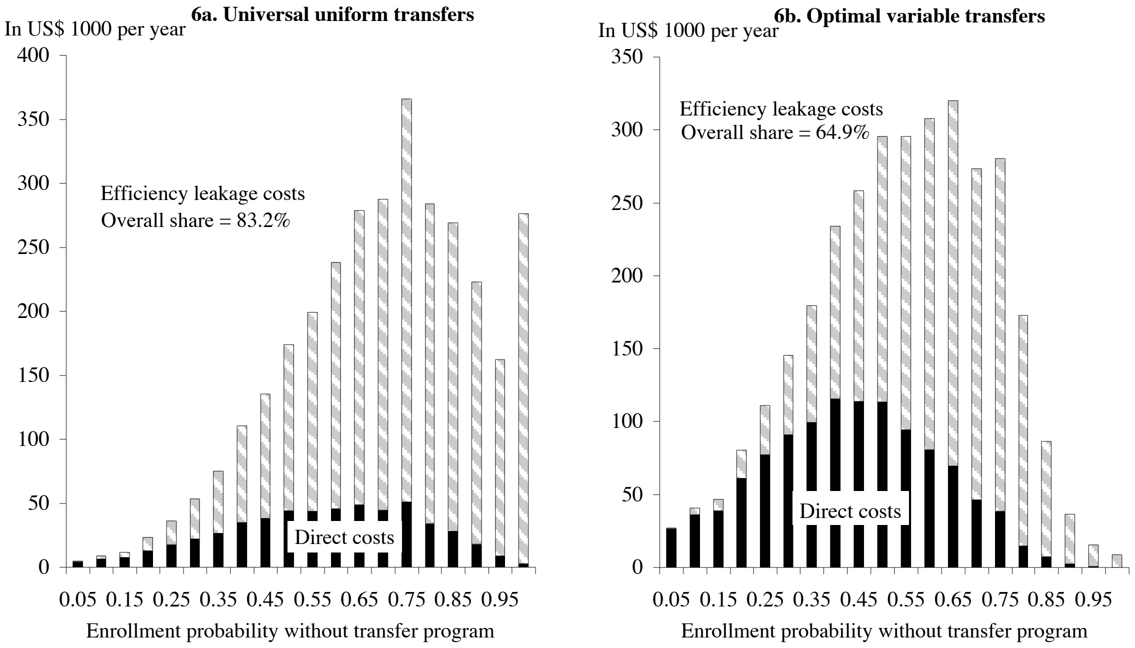


Figure 5. Density functions of transfers in the optimal an implementable schemes



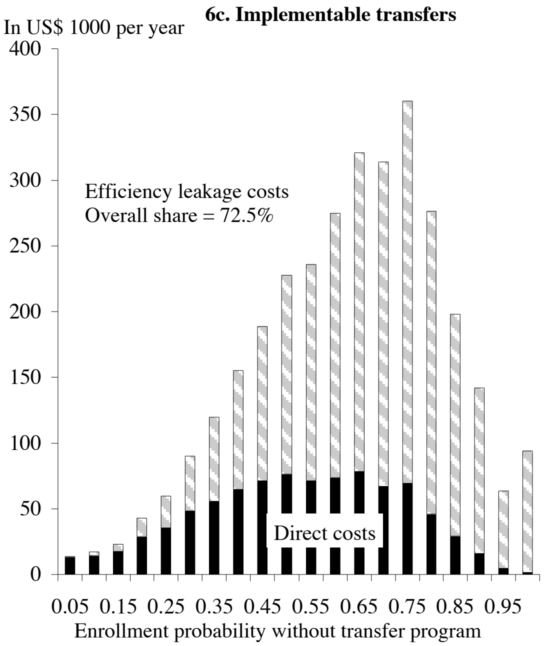


Figure 6. Total direct and leakage costs under different transfer schemes

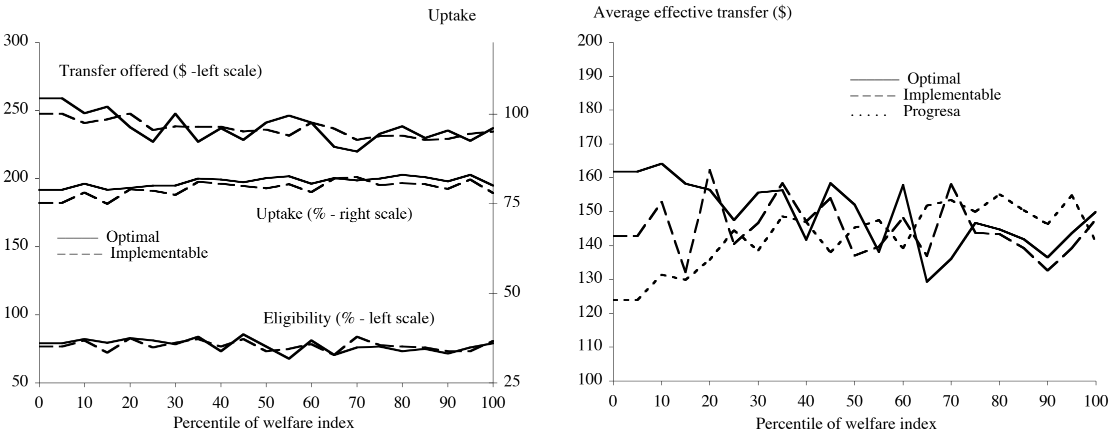


Figure 7. Eligibility and transfer by welfare index